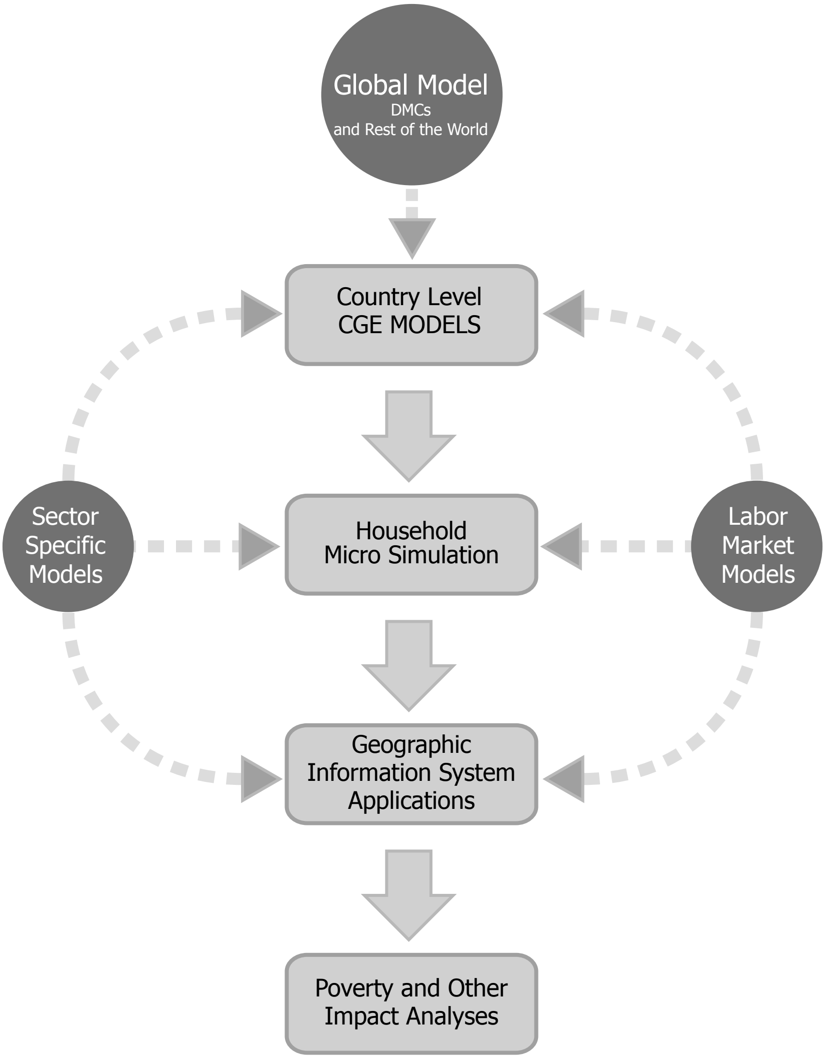
Poverty Impact Analysis
Selected Tools and Applications

Edited by Guntur Sugiyarto



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Foreword

The Asian Development Bank (ADB) formally adopted poverty reduction as its overarching goal in 1999, underlining ADB's systematic approach to poverty reduction by promoting policy reforms, assisting the development of overall physical and institutional capacity, and designing projects and programs to better target poverty. ADB's high level of commitment is also reflected in the increasing number of its pro-poor programs and projects.

In its effort to reduce poverty, ADB also recognizes the importance of remaining accountable to both donors and the public. Development institutions such as ADB should be able to account for how well they are using better project designs to achieve better outcomes, spending resources more efficiently, implementing programs according to plan and learning from their experiences, and examining as well as minimizing any adverse effects of their programs. ADB and other development institutions should be able to answer more specific questions about their programs and projects, such as: whether they produced the intended benefits; whether overall impact, isolated from other possible impacts, was positive; how much of the benefits went to the poor; and what the transmission mechanisms of the effects were.

However, there is still very little known about the actual impact of many programs and projects on the lives of the poor. This knowledge gap exists despite the increasing awareness that good poverty impact analyses (PIAs) will help improve resource allocation–which is especially important for the resource-scarce developing countries. The gap remains partly because it is difficult to conduct a PIA–even if a project specifically targets the poor. Identifying the poor and measuring the actual impact of a project involves technical complexities, and isolating the impact without selection and other biases further add to the difficulty. The overall cost of conducting PIAs can also be seen as anti-poor since the resources needed for them could be used for helping the poor in other ways. Political considerations further complicate the problem and there is also the issue of whether PIA should be done before or after a project. To be effective, however, impact analysis should begin with project design and continue throughout the project cycle.

Regarding methodology, there is an urgent need for better PIA tools. Current methods of measuring poverty impacts by examining the distribution of the net present value of project's benefits that go to the poor, offer only partial impact analysis and ignore the project's economy-wide and other effects. In addition, current practices to derive a baseline and to measure the likely impact on the poor based on household income and expenditure surveys are problematic. Conducting such surveys requires substantial time and resources. Furthermore, the survey's geographical coverage is often too broad and the surveys' timing and main concerns may also be incompatible with the project's purpose. This makes the survey results less useful; and it makes conducting PIA at the project level in a specific location very difficult. PIAs using the existing household survey data may accordingly suffer from misattributions in terms of timing, topical relevance, and geographical coverage. Moreover, as there is no standard approach to conducting PIAs, each PIA must be tailored to a specific project, country, and institutional context. This calls for specific surveys and tools relevant to specific projects or policy interventions.

In response to the situation highlighted above, the Economics and Research Department (ERD) of ADB has developed PIA frameworks through a series of research studies, generating knowledge useful for designing better poverty-reducing programs. The frameworks cover three critical areas for identifying the poor at the household level, over a specified geographical area, and for PIA in an economy-wide context. This special volume is intended to disseminate part of the research outputs to policy makers, project managers, planners, and the general public.

Given the progress reported in this book, the key challenges ahead are to adopt more comprehensive impact analysis by providing more complete and rigorous macro-micro linkages, giving greater consideration to the dynamic aspects of policy interventions and their impacts on the overall economy and targeted groups, and better integrating long-term and inclusive growth in the modeling approach. The modeling tools should also be able to provide scenario and sensitivity analyses for better and more complete information about the overall likely impacts.

It would also be very useful to make the tools more user-friendly and developed in such a way that they can be applied to address different topics, sectors, and countries. As partly demonstrated in the poverty reduction integrated simulation model (PRISM) described in this book, linking various modeling frameworks at global, national, local, sector, household, and individual levels can be done. Therefore, expanding PRISM to include other countries and to link with global and sectoral models would be desirable. Additionally, in each part of this modeling framework, an independent link to a geographic information system (GIS) application can be established for spatial analysis. With this complete modeling framework in place, wide-ranging impact analyses can be conducted in a systematic and comprehensive manner by considering all important coverage levels–from global to individual.

To better tackle poverty, ADB needs to learn from its experiences, make good use of its knowledge of best practices, and build from its successes. The right information from PIA can be used to redesign, improve, or even eliminate programs which are poorly designed and would not reach their intended beneficiaries–or those that are wasteful. As other researchers, such as Judy Baker (2000) and Martin Ravallion (2005), have likewise pointed out, the knowledge gained from impact evaluation will also provide critical inputs to the appropriate design of future programs and projects. Governments and donor agencies therefore need to learn from PIA to enable them to identify the kinds of policies and projects that are most likely to succeed, including factors that contribute to that success. The research discussed in this book is a small step in this direction.

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November 2007

Preface

Poverty is a deprivation of minimum essentials and opportunities to which every human being is entitled. ADB views poverty as an unacceptable human condition that can and must be eliminated by public policy and action (ADB 1999). Fighting poverty has therefore become the most urgent challenge–it is also a daunting challenge since poverty remains a global problem. Fortunately, various levels of stakeholders are evidently concerned about poverty reduction, making it the ultimate goal of many institutions, including ADB. This concern has also made considerations on pro-poor and inclusive growth, as well as on other poverty-reducing policies, extremely important.

Fueled by mounting pressures on governments and donor agencies to broaden their development strategies and better monitor development contributions and poverty reduction results, PIA have received considerable attention in recent years. The Development Assistance Committee (DAC) of the OECD has, for instance, developed a guideline for harmonizing PIA among donor agencies. The DAC-PIA is a simplified version of the World Bank's Poverty and Social Impact Analysis (PSIA) tool to examine a project in the context of a national poverty reduction strategy, benefits to stakeholders that includes targeted groups, transmission channels of systemic poverty reduction, and project impact contributions on MDGs and other strategic development goals. PSIA is mandatory for all sovereign sector investments financed by ADB and summaries of PSIA results are part of all ADB public sector loan documents (see the respective sections of the ADB poverty website http://www.adb.org/poverty/tools-innovations.asp for more information). Furthermore, ADB also tracks direct and indirect poverty reduction contributions of all its operations through its project classification system.

It is recognized that good PIAs help in better allocating resources that benefit the poor. Many attempts to conduct PIAs have, however, mostly suffered from insuffi cient analytical rigor, faulty questions, and the use of wrong time frames (Baker 2000). As a result, there is no comprehensive PIA that can be used as an example of how it should be conducted.

Progressing from the current situation, ERD has developed five different tools that can be used for PIA. The developments and application examples of the tools are presented in this book, which covers: (i) poverty predictor modeling for identifying the poor at the household level; (ii) poverty mapping for identifying the poor over geographical areas or developing poverty indicators at lower administrative levels that cannot be produced using household surveys; (iii) computable general equilibrium (CGE) modeling for assessing the economy-wide effects and distributional implications of wide-ranging issues; (iv) CGE-microsimulation modeling for further assessing the impacts at the household level; and (v) PRISM for integrating CGE-microsimulation modeling and poverty mapping with a GIS application. The first two tools presented in the first part of the book can be used at the project level while the other three tools presented in the second part are more relevant for PIA at the national or sectoral levels.

The book begins by discussing PIA and the three important aspects of identifying the poor, identifying and measuring the program impacts, and conducting PIA in the CGE modeling framework. The succeeding discussions are organized around the five different tools developed in this study.

Part 1 addresses the issue of identification of the poor at the household level and over a geographical area which is conducted through poverty predictor modeling and poverty mapping, respectively. Chapters 1 through 5 discuss poverty predictor modeling in Indonesia, the People's Republic of China (PRC), and Viet Nam; followed by validations of their poverty predictor variables through pilot surveys. The identification was conducted by estimating the poverty predictor variables based on household survey data, transforming the predictor variables into a short questionnaire, and then pilot-testing the questionnaire on household samples consisting of those selected in the previous national survey and the newly selected households. This was done to cross-check and validate the poverty predictor modeling results. Moreover, different ways of classifying the poor based on independent assessments were also carried out to further validate the poverty predictor variables and provide local poverty assessments. This participatory approach can complement the survey results that may contain errors due to respondents' memory recall and other sampling and nonsampling errors. Chapter 6 discusses poverty mapping in Indonesia and a GIS application based on the results. It highlights poverty mapping's usefulness in generating reliable poverty estimates at the district level, which otherwise cannot be estimated from the existing household survey due to its limited sample size and coverage area. The poverty indicators are then presented in dynamic maps using a "traffic-light" classification system and interactively linked with other variables in a GIS application of a poverty-reduction information system for monitoring and analysis (PRISMA). Other poverty-related variables used include access to safe water, education, health, and so on. Accordingly, the interactive and dynamic maps of poverty indicators can be overlaid with the graphs of other poverty-related variables to examine their spatial association.

Part 2 summarizes case studies of developing and applying CGE modeling framework for poverty impact analysis. Chapter 7 and 8 discuss the developments and applications of individual country CGE models to examine the poverty effects of trade liberalization in Indonesia and infrastructure development in the PRC. The models were developed specifically for each country to represent the main feature of the economy with some important characteristics such as an open economy with foreign trade and international capital transactions, multiple sectors and factors, and relatively disaggregated household groups. Chapter 9 presents a case study of developing and using CGE-microsimulation to assess economic and poverty impacts on trade liberalization in Indonesia. The simulations are consistent with those in the CGE paper discussed in Chapter 7 to highlight the different results between CGE and CGE-microsimulation models. In the latter for instance, poverty impact can be measured at the household level so that the commonly used Foster-Greer-Thorbecke (FGT) poverty indicators can be calculated. Chapter 10 demonstrates how PIA is conducted in the integrated simulation approach by using PRISM. Trade liberalization effects on the Philippine economy are addressed by showing how further trade reform will benefit the economy and the poor.

The final section summarizes the main findings and their policy implications. Key challenges for the future are also highlighted. More detailed suggestions on making a comprehensive PIA an integral part of the evaluation system are provided, including the need to use some sensitivity analyses at the entry, monitoring, and assessment stages.

The book is written for at least four different groups of audiences. Firstly, it is for policy makers and planners, who decide how PIA should be conducted and, more importantly, how public resources should be allocated across competing needs. Secondly, it is intended for project managers or project economists, who can use PIA to critically improve their current and future projects' performance. Thirdly, it is for PIA practitioners, who are directly responsible for the development and applications of poverty impact evaluation tools. Lastly, it can be useful for researchers working in the area of impact analysis and other interested parties that could use the information in their various endeavors to help reduce poverty.

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Abbreviations

ADB	–	Asian Development Bank
BPS	–	Central Board of Statistics (*Badan Pusat Statistik*)
CGE	–	computable general equilibrium
DDA	–	Doha Development Agenda
ERD	–	Economics and Research Department
FGT	–	Foster-Greer-Thorbecke
GDP	–	gross domestic product
GIS	–	geographic information system
HCR	–	headcount ratio
NBS	–	National Bureau of Statistics
NCR	–	National Capital Region
PIA	–	poverty impact analysis (or assessment)
PCA	–	principle components analysis
Podes	–	village census (*Potensi Desa*)
PPM	–	poverty predictor modeling
PRC	–	People's Republic of China
PRISM	–	poverty reduction integrated simulation model
PRISMA	–	poverty-related information system for monitoring and analysis
RETA	–	regional technical assistance
RHG	–	representative household group
ROW	–	rest of the world
RSO	–	Rural Survey Organization
SAM	–	social accounting matrix
SP	–	population census (*Sensus Penduduk*)
SMERU	–	Social Monitoring and Early Response Unit
SUSENAS	–	National Socioeconomic Survey (*Survey Sosial Ekonomi Nasional*)
TRP	–	tariff reform program
VIF	–	variance inflation factor
VHLSS	–	Vietnam Household Living Standard Survey
VLSS	–	Vietnam Living Standard Survey
WTO	–	World Trade Organization

INTRODUCTION

Poverty Impact Analysis: Approaches and Methods

Introduction

Background

At the start of this century, poverty remains a global problem of huge proportions. Of the world's 6.0 billion people, 2.8 billion live on less than $2 a day and 1.2 billion on less than $1 a day (World Bank 2000). The latest poverty estimates show an improvement, but the challenge to further reduce poverty remains daunting. In the Asia and Pacific region, for instance, about 1.9 billion people still live on less than $2 a day, and over 620 million survive on less than even $1 a day. This condition is unacceptable and therefore fighting poverty is the most urgent challenge (ADB 2006b). The good news is that most of the Asian Development Bank's (ADB's) developing member countries (DMCs) are on track to achieve the Millennium Development Goal (MDG) No. 1: Halving poverty by 2015 (ADB 2005a). This, however, means that the poverty rate for the DMCs in 2015 would still be around 17 percent, as the starting point of their poverty rate in 1990 was about 34 percent.

In order to reduce poverty and achieve maximum benefit for the poor, there must be global actions by international communities to complement similar actions by countries and local communities. Fortunately, concerns over poverty reduction are evident among various stakeholders at all levels. At the global level, this is reflected by worldwide acceptance of the human development paradigm, in which people are at the center of development, bringing about development of the people, by the people, and for the people.[1] This position is further strengthened by national and international commitments of countries to achieve the MDGs.[2]

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1 The United Nations Development Program (UNDP) launched the Human Development Report in 1990 with the single goal of putting people back at the center of the development process in terms of economic debate, policy, and advocacy. The goal was both massive and simple, with far-ranging implications—going beyond income to assess the level of people's long-term well-being.

2 The United Nations (UN), in its Millennium Summit in September 2000, unanimously adopted the MDGs that enshrine poverty reduction as the overarching objective of development. There are altogether eight MDGs, namely: eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality, reduce child mortality, improve maternal health, combat HIV/AIDS and malaria, provide access to safe water, and ensure environmental sustainability (Detailed information about the MDGs can be found on http://mdgs.un.org/unsd/mdg/Data.aspx).

Poverty reduction has become the ultimate goal of many institutions, including ADB, that make considerations on pro-poor growth, growth inclusiveness, and other pro-poor policies very important in their operations. The overall policy paradigm favored by international agencies is pro-poor growth combined with targeted poverty-focused interventions (Fujimura and Weiss 2000).[3] Multilateral development banks–reflecting a serious commitment–have spent billions of dollars and other resources in their programs and projects[4] for helping the poor. However, not much is known about the actual impact on the poor of these efforts. This information gap is partly due to the lack of good and comprehensive poverty impact evaluations.

ADB's Goal of Poverty Reduction

ADB views poverty as an unacceptable human condition that can and must be eliminated by public policy and action. Poverty is a deprivation of minimum essential assets and opportunities to which every human being is entitled. Everyone should have access to basic education and primary health services. Poor households have the right to sustain themselves by their labor, and be reasonably rewarded, and be afforded some protection from external shocks (ADB 1999).

Beyond income and basic services, individuals and societies are also poor–and tend to remain so–if they are not empowered to participate in making the decisions that shape their lives. Poverty is thus better measured in terms of basic education, health care, nutrition, water and sanitation, in addition to income, employment, and wages. Such measures must also serve as a proxy for other important intangibles such as feelings of powerlessness and lack of freedom to participate (ADB 1999).

In November 1999, poverty reduction was formally adopted as ADB's primary goal. The poverty reduction strategy followed a framework comprising three pillars–pro-poor sustainable economic growth, social development, and good governance. Hence, ADB adopted an approach that aims to systematically reduce poverty through policy reforms, building physical and institutional capacity, and improving the design of projects and programs in targeting poverty more effectively.

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3 Growth is pro-poor when it is labor absorbing and accompanied by policies and programs that mitigate inequalities and facilitate income and employment generation for the poor, particularly women and other traditionally excluded groups (ADB 2004). See also other ADB publications on the pro-poor growth issue.

4 *Programs* and *projects* are used interchangeably in this book to refer an array of activities designed to improve the quality of life in its many aspects.

All ADB loans and technical assistance are expected to contribute to poverty reduction. Each proposal is subjected to an assessment of its poverty impact, and the logical framework that accompanies each proposal will commence with poverty reduction as its ultimate objective. Accordingly, projects or programs may be designed to accelerate pro-poor growth or focus directly on poverty.[5] Figure 1 shows how ADB's operational cycle in reducing poverty would work with poverty impact analysis (PIA) playing an important role in poverty-focused project identification, poverty analysis concept paper, poverty analysis and monitoring progress, and finally on poverty impact. Box 1 provides an example of pro-poor checks for intervention in ADB projects to ensure that the poor are not left behind, while Box 2 summarizes the benchmark criteria for preparing effective pro-poor projects.

In view of ADB's adoption of its poverty reduction strategy, which was further enhanced in 2004, there remains an urgent need for tools that provide mechanisms by which PIA can be conducted. This is at the core of ADB's Operational Cycle, as depicted in Figure 1, in which monitoring progress and impact analysis should be an integral part of each stage of the operational cycle.

Current methodologies to measure poverty impacts by examining net present value (NPV) distribution to the poor of a project's benefits,[6] present only a partial analysis of how interventions affect the poor, ignoring the project's effects on the overall economy and on other aspects of the lives of the poor. The current practices also rely very much on household income and expenditure survey data.[7] This approach can be overly demanding on time

5 Subsequently, ADB took several initiatives, including major revisions in important policies, new operational business processes, and reorganization of its operational structure, to effectively implement the poverty reduction strategy (ADB 2004). The ADB poverty reduction strategy indicates that all public sector loans will aim to reduce poverty, directly or indirectly. The strategy also specifies a target: from 2001 onward, not less than 40 percent of lending volume should be directed at fighting poverty, including core poverty interventions (ADB. 2000. *Loan Classification System: Conforming to the Poverty Reduction Strategy*. Manila).

6 See De Guzman (2005) and ADB 2001a for more details about this issue, especially the discussion on the poverty impact ratio of a project.

7 Household income and expenditure data across countries available for PIA include data from living standards measurement surveys, household income and expenditure surveys, household expenditure surveys, socioeconomic surveys, and rapid monitoring surveys.

Box 1 Propoor Checks for Asian Development Bank's Projects

In line with ADB's thrust to reduce poverty, the project officers should ensure that project-induced growth effects lead to poverty reduction in two contexts: macroeconomic, public expenditure, and governance and at geographical disaggregated levels.

The macroeconomic context includes controlled inflation and fiscal stabilization that could have an adverse impact on the poor. Public services are often translated into a measure of welfare as an approximation of true benefit incidence. Tax incidence analysis can be applied in combination with public spending analysis. For the institutional or governance context, governance indicators can be divided into neutral and proactive indicators. Neutral indicators include accountability and credibility of the institutions in terms of finances, efficiency, and anticorruption framework and enforcement, while proactive indicators include asset distribution, voice of the poor, social and environmental protection, social safety net systems, etc.

In the context of geographical disaggregated levels, the project analyst is responsible for collecting and complementing information specific to local situations and examining whether the project environment is conducive to facilitating the poor's access to services generated by the project.

Source: ADB 2001a.

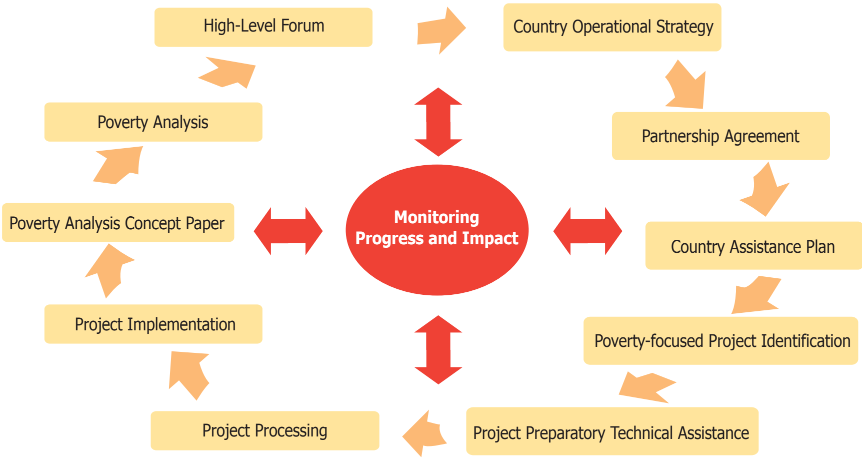
and resources. Household surveys' geographical coverage is usually so broad as to make project PIA in a specific location difficult and impractical.[8]

Furthermore, the timing of household surveys may not be in line with program implementation. Most household surveys in developing countries are not conducted annually and their main purpose is not necessarily to analyze poverty-related issues. Accordingly, the surveys may not have the necessary detailed information on income and expenditure. In addition, the surveys may have specific topics or modules such as health, education, and others that could make them less useful for PIA, especially if the modules are not related directly to the project's concerns. As a result, the timing, topics, and coverage of the household surveys may not be directly related to PIA.

In addition, as there is no standard method for assessing impact, each assessment has to be specifically designed for each project, country, institution, or stakeholder group. This situation requires using a survey and tool designed specifically for assessing a particular project or policy intervention.

8 Household surveys in Indonesia, for instance, are designed to generate reliable poverty indicators at the provincial level. In some cases, the indicators can still be estimated with a high degree of confidence at district level in Java and other populated islands. The similar geographical representation is also observed in the Philippines and other developing countries. Accordingly, any effort to generate poverty indicators for smaller areas using the existing household surveys must involve adding a substantial number of household samples at the start of the data-collection stage.

Figure 1 **Operational Cycle of the Asian Development Bank**



Source: ADB 1999.

Motivation for and Impediments to Conducting PIA

PIA[9] has received considerable attention in recent years partly due to the previous experience in pro-poor programs.[10] The interest in PIA has also been fueled by mounting pressure on governments and donor agencies to broaden their development strategies to address issues such as poverty, environmental quality, and the economic, social, and political participation of women in developing countries. Resource constraints have also heightened interest in the use of more cost-effective analysis to help identify the more cost-effective and equitable ways of delivering services to priority target groups, including the poor.

Good PIAs will help multilateral development banks better allocate their resources in the future. This is particularly important for the developing countries, where resources are relatively scarce. Knowledge about project impact is essential and has great bearing on the availability of resources.

9 The terms *poverty impact analysis* and *poverty impact assessment* are used interchangeably in this book. One might argue, however, that poverty impact analysis covers more aspects than poverty impact assessment, which is also quite often considered as more ex post than poverty impact analysis.

10 Empirical evidence shows that the portfolio performance of projects supported by the World Bank from 1981 to 1990, for instance, deteriorated steadily with the share of projects having "major problems" increasing from 11 to 20 percent (World Bank 1991a). Such figures may not even indicate the real size of the problem, as they refer only to project implementation with no account of how well the projects are able to sustain the delivery of services over time or to produce their intended impacts.

Box 2 Benchmark Criteria for Preparing Effective Propoor Projects

The criteria for preparing effective propoor projects can be examined with questions such as whether the project has drawn on evidence about and addressed the causes of poverty, explicitly addressed poverty reduction, been developed to reduce possible adverse impacts on poor people, been aligned with poverty-focused policy reforms and institution building, been a part of integrated project and programs, addressed and assessed the possibility that the project will crowd out other poverty reduction projects, assessed the extent of the situation of the poor in general and that of target groups in particular, and carried out incidence assessments on poverty impact distribution and benefits.

Based on these criteria, the following checklists are recommended to identify weaknesses and shortcomings in the project design:

- The project selection, design, and implementation arrangements should incorporate key social issues and the views of major stakeholders, as determined through a participatory process.
- The project's social impact should be disaggregated by social group, including gender and adequate provision should be made to mitigate any adverse impacts.
- The project should be consistent with the ADB's poverty reduction strategy and its design should ensure that the project benefits the target beneficiaries.
- The project's direct and indirect impacts on the poor should be clearly articulated and quantified.
- There should be adequate arrangements for monitoring and evaluating social impacts, including poverty impacts that include a baseline survey, clearly specified targets, provision for data collection on outcome indicators, and ex post evaluation of project impact.
- In addition, the project design should comply with ADB policies on indigenous peoples, involuntary resettlement, and cultural property.

Source: Summarized from ADB 2001a.

The poor also benefit from good evaluations, which weed out defective anti-poverty programs and identify the effective ones (Ravallion 2005).

There have been many attempts to conduct PIAs but they mostly suffer from insufficient analytical rigor, faulty questions, and use of wrong time frames (Baker 2000). As a result, there is no comprehensive PIA of any project which can be used as an example on how PIAs should be conducted. The case studies of PIAs included in Baker (2000), for instance, were selected not for their exemplary features but as an attempt to cover a broad mix of country settings, types of projects, and evaluation methodologies, from a range of evaluation activities carried out by the World Bank, other donor agencies, research institutions, and private consulting firms.[11]

One main reason for the lack of a comprehensive evaluation–defined here to include cost-benefit, monitoring, process, and impact evaluations–is the difficulty in conducting such evaluation (Baker 2000). This is true even for a project specifically designed to assist the poor.[12] Getting the key stakeholders to agree to actually implement the comprehensive evaluation is the first problem. Second, PIA is technically very complex and difficult, especially in identifying a project's beneficiaries and actual impact. This is compounded by the more difficult tasks of isolating and then measuring the actual impact, which should be attributed only to the project and free from biases due to "selection" of participants or other factors. The biases may arise from observable or unobservable factors, spillover effects, and data and measurements (Ravallion 2005).

There are also other major issues contributing to the difficulties in conducting PIAs such as the following:

- PIAs can be very costly and time consuming, which may not be consistent with the main purpose of the project since the money spent for conducting PIAs could be used to further help the poor.
- PIA results can be politically sensitive, especially if the results turn out to be negative.
- In developing a comparison group necessary for PIA, there might be compelling ethical objections for excluding an equally needy group such as the elderly, malnourished, unemployed, and uneducated from participating in a program under evaluation.
- There is always a timing issue–whether PIA should be conducted ex ante, ex post, or at both junctures.
- Regarding methodology, there is the difficult task of answering questions of "with" and "without" as well as "before" and "after" the project. This is essentially providing the project's counterfactual, which is intrinsically unobserved since it is physically impossible to observe someone in two conditions at the same time, i.e., participating and not participating in the program (Ravallion 2005). In addition, there is no single method that dominates others, thus, anyone designing policy-

11 The Organisation for Economic Co-operation and Development (OECD, 1986) has estimated that an average donor agency conducts 10 to 30 evaluation activities a year, while the United States Agency for International Development (USAID) and the World Bank conduct as many as 250 (Baum and Tolbert 1985). The OECD study also concluded that interest in evaluation generally tends to be stronger among those allocating resources than among those using them.

12 As a result, many have given up doing the ex ante impact evaluation and concentrate instead on improving the quality of project at entry (Gajewski and Luppino 2004).

relevant evaluations should be open minded about methodology, including the use of quantitative or qualitative methods, or both (Baker 2000, Ravallion 2005).
- Whatever approach and methodology are used, there is an issue on the availability and quality of data necessary for conducting a PIA.

Key Issues in Poverty Impact Analysis

The first thing to note about PIA is that there is no standard way of doing it. The design of each PIA should be unique, depending on many factors such as the main purpose of the project or program, data availability, local capacity, budget constraints, and time frame. PIA should be made part of a comprehensive evaluation, which includes cost-benefit, monitoring, process, and impact evaluations (Baker 2000, Bourguignon and Pereira da Silva 2003a). PIA can also be a part of other impact assessments such as economic and environmental assessments. PIA should occur at strategic junctures of and follow closely a program's life cycle–ex ante, mid-term, terminal, and ex post. Therefore, PIA should ideally begin at the earliest stage of project design and continue through the disbursement cycle and beyond (JICA 2004). The best ex post evaluations, for instance, should be designed ex ante, often side by side with program implementation (Ravallion 2005).

ADB's *Guidelines for the Economic Analysis of Projects* (ADB 1997) states that the main purpose of PIA is to bring about better allocation of resources. In addition, PIA should include sensitivity and risk analyses to enhance project quality at entry. In this context, learning from PIAs of previous projects to design better projects in the future can also be seen as enhancing project quality at entry. ADB also recognizes the difficulties in conducting PIA, especially given the variety of projects across sectors with their own characteristics. This is highlighted further in Box 3.

PIA is used essentially to examine whether a project or program has generated the intended effects on the targeted low-income group. For a pro-poor project, this means answering the question of whether the project really benefits the poor. The poor may be characterized by low skill, illiteracy, unemployment, working in low-productivity sectors, located in underdeveloped regions, or belonging to certain ethnic groups. In the case of complex targets, there would be primary, secondary, and other targets. This is consistent with ADB's view on poverty as a multidimensional issue including, for instance, lacking access to employment, health care, and education. Accordingly, poverty analysis cannot be conducted in isolation but it should include many aspects as summarized in Box 4.

Box 3 **Variety of Projects and Difficulties in Conducting Poverty Impact Analysis**

One obvious limitation in the distribution analysis of PIA is that it cannot cover all types of projects. The use of distribution and poverty analysis for projects in sectors such as power, water, and irrigation, where full benefit-cost analyses are regularly applied, may be a natural extension of the current work.

But economic internal rate of returns (EIRR) are rarely calculated in social sectors such as health and primary education. Such projects can be subject to cost-effectiveness analysis. Alternative criteria can also be applied to poverty-focused projects where monetary estimation of benefits is not possible and beneficiaries must be measured in terms, of number of poor patients or poor pupils, for instance.

Between these edges, there will be a range of intermediate situations where there may be technical difficulties in conducting distribution and poverty analysis. Projects for which the methodologies are very difficult to apply include institution building and private sector development. This is due to the difficulty in relating investment expenditures with tangible outputs and income flows.

Source: Summarized from ADB 2001a.

Box 4 **Poverty Analysis Coverage**

In the poverty analysis of a country, the following information should be covered:

- Macroeconomic stability and its trend, including inflation and exchange rates and their impact on the poor in urban and rural settings.
- Asset distribution, including landownership with geographical breakdown and its implication on the poor's capability to participate in market activities.
- Labor market condition, such as market competitiveness and the location and density of labor-intensive industries and small and medium enterprises and their implications for employment of the poor.
- Public spending and tax incidence, preferably with geographical breakdown.
- Government antipoverty programs, including their magnitude, location, sectors, and types.
- Social safety nets for the poor, preferably with geographical breakdown.
- Effectiveness of the regulatory regimes and implications on the poor, such as the existence and enforcement status of anticorruption laws.
- Indicators of risk-coping capacity of the poor and social indicators, such as education levels and health status, preferably with geographical breakdown.
- Support of civil society and the private sector, including the existence of nongovernment and community-based organizations that represent and promote the interests of the poor, with geographical breakdown.
- Ongoing and planned external assistance, including the existence of targeted poverty reduction initiatives, preferably with geographical breakdown.

Source: Summarized from ADB 2001a.

PIA results also serve as instruments for public accountability to the donor community and general public about the relevance and management of the project or program. A systematic and comprehensive PIA can ensure that benefits of the programs reach the right beneficiaries.

The implementation of PIA should start by identifying the main objective of the project, followed by identification of the intended beneficiaries. The next steps are measuring the project's impact, to ensure that the impact is due to the project only, and that the measurement used is the right one. These are key issues that must be taken into account in conducting PIA.

Identification and Measurement of Impact

After identifying the project's beneficiaries (i.e., the poor), the next crucial step in conducting PIA is how to identify and measure the impact. Some of the issues related to this step are discussed below.

Impact is different from output or outcome. A project's impact is a consequence of its output and outcome. PIA studies the impact of an intervention on the final welfare outcomes for the target groups, rather than the project outputs or project implementation process. More generally, project impact evaluation establishes whether the intervention had a welfare effect on individuals, households, and communities, and whether the effect can be attributed to the project. Figure 2 is a simplified framework of the project implementation process, emphasizing how impact is different and goes beyond output. The misunderstanding over what constitutes impact results in the fact that many impact analyses actually examine project outputs or outcomes. In some cases, the impact analyses even refer to input, such as measuring the number of a project's participants and beneficiaries. Figure 3 shows a sample framework of impact analysis on the effect of education on women. The difference between impact and other project components may be deduced from the figure.

Identifying, isolating, and measuring impact are difficult tasks. Project impact could depend greatly on the project purpose and only effects that result from project implementation should be measured in a PIA. The project's impact should not be mixed with the impact of other interventions or factors. In some cases, the project impact simply cannot be measured quantitatively. The social impact of education on women identified in Figure 3, for instance, cannot be completely measured. Impacts on attitude and control over own life, for instance, cannot be fully represented by quantitative indicators.

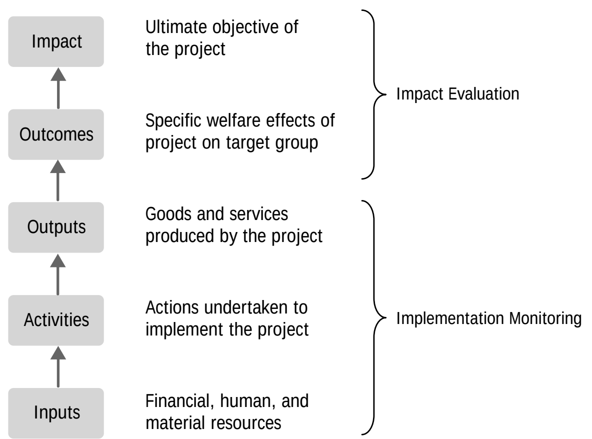
Some benefits cannot be represented as monetary units. The standard procedure of measuring poverty impact by estimating project benefits that accrue to the poor suggested by cost-benefit analysis (i.e., estimating the NPV of the benefits that go to the poor) may not reflect the actual impact of the project on the poor. Box 5 summarizes a distributional analysis of project impact which is calculated and presented as poverty impact ratio.

The transmission mechanism is not always straightforward. The transmission mechanism of impact, i.e., how project benefits reach the beneficiaries, can take different forms that can be very difficult to trace. There are direct and indirect effects, as well as multi-round effects or even general equilibrium effects of the project that should be taken into account in measuring the overall project impact.

Project impacts can materialize in the short or long term. It is important that the impacts should be examined in the right time frame. The time frame used for measuring a food subsidy program to boost school attendance of targeted pupils, for instance, should be different from the time frame used for measuring programs with more long-term impacts, such as training and other employment-generation programs for the labor force.

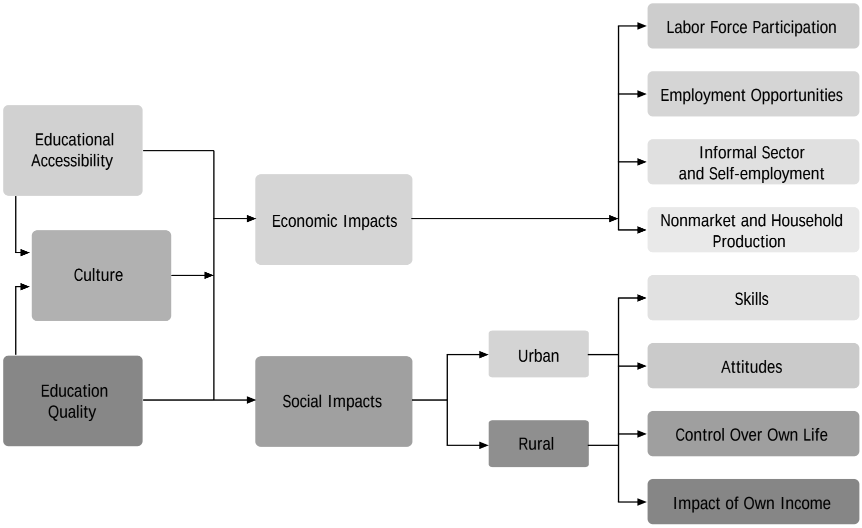
Timing is always an issue in conducting PIA. At what stage the impact analysis should be conducted–either ex ante or ex post, or both–needs to be determined. As mentioned before, a good PIA should consider the project life cycle, following closely its different stages, i.e., ex ante, mid-term, terminal, and post evaluations (JICA 2004).

Figure 2 **Simplified Model of Project Monitoring and the Evaluation Framework Process**



Source: Nguyen and Bloom 2006.

Figure 3 **Sample Impact Analysis Framework**



Note: This is a framework for the analysis of the impacts of education on women.
Source: Valadez and Bamberger 1994.

Methodology for Conducting Poverty Impact Analysis

The choice of methodology used in PIA is not straightforward because the methods are not mutually exclusive. There is always a trade-off for each method selected. In addition, no method is perfect and no single method dominates, making a triangulation of methods a good option. In general, the methods available can be classified into quantitative and qualitative methods.

Quantitative Methods. Quantitative methods are analytically more thorough than qualitative methods and can facilitate project impact comparison. Theoretically, the most accurate quantitative method is the experimental design, in which the program beneficiaries of a concerned project are randomly assessed. Therefore, the design can answer questions of impact with and without the intervention, as well as impact before and after the project. The experimental designs are considered the optimum approach to estimating project impact, providing the most robust of the evaluation methodologies. There may, however, be some practical objections to their implementations as summarized in Box 6.

In practice, the experimental designs are conducted by randomly allocating the intervention among eligible beneficiaries such that the assignment

Box 5 Steps to Conduct a Distributional Analysis of a Project: Calculating the Poverty Impact Ratio

In calculating the poverty impact ratio (PIR), the following procedure is suggested:

1. Set out financial data by showing the inflows (revenue and loan receipts) and outflows (investment, operating costs, loan interest and principal repayment, and taxes both on profits and purchased inputs).
2. Discount each annual inflows and outflows to derive present values for each category and a net present value (NPV) (discount rate is normally set at 12 percent). The NPV will be the income change due to the project.
3. Identify the economic value to be used for each project input/output category.

   The ratio between economic value and financial value for actual transaction is the conversion factor (CF) for the items concerned. Normally where CF=1, economic appraisal is in domestic price numeraire. However, if a world price numeraire is required to calculate economic value, all financial values from steps 1 and 2 must be converted to world prices by using the standard conversion factor.
4. Express all project items in economic terms. This can be done by applying CF to revalue the financial data from step 1.
5. Allocate any difference between financial and economic values to particular groups to get the net benefit generated by the project. The net benefits to different groups must add up to the economic NPV of the project, since this measures the total net benefits of the project. This can be seen as an identity: Economic NPV= Financial NPV+(Economic NPV-Financial NPV).
6. In analyzing poverty impact, estimate the net benefits for each group affected by the project that belong to the poor category. Groups vary according to projects but typically include consumers, workers, producers, government, and the rest of the economy.

   For the government, the counterfactual is estimated by calculating what proportion of government expenditure diverted from other uses by the project under consideration would have otherwise benefited the poor. Similarly, if a project generates government income, a proportion will benefit the poor—indirectly caused by the project.
7. Finally, add all net benefits going to the poor and divide by the total net benefits (economic NPV). This is the PIR.

Caution on the Interpretation of PIR

- PIR is not a summary indicator for PIA. It is a proportion of NPV accruing to the poor against the total project NPV. PIR does not inform poverty impact ranking or efficiency of poverty reduction among alternative projects designs.
- A project should maximize NPV going to the poor (absolute poverty impact) or the NPV going to the project cost (efficiency of poverty impact) not PIR.
- While PIR is superior to headcount, PIR is usually sensitive to assumptions which are uncertain. Sensitivity tests are therefore recommended with respect to uncertain parameters.

Source: Summarized from ADB 2001a.

Box 6 **Implementing Experimental Designs: Some Challenges**

Even though there is a little doubt that experimental design will generate the most plausible results of impact analysis, its implementation could give rise to some problems such as:

- It could be unethical, owing to the denial of program benefits or services to otherwise eligible members of the population for the sake of the study;
- It could be politically or even socially difficult to provide an intervention to one group and not to others;
- It could be technically difficult to identify who should be in the nontreatment (control) group. If the scope of the programs, projects, and policy changes are too broad, this may mean that there will be no control group;
- Individuals in the control group may change their identifying characteristics during the experiment that could invalidate or contaminate the assessment results;
- It may be difficult to ensure that the assignment of the project participants is truly random; and
- It can be expensive and time consuming in certain situations, particularly in data collection.

Source: Summarized from Baker 2000, Bourguignon and Pereira da Silva 2003, Ravallion 2005, and JICA 2004.

process will create comparable groups: the treatment and control groups. Both groups are statistically equivalent to one another and, theoretically, the control group made through this random assignment serves as a perfect counterfactual to the treatment group, free from selection bias that exists in most other designs. Having control and treatment groups also allows the evaluators to clearly determine the impact on the targeted beneficiaries. The main benefit of using experimental designs is the simplicity in interpreting the results as the program impact can be measured by the difference between the means of the samples of the treatment and control groups.

Other quantitative methods are classified as nonrandomized designs that include matching methods or constructed controls, double difference or difference-in-difference, instrumental variables or statistical control, and reflexive comparison. Detailed information about each method is beyond the scope of this book.

Qualitative Methods. Qualitative and participatory methods can also be used to assess project impact. These techniques often provide critical insights into beneficiaries' perspectives, the value of programs to beneficiaries, the processes that may have affected outcomes, and a deeper interpretation of results observed in quantitative analysis. As there is no constraint on predetermined categories of analysis, qualitative methods permit an in-depth and detailed study of issues.

Qualitative techniques are used with the intention of determining impact by relying on something other than the counterfactual to make a causal inference (Mohr 1995). The focus of this method is on understanding processes, behaviors, and conditions as they are perceived by the individuals or groups being studied (Valadez and Bamberger 1994). For example, qualitative methods and particularly participant observation can provide insight into the ways in which households and local communities perceive a project and how they are affected by it. It should be noted that some qualitative data can also be quantified in a limited manner, enabling the development of different measures. Moreover, the validity and reliability of the qualitative method depend on the methodological skill, sensitivity, and training of the evaluator.

According to Patton (1984), a typical qualitative evaluation will provide:

- a detailed description of the program implementation;
- an analysis of major program processes;
- descriptions of different types of participants and participations;
- descriptions of how the programs have affected participants;
- observed changes (or lack of them), outcomes, and impacts; and
- an analysis of program strengths and weaknesses as viewed by different stakeholders of the project.

Different methods require different data and information that may depend on answers to the questions: Who will need the information and use the evaluation findings? What kind of information is needed? How is the information going to be used and for what purpose is the evaluation conducted? When is the information needed? What are the resources available for the evaluation?

Recent developments in evaluation have led to an increase in the use of multiple methods, including combinations of qualitative and quantitative approaches to ensure robustness and to provide for contingencies in implementation. A qualitative method, for instance, can be incorporated in a quantitative approach to allow for the triangulation of findings.

Counterfactual and Non-Counterfactual Methods of PIA

Another way of looking at PIA is that it can be done using counterfactual or non-counterfactual methods but the non-counterfactual method may systematically contain bias. The counterfactual approach removes bias by providing the appropriate comparison. Therefore, to ensure methodological rigor, PIA must be able to estimate or construct the counterfactual to provide the condition of what would have happened had the project never taken place. Box 7 summarizes how to minimize selection and other biases in PIA.

Box 7 **Minimizing Selection and Other Biases in Poverty Impact Analysis**

A major concern in PIA is how to measure project impact correctly. This process includes properly identifying the beneficiaries and measuring the impact. The impact measurement must be obtained through methods that eliminate or minimize bias.

Bias is essentially the difference between the actual and the expected or observed impact. The program effect is the difference between outcomes of with and without the project. A failure to provide a counterfactual, i.e., the condition without the project, will make the PIA biased. Bias can also originate from measurement and research design issues. Design issues include selection bias, which literally means errors because of bias in selecting the beneficiaries. Selection bias is due to un-observables, which are either not known by the researcher or are not easily measured. The problem of selection bias arises because of missing data on common factors affecting both participation and outcomes. Other external factors may also produce bias, such as the existence of trends, interfering events, and maturation.

An example of selection bias is shown in figure 2.3 in which project impact on increasing female participation in the labor market is measured. If the model used in the impact assessment uses data on female workers and their wages, the result assessment might be biased. This is because the decision to work among women might not be made randomly. The women's reservation wage might be greater than the wage offered in the market, preventing them from working. This bias can be corrected by introducing some variables that strongly affect the reservation wage but not the outcome of project (the offer wage) such as the number of children at home.

Randomized design may solve the selection bias by basically generating the perfect control group whose access to the program was randomly denied. The random assignment does not actually remove the selection bias but it balances the bias between the participant and nonparticipant groups.

In nonrandomized designs, various statistical techniques can be used to create the representative control group. This includes matching, double differences, and instrumental variables. In principle, these methods try to copy the random design condition by modeling the selection processes to arrive at an unbiased estimate using nonexperimental data. The general idea is to compare program effects on participants and nonparticipants by holding the selection process constant. The validity of these models depends on how well the models are specified.

Source: Summarized from Baker 2000 and Rossi, Lipsey, and Freeman 2004.

To develop a counterfactual, it is necessary to isolate the effects of interventions from other factors. This could be accomplished by using a comparison or control group, i.e., those who do not participate in a program or receive benefits. They are subsequently compared with the treatment group, i.e., those who participate in the program or receive benefits. Randomized or nonrandomized designs can be used to develop the counterfactual which is at the core of evaluation design. As mentioned before, it is difficult to develop a counterfactual, especially in isolating the program impact from the impact of other events. In addition, the counterfactual can be affected by history, selection bias, and other contaminations.

Developing counterfactuals using a quantitative approach of randomized design is best for measuring impacts in scenarios of with and without, before and after, and their combinations. Impact analysis using an economic modeling approach such as a computable general equilibrium (CGE) model can also produce a counterfactual by generating scenarios of impact with and without the policy or project.

Different Measures of Impact

The impact of a project can be measured in different ways. As in conducting PIA, there is no standard way of measuring the impact. To some extent, the measurement of impact depends on the main purpose and characteristics of the project and the target beneficiaries. Moreover, the impact measurement on the poor is not limited to Foster-Greer-Thorbecke (FGT) poverty indicators such as the headcount ratio (HCR), poverty gap index (PGI), and poverty severity index (PSI), but it may reflect a broader concept of poverty measures, including measures such as improvements in education, morbidity, employment, and basic services.

In addition, there could also be non-poverty income measures of benefits obtained by the targeted beneficiaries. The impact of a rural road project, for instance, can be in the form of reducing travel time, transport costs, and other costs. The impact can also be reflected in the growing number or availability of economic facilities that can be accessed by the beneficiaries. The framework for measuring impact of an education project on women shows that the impact can take the form of economic and other social impacts (Figure 3).

Measuring project impact is also different from measuring project results or output, and the impact could be intended or could be by-products. Accordingly, as mentioned before, a project could have main, secondary, and other targets. Furthermore, project impact can be measured in terms of total, average, or marginal, and the effect can be measured at individual, household, or other social group level.

How a project impact is channeled to the beneficiaries–its transformation mechanism–is also an important issue in PIA. Project impact can be channeled through market and nonmarket mechanisms, in formal or informal ways. Labor and factor markets are examples of market channels through which projects can affect employment levels and wages. In commodity markets, changes may be reflected in the fluctuations of supply and demand of products as well as on their prices. Nonmarket channels can be in the form of transfers that affect access to services.

Developing Tools for Poverty Impact Analysis

To address the limitations of current PIA methodologies and related issues described above, the Economics and Research Department (ERD) of ADB developed a new PIA approach by conducting a series of research studies under regional technical assistance (RETA) 6073 for developing tools for assessing the effectiveness of ADB's operations in reducing poverty, and RETA 6042 for poverty mapping in some selected DMCs. The studies could subsequently help ADB better understand the interlinked nature of poverty impacts at macro and household levels; and to be able to conduct PIA with sufficient analytical rigor by examining the general impacts at the macro level and more specific effects at the micro or household level.

The importance of including PIA in project and policy analysis has long been recognized by ADB, as summarized in Box 8. The problems with methodologies, however, remain–especially given the types of questions that must be considered in poverty-reducing projects.

The research for and development of PIA tools and their applications are presented in this book. The tools were developed by maximizing available information from various censuses and surveys. As mentioned before, the availability and quality of data have become one of the main issues in the PIA, especially with regard to the timeliness and appropriateness of the geographical aggregation. On the other hand, there is also a concern that the existing impact assessments have not been maximizing the existing data available in each country (ADB 2001a). The method currently in use of examining the distribution of NPV benefits, for instance, only needs limited data on the share of the poor among the project beneficiaries. Therefore, ADB research discussed in this book answers both concerns by demonstrating that rigorous impact assessment can still be conducted in a second-best situation, where not all desirable data are readily available.

The five different PIA tools developed by ERD and discussed in this book (Figure 4) are:

- poverty predictor modeling (PPM) for identifying the poor at the household level;
- poverty mapping for identifying the poor over geographical areas or developing poverty indicators at lower-level administrative regions that cannot be produced using household survey data;

Box 8 **Poverty Impact Analysis for Propoor Projects in the Asian Development Bank**

The ADB, as early as the 1970s, recognized the importance of including beneficiary identification and distribution impact analysis in project analysis (ADB 1978). Poverty intervention projects are subjected to specific analysis of poor beneficiaries, in addition to the standard criteria using economic internal rate of return or net present value . Ideally, a consistent yardstick could be applied to rank all interventions by using a weighting system, but the methodological problems fall short of this theoretical ideal. Due to the diverse nature of poverty interventions, efficiency-based analysis is the common practice in standardized PIA.

Economic analysis uses a money-metric measure, calculating project effects of economic benefits and costs in monetary units. Hence, poverty can be defined as income or consumption as opposed to headcounts. For ADB appraisals, the poverty line should be the national poverty line agreed upon by ADB and the developing member country concerned. However, if household surveys are not available, proxy indicators that correlate to poverty can be used.

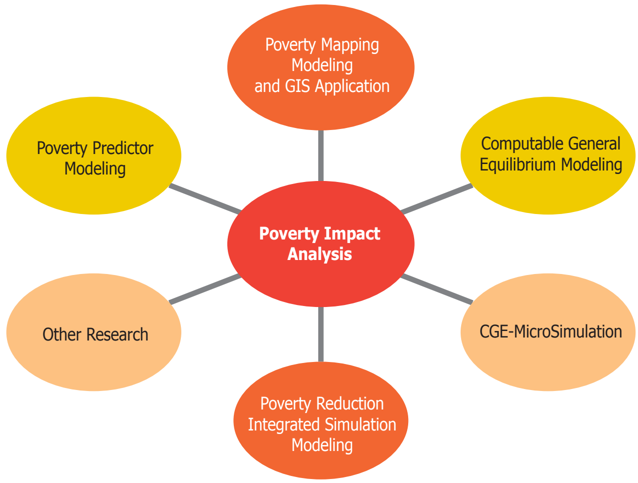
Initial issues that should be considered in the pre-project preparatory stage of poverty intervention include:

- Description of envisaged poverty impact by defining, identifying, and estimating poverty and its correlates. The description also explains the mechanism through which the poor are affected, i.e., as consumers through lower prices, nonpaying users, workers through new jobs, and producers using services of the project as inputs.
- Explanation of critical assumptions required to conduct PIA (e.g., policies for targeting, uptake by the poor, willingness to pay by the poor, financial sustainability of project).
- Explanation of the risks involved in achieving poverty objectives, such as benefit leakages to nonpoor, financial difficulties, and available measurements.
- Detailed socioeconomic assessment and questions on poverty impact.

Source: Summarized from ADB 2001a.

- CGE modeling for assessing the economy-wide effects and distributional implications of wide-ranging issues on the economy with representative household groups (RHGs);
- CGE-microsimulation modeling for conducting assessments such as those in CGE modeling but with a complete household data set instead; and
- the poverty reduction integrated simulation model (PRISM), which is essentially an integration of CGE-microsimulation and poverty mapping with its dynamic, interactive, and user-friendly geographic information system (GIS) application.

Figure 4 **Tools for Poverty Impact Analysis Developed by ADB's Economics and Research Department**



Source: Author's framework.

The first two tools are for identifying the poor, and can be used at the project level while the three other tools are more relevant for PIA at the national or sector level given the data aggregation used in the models. In some cases, the modeling coverage of the three tools can be expanded at the provincial level, if the database is available. The use of the correct tool and appropriate aggregation level is very important since PIA can be done at national, regional, sectoral, and household levels.

The poor can be identified at the household level or over a geographical area. Household poverty indicators can also be used as a basis for estimating poverty indicators of a small geographical area provided the sample size of the household survey used is representative. The development of household poverty indicators is done by implementing PPM, while the area approach is developed through the application of poverty mapping.

Poverty Predictor Modeling

Poverty indicators at national or other aggregated levels available from official publications are often not suitable for PIAs of specific programs, projects, or policies. Therefore, there is a need to develop tools that can be used to generate poverty indicators for a small geographical area relevant to the PIA. In this context, PPM was developed to identify the poor household based solely on predictor variables. PPM is based on a regression analysis of household income and expenditure and other predictor variables that can accurately predict household income and poverty status. The data used are from the national household income and expenditure surveys. The estimated regression coefficients form the basis for indirectly estimating household income and poverty status based solely on the predictor variables.

The predictor variables should be easy to collect and not be computed from a large number of variables nor rely heavily on respondent recall (ADB 2001a). As a result, the predictor variables can be transformed into a short questionnaire, which can be used for developing household poverty indicators that would be very useful for PIA and monitoring. PPM, therefore, provides an efficient way of collecting baseline data and following up with poverty measures necessary for PIA.[13] In this context, PPM can be used for developing a practical alternative to the time-consuming and expensive way of collecting income and expenditure data through a complete household survey.

The implementation of PPM was pilot-tested in the People's Republic of China (PRC), Indonesia, and Viet Nam through small-scale surveys to examine their appropriateness and effectiveness. The number of samples included in the pilot surveys in the three countries were around 600, 1000, and 500 households, respectively. In each country, the household samples consisted of the newly selected households and the households selected in the previous national household survey, the results of which were used in the PPM. This was to ensure that the PPM results were representative and applicable to the new households.

Overall, PPM results can be used for: (i) estimating household poverty indicators; (ii) selecting program participants by using a proxy means test, in which all potential participants are assigned based on a score calculated as a function of observed characteristics (Ravallion 2005); (iii) targeting directly poor households by identifying variables highly correlated to income and expenditure that are easy to measure, not expensive to collect, and less prone to manipulation; and (iv) conducting PIA and monitoring of a project.

The idea of using only poverty predictor variables to derive poverty estimates is actually not new. It had previously been attempted by the World Bank (Africa Region) in collaboration with the United Nations Development Program (UNDP) and the United Nations Children's Fund (UNICEF).

13 This is in line with the need to develop cost-effective and rapid monitoring data–collection instruments, along with recommended administrative procedures for national agency cooperation, sampling methods, standard questionnaires, data processing programs and manuals, and guidelines for statistical analysis and poverty assessment based on non-income data.

This is documented in the Core Welfare Indicators Questionnaire (CWIQ) survey.[14] In this survey, data on income or expenditure were not collected, but variables strongly correlated to poverty. CWIQ survey results can be used to estimate the proportion of the poor within the project-affected area. This information is useful for identifying the likely effects of the project on the poor and other groups. The CWIQ survey is primarily designed for use in a limited geographic area to collect data needed for project monitoring and evaluation.

In addition to PPM, a different way to assess household poverty status is also introduced in the pilot surveys, such as by classifying the households into poor and nonpoor based on assessments made by respondent, enumerator, neighbor, and village chief. Results of these assessments could complement the survey result and be useful as a basis for setting priorities in poverty-targeting programs.

The use of proxy indicators in poverty targeting, however, raises the possibility of misidentifying a poor household as nonpoor (under coverage) or a nonpoor household as poor (leakage). Therefore, further refinement and pilot surveys of the PPM may be necessary before the PPM results are implemented across countries or regions, considering the extent of variations among them. It should be noted here that PPM was developed using national data sets and pilot-tested in some small regions. Therefore, PPM results may not be representative for each region covered in the national survey. Nonetheless, the overall results show the potential use of PPM.

Poverty Mapping and the GIS.

Poverty mapping is used to generate poverty estimates for geographical areas that the household survey cannot produce. The main purpose of poverty mapping is to maximize the rich information of surveys and the wider coverage area of censuses to estimate reliable poverty indicators of more disaggregated areas. The estimation is based on a modeling relationship between poverty indicators and some common variables available in both surveys and censuses. The results are then used to estimate more disaggregated poverty indicators from census data.

14 CWIQ Survey was first conducted in 1997 in Ghana. Its variations have been implemented in many African countries. For details see http://www4.worldbank.org/afr/ poverty/ databank/survnav/default.cfm and http://www.surveynetwork.org/ plannedsurveys/index.php?request=SURVEY_BROWSE.

Poverty mapping technique has been implemented successfully in a number of countries and its application is not limited to poverty but also includes other welfare indicators such as child malnutrition and unemployment.

The application of poverty mapping to Indonesian data results in reliable estimates of district poverty indicators in both urban and rural areas. The results have also been interfaced with a GIS application of the Poverty Reduction Information System for Monitoring and Analysis (PRISMA) to provide an interactive tool that can be used to conduct spatial analysis of poverty in relation to other variables. In the application, poverty indicators are presented as dynamic maps, which can be combined with graphs of other variables to produce graphical representations of the poverty and other variables concerned. The maps use a "traffic-light classification system", in which red, yellow, and green colors represent high, average, and low poverty incidences. Users can change the default cut-off points to reflect their own preferences.

CGE Modeling

ERD has been developing individual country CGE models for the PRC, Indonesia, and the Philippines to examine the economy-wide effects and distributional implications of wide-ranging policies or shocks, or both, on the economy, sectors, factor markets, and income and consumption of RHGs included in the models. These models provide tools for PIA at the macroeconomic, sectoral, and RHG level. Some desirable characteristics such as reasonable disaggregation on sectors, factors, and households useful for poverty and income distributional analysis have already been included in the models. The models were also developed specifically for economies concerned with some common characteristics such as open economies with a possibility of substitution between imported and domestically produced products (Armington specification), and other country-specific characteristics. These features are important for making PIA results more meaningful. The CGE modeling for Indonesia is to address issues related to trade liberalization, while for the PRC, it is for assessing the effects of infrastructure development on poverty reduction. The Philippine CGE is used as a basis for PRISM.

CGE-Microsimulation Modeling

In this modeling approach, the CGE models for the Philippine and Indonesian economies are linked to their corresponding household data sets in a top-down method. In this way, microsimulation at the household level can be conducted as part of the CGE model simulations. In doing so, the poverty and other economic impacts of simulations introduced in the models can be traced at the household level. As a result, the commonly used FGT class of poverty measures such as the HCR, PGI, and PSI can be calculated before and after the simulations along with other results from CGE modeling at the macro, sectoral, foreign sector, and factor market.

The CGE-microsimulation of the Philippine economy was integrated in the PRISM, while the model for Indonesia is used for assessing the economic and poverty effects of trade liberalization, by highlighting the more complete results for poverty indicators from the CGE-microsimulation compared with those of the CGE model.

PRISM: An Integrated Modeling Approach

The latest tool developed by ERD is the PRISM.[15] It is an online modeling tool that combines the CGE-microsimulation model with a poverty-mapping GIS application to view poverty impacts by region. All complexities of the modeling aspects have been interfaced in a user-friendly way, so that users can run simulations and conduct analyses with ease. Users can run various "what if" scenarios of important issues related to taxes, foreign sector economy, factor market, and household income. The impacts can be examined on the macro economy, the external sector, the factor market, household income, and poverty. All simulation results are presented in graphs and tables that can easily be downloaded or copied to other computer program applications. Moreover, the poverty impacts of the simulations are also presented in an interactive GIS map on a dual-window viewing system to enable a poverty impact comparison between two different scenarios.

Other Research

In addition to the series of research studies described above, ERD has also been conducting independent research, outside the technical assistance support, which can also be useful for PIA. These activities include research on applied econometric and CGE models to address various policies relevant to ADB and DMCs. Detailed information about research topics studied by ERD can be found on the ERD website (http://www.adb.org/Economics/default.asp). Moreover, ERD has also systematically developed a survey data depository of DMCs for further research.

15 PRISM is available at the ADB portal http://prism/adb_prism.

Modeling Developments of the Tools

Identification of the Poor

The poor are usually identified using a benchmark level of income or consumption. The most widely used data for measuring poverty in developing countries is household consumption expenditure. The main reason for this is that income data are hard to collect and are not accurate. On the other hand, expenditure data is available for different kinds of products, such as for food and nonfood commodities. Like income, expenditure data is also expressed in monetary units making it very intuitive, easily understood on a comparative scale, and useful in providing a basis for developing poverty indicators.[16]

For calculating poverty indicators using a poverty line, the poverty line is commonly based on certain expenditure equivalents to food, nonfood, and total poverty lines. The HCR, PGI, and PSI indicators can then be calculated based on the poverty line.

Collecting data on household consumption expenditure, however, is not simple. It involves plenty of effort, time, and resources. In addition, it also demands patience and cooperation from respondents. The survey enumeration for each household, for instance, may take as long as a week or more. To record in-house consumption of food during the survey reference period, respondents have to note all kinds of food expenditures by considering the food available at the beginning and at the end of the survey reference period. This is to ensure that the actual consumption by family members inside the house is recorded. Enumerators also need to ensure that food consumed outside the house is included in the enumeration to constitute the total food consumption.

For nonfood commodities, data collection would involve a longer memory recall, ranging from consumption for one month to one year, depending on the type of nonfood products. Memory recall will affect data quality–in general, the longer the recall period the more likely respondents will forget, hence reducing data quality.

Considering the problems and difficulties in conducting household surveys mentioned above, researchers have tried to develop a proxy variable

16 The ratio of expenditures on food to total expenditure, for instance, has been widely used in various demand analysis and is known as the Engle ratio. The ratio can be used as a welfare indicator, showing that the higher the income, the lower the ratio.

for expenditure and, therefore, for poverty. This proxy is based on easy-to-collect variables derived from household characteristics that have proven to significantly influence poverty. The variables may include asset ownership, employment status, and educational level of the household head. The main purpose of using a proxy variable is to get a comparatively cost-effective and easily verifiable variable that ranks households in more or less the same order as they would have been ranked using per capita consumption expenditure.

One of the widely cited studies on estimating household expenditure is a study by Filmer and Pritchett (1998a). The study uses the principal components analysis (PCA) method to calculate long-term household wealth, which is also used as an explanatory variable of school enrolment. Abeyasekera and Ward (2002) and Ward, Owens, and Kahyrara (2002) use the regression method on survey data from Tanzania to predict expenditure and income poverty. A similar study in Africa was reported in Geda et al. (2001), which uses data from Kenya to test the model's performance in predicting welfare by comparing the ranking of households using the new index with the ranking of households based on consumption expenditure.

Identifying the Poor Household

The existing literature suggests that there are at least three methods commonly used to identify the poor household by creating non-income or consumption poverty predictors: PCA, to determine the main components of variables that correlate to poverty; the multiple linear regression (MLR) model, to identify variables that can predict household living standards; and the logistic regression model, to predict the probability of a household being poor or not. These three methods are discussed in turn below, while their applications in selected DMCs are further discussed in Chapter 1.

Method 1: Principal Component Analysis. Data on asset ownership are relatively easy to collect, especially if asset ownership can be observed directly by enumerators. This data can be used as household socioeconomic indicators by ranking households by asset ownership. Unfortunately, asset ownership is usually only available in the form of binary variables, indicating whether a household owns a certain kind of asset or not. For ranking, additional information on the quality or price of each asset owned by the household is necessary purposes. To deal with this problem, the weight of each asset is determined by the data itself using the PCA method.

Intuitively, PCA is a technique for extracting variables that best capture common information from a large number of variables with few orthogonal linear combinations (Filmer and Pritchett 1998b). The technique's application is to reduce the dimensionality (number of variables) of the data by summarizing the most important parts while simultaneously filtering out noise. The first principal component is the linear index of variables with the largest amount of information common to all variables and each succeeding component accounts for as much of the remaining information as possible.

PCA is also a way of identifying patterns in data, and expressing the data in a way that highlights their similarities and differences. Since patterns in data can be hard to find, especially in high-dimension data with no graphical representation, PCA is a powerful tool for analyzing data (Smith 2002). Zeller (2004) also pointed out that the major advantage of PCA is that it does not require a dependent variable such as household's consumption level or poverty status. PCA, however, can only measure relative poverty, whereas absolute poverty should be measured by consumption level.

The PCA index can be calculated as:

$$A_j = f_1 \times \left(a_{j1} - a_1\right) / \left(s_1\right) + \ldots + f_N \times \left(a_{jN} - a_N\right) / \left(s_N\right)$$

Or simply

$$A_j = \sum_{i=1}^{N} \frac{f_i (a_{ji} - a_i)}{s_i} \qquad (1)$$

where

f_i is the 'scoring factor' for the i^{th} asset determined by the method

a_{ji} is the j^{th} household's value for the i^{th} asset and

a_i and s_i are the mean and standard deviation respectively of the i^{th} asset variable over all households.

A_j = An asset index

PCA results rank households' socioeconomic level from the lowest to the highest. To test the reliability of this ranking in predicting poverty, a cut-off point is required to separate the predicted poor from the nonpoor. Since there is no a priori poverty line that can be determined objectively from the PCA results, the cut-off point used can be determined such that the proportion of poor households based on PCA is the same as that based on the actual consumption expenditure.

The asset measurement or asset index is a good proxy for income and consumption (Filmer and Pritchett 1998, Montgomery et al. 1997, Wagstaff, Van Doorslaer, and Paci 1991). The asset index, however, defines poverty purely in economic terms, ignoring other factors such as gender, education, and ethnicity. Moreover, a fixed list of assets is not necessarily adequate to measure wealth in all environments (Falkingham 1999). In response to this limitation, McKinley (1997) has suggested a shift toward measuring capability poverty, which incorporates access to public services, assets, employment, and income poverty. Capability poverty can be measured directly in terms of capabilities themselves, e.g., the level of malnutrition in a population, or indirectly in terms of access to education and public services.

Method 2: Multiple Linear Regression. In this approach, poverty predictors are developed based on the regression of variables that correlate with household consumption. The predictor variables can be obtained by estimating a correlate model of household consumption, where the left-hand side of the equation is per capita consumption and the right-hand side is a set of variables which are expected to be correlated with household consumption. Chapter 1 further discusses this issue in the case study that uses the PPM.

The model takes the form of:

$$y_i = \alpha + \sum_{k=1}^{n} B_k x_{ki} + e_i \qquad (2)$$

where

y_i is the dependent variable

α is the model intercept or constant

β_k are vectors of estimated coefficients

x_{ki} are independent/predictors variables

e_i are random errors or residuals, capturing effects of all variables excluded in the model.

Method 3: Logistic Regression. Logistic regression is similar to multiple regression, however, the dependent variable used is not per capita household consumption but the household poverty status such as poor or not poor which is transformed into variables of *1* and *0*. The dependent variable is, therefore, a binary variable that makes the model a type of limited dependent-variable model of logistic regression (logit model).

Therefore, a logit model is a univariate binary model where the dependent variable *yi* can only be *1* (poor) or *0* (not poor), as a function of a continuous independent variable *xi* such that *Pr (yi=1) =F(xi'b)*. Here, *b* is a parameter to be estimated, and F is the logistic cumulative density function. In the modeling estimation, the probabilistic model (probit model) might be used instead of the logit model. In this case, the logistic cumulative density function for F in the equation above is replaced by the normal cumulative density function.

The logit model takes the form of:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \alpha + \sum_{k=1}^{n} B_k x_{ki} + e_i \qquad (3)$$

where,

$p_i = P(y_i = 1 \mid x_{1i}, x_{2i}, \ldots, x_{xki})$ is the probability of an event given $x_{1i}, x_{2i}, \ldots, x_{ki}$

$\frac{p_i}{1-p_i}$ is the odds of experiencing an event.

α is a constant

β_k is vector of estimated coefficients

x_k are independent variables/predictors

Whether it is best to use multiple regression or a logit or probit model in predicting poverty is always an issue. The logit or probit model may be criticized for the loss of information that occurs in transforming household consumption data into a binary variable of household poverty status of poor and nonpoor. On the other hand, the regression model has also some weaknesses. First, the model does not directly produce a probabilistic statement about household poverty status. Therefore, one cannot directly determine whether the household is poor or not. Second, the model's main assumption is that consumption expenditure is negatively correlated with poverty. Therefore, variables that are positively correlated with consumption are assumed to be automatically negatively correlated with poverty. Some variables, however, may be positively correlated with consumption but only for those who are already above the poverty line. Although positively correlated with welfare in general, such variables will not be correlated with poverty.

Modeling Estimation and Variable Selection. In the estimation, some variables were included in the model to take into account other factors excluded in the model, as well as anomalies in the data set. The variables include control and dummy variables of provincial and community characteristics. To have better estimation results, transformed variables were used, such as the logarithmic form for per capita expenditure. This issue is further discussed in the application of PPM in the PRC.

In the modeling estimation, similar sets of initial variables were used which were then narrowed down using the stepwise method. In this case, a variable is incorporated in the model only if its inclusion significantly adds to the explanatory power of the regression. Therefore, in case the estimation is conducted separately for urban and rural areas, the final sets of predictor variables for each area will differ.

The use of the stepwise method to get a manageable number of poverty predictors may be criticized for lacking economic reasons. This concern, however, may be less relevant since the potential variables were already preselected for their expected role in explaining poverty, such as asset and livestock ownership, as well as characteristics of house building, and household and consumption patterns. In the PRC, community characteristics variables were also included in the model such as village physiognomy, number of natural villages with a road for motor vehicles, and distances to countryside, township, and nearby market.

In conducting PPM in Indonesia, the three methods discussed above were used. Based on the results, the most robust method in determining poverty predictors was selected. It was found that PCA is the least successful at predicting the poor and that results from multiple regression and the logit model were not significantly different. The use of PCA was not further explored in the second pilot country of PRC. Instead, efforts were concentrated on multiple regression and the logit model. Results from PRC further confirm that the use of multiple regression and the logit model will produce similar results in terms of poverty predictor variables generated. The application of PPM in Viet Nam, therefore, involved use of only the multiple regression model.

Furthermore, since it is widely recognized that household welfare conditions in urban and rural areas differ significantly, the modeling estimations in Indonesia and Viet Nam were implemented separately for urban and rural areas. This separate estimation could not be conducted in the PRC since the data available from the National Bureau of Statistics of the PRC was only for rural areas.

Independent Assessment. A more participatory approach (mentioned earlier on p. 21) to assess poverty at the household level was also introduced in the PPM pilot surveys in the PRC, Indonesia, and Viet Nam. In addition to classifying households into poor and nonpoor based on household expenditure data or survey results, the participatory approach involved asking respondents to assess themselves–whether they thought they were poor or not. This self-assessment was then complemented by independent assessments conducted by enumerator, neighbor, and village chief. Results of these assessments could provide a more participative way of classifying the poor. They could be used as complementary indicators to survey results or to provide alternative ways of assessing the poor. The different assessments could also be useful for setting resource allocation priorities in poverty targeting and other programs.

Table 1 summarizes how different assessment approaches have been used in a variety of programs. As can be seen, in addition to relying on the survey result, the assessments of project beneficiaries can include self-assessment,

Table 1 **Applications of Different Poverty Assessment Approaches**

Approach	Tool	Project Description	**Country** / Reference
Self-assessment	Self-selection	TRABAJAR project – employment generation program offering relatively low wages to attract only the poor, unemployed workers as participant	**Argentina** Baker (2000)
Self-assessment	Self-selection	School Autonomy Reforms – schools enter the program through a self-selection process involving a petition from teachers and school directors	**Nicaragua** Baker (2000)
Community assessment	Municipal poverty index	Bolivian Social Investment Fund – developing areas historically neglected by public service networks, i.e., poor communities	**Bolivia** Baker (2000)
Community assessment	Participatory wealth ranking – community defines its own concepts of poverty and relative wealth	Tshomisano Programme of the Small Enterprise Foundation – offering loans to poor areas as determined by villagers themselves	**South Africa** Simanowitz and Nkuna (1998)
Participatory assessment	Participatory poverty assessment – focused on the causes of poverty and how to reduce it from the perspective of citizens and local officials	Results are input into the Social Economic Development Strategy 2001–2010 and the Comprehensive Poverty Reduction and Growth Strategy (CPRGS)	**Viet Nam** Koos and Hoang (2003)
Independent assessment	Project leaders to screen participants/beneficiaries	Microfinance programs – providing loans to households who own less than one-half acre of land Food for Education program – helping households who are landless, female-headed, and low-income and located in economically backward areas with low schooling levels	**Bangladesh** Baker (2000)
Independent assessment	Project leaders to screen participants/beneficiaries	Dropout Intervention Program – for all grade levels in selected schools from a low-income municipality with a high dropout rate and no school feeding program in place	**Philippines** Baker (2000)
Independent assessment	Project leaders to screen participants/beneficiaries	Structural Adjustment Program – helping large-sized, unemployed and low-education households	**Papua New Guinea** Gibson (1998)
Qualitative assessment	Proxy for welfare	CASHPOR House Index – simple, observable, and verifiable information based on external housing conditions assumed to have a strong relationship to poverty	**Bangladesh** Simanowitz, Nkuna, and Kasim (2000)
Surveys	Asset indicators to determine socioeconomic status	Demographic Household Surveys – identifying the poor based on indicators: has electricity, source of drinking water, time to water source, type of toilet facility, main floor material, number of persons per sleeping room, and household possessions	**50 countries in Africa, Asia, the Arab World, Latin America and the former Soviet Union** Falkingham and Namazie (2002)
Surveys	Proxy indicators used for proper targeting of food subsidies	International Food Policy Research Institute – assessing poverty using variables: household demographic make-up, education, utility use, dwelling characteristics, asset ownership, occupation, and location	**Egypt** Ahmed and Bouis (2002)

Source: Authors' compilation.

community assessments, and other independent assessments including assessments from the project leader. A major limitation of this method is that it is based on perception and there is no verification whether the perception is consistent.

In terms of methodology, the different assessments provide practical alternatives to measuring poverty that may be more relevant at the local level and for project purposes, in addition to being more cost-effective and quicker to complete. Recall that the official poverty line used for classifying households into poor and nonpoor is usually based on consumption expenditure at national and provincial levels, with a possibility of estimating separately for urban and rural areas. Given the regional variations of consumption expenditure, the official poverty line estimates may not be representative for some small regions below the provincial level. The poverty line set at the provincial level, for instance, will not be representative for an individual district in the province and even less so for subdistricts and villages.

Identifying the Poor over a Geographical Area. In addition to poverty indicators at the household level, poverty indicators for specific geographical areas may be needed for various reasons. The indicators can be estimated by using poverty mapping (mentioned earlier on p. 23). The method originates from small-area poverty estimation (Ghosh and Rao 1994, Rao 1999) to develop estimators of population parameters for a smaller geographical area. The poverty-mapping technique is used to mine detailed information about living standards from a household income and expenditure survey and to derive estimates from the extensive geographical coverage of a census of disaggregated poverty or other welfare indicators. The rich information of the census is also used to develop poverty indicators for smaller geographical areas and lower administrative boundaries than the household survey can produce. The methodology is described in detail in Elbers, Lanjouw, and Lanjouw (2000, 2002, 2003a, and 2003b).

Poverty mapping applications have been implemented successfully in some countries as summarized in Table 2. The results show that the technique's applications can be expanded to include other welfare indicators such as malnutrition, education, and health. In many cases, the application can produce reliable estimates of the desired indicators at the lowest administrative level, such as communes, villages, or *jamoat* (local self government), while the official poverty and other welfare estimates are mostly reliable only at the provincial level.

Figure 5 is a schematic representation of the poverty-mapping technique. The horizontal line represents the number of variables, in which household surveys contain much more variables than the population census. The vertical

Table 2 **Applications of Poverty Mapping in Some Countries**

Country/Reference	**Focus of Estimation**	**Lowest Disaggregation Level**
Cambodia Fujii (2005)	Children malnutrition indicators	Commune
Ecuador Hentschel et al. (2000)	Basic needs and welfare indicators	Parish (lowest administrative area)
Indonesia Suryahadi and Sumarto (2003a)	Poverty incidence	Village
Madagascar Mistiaen et al. (2002)	Welfare indicators	Commune (lowest administrative area)
Mozambique Simler and Nhate (2003)	Welfare, poverty (incidence and gap), and inequality measures	Village
Philippines World Bank (2005)	Poverty incidence, gap, and severity	Municipality (urban and rural)
South Africa Alderman et al. (2003)	Poverty incidence	Magisterial district and transitional local council
Tajikistan Baschieri and Falkingham (2005)	Poverty incidence based on estimated consumption and food consumption expenditure	Rayon (district) and Jamoat (lowest administrative area)
Viet Nam Minot (1998)	Household characteristics as poverty indicators	District

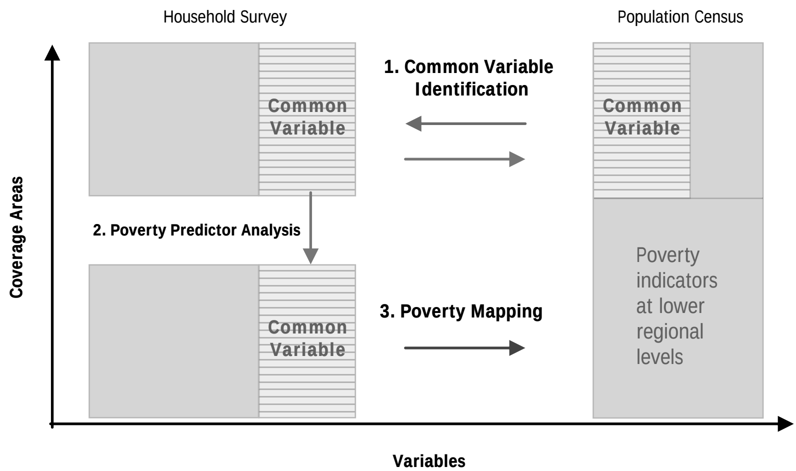
Source: Authors' compilation.

line shows coverage areas, in which the population census covers much more area than household surveys. The rich information collected in the household survey is achieved at the cost of less geographical coverage due to the amount of resources needed to collect data from each household. Thus, household surveys always have limited sample sizes and sample distribution. As a result, many poverty and other welfare indicators derived from household survey data are reliable only at aggregate levels, such as at national and provincial levels with a possibility to disaggregate further into urban and rural areas.

The application of poverty mapping consists of three main steps, i.e., common variable identification, poverty predictor analysis, and actual poverty mapping as shown in Figure 5. In common variable identification, all strictly comparable variables from the household survey and population census are identified. With the household data set, a PPM is then developed using these variables. The results are then mapped using population census data to generate poverty indicators at lower regional levels. Detailed methodology on how to apply the technique is discussed in Chapter 6, which also describes the interactive and user-friendly GIS application developed from the poverty-mapping results. Poverty-mapping technique was implemented in Indonesia by using data sets of the 1999 National Socioeconomic Survey (Susenas), 2000 Population Census, and 2000 Village Census (Podes).

It should be noted, however, that the reliability of the estimates also depends on the sample size and distribution of the household survey used as the basis for the poverty mapping. In general, if the sample size is not representative, the predictability of the poverty predictors will be reduced,

Figure 5 **Poverty Mapping Technique**



Note: Common variable is available from both census and household survey.
Source: Author's framework.

and, therefore, the resulting indicators will be less reliable.[17] In addition, poverty mapping results may also contain some errors such as idiosyncratic, model, and computational errors (see Elbers, Lanjouw, and Lanjouw 2002 for a detailed discussion on this issue).

The term "poverty mapping" has been used interchangeably to refer to three different things: (i) an econometric modeling for estimating poverty indicators for smaller geographical areas, i.e., poverty mapping modeling; (ii) development of maps of existing poverty indicators, i.e., mapping of existing poverty indicators using GIS; and (iii) a combination of (i) and (ii), i.e., estimating the poverty indicators and then generating their GIS maps. The combined approach provides more detailed poverty estimates and GIS maps, which can be used for spatial and distributional analysis. The maps can also be made interactive and dynamic by incorporating some flexibility and user friendliness in the GIS application, as well as by overlaying other socioeconomic and poverty-related indicators to provide more meaningful information.

ERD uses the combined approach, including the development of PRISMA based on the poverty-mapping modeling results. PRISMA interactively combines district poverty indicators of household or population

17 Elbers, Lanjouw, and Lanjouw (2002) and Elbers et al. 2003 show that poverty mapping estimates of welfare measures are quite reliable for an area with populations as small as 15,000 households. The reliability of the poverty-mapping estimates, however, also depends on the sampling design and variations in household characteristics across regions.

with other poverty-related indicators, such as population density, share of agriculture household, average urban score, average distance to the center of the subdistrict, family welfare status, and accesses to communication facilities, television networks, schools (secondary and high school), hospitals, electricity, and safe water facilities. As mentioned earlier (p. 23), the poverty-indicator maps are presented in a "traffic-light" classification system, in which red represents high poverty incidence, yellow stands for average or moderate incidence, and green for low incidence. In addition to the default cut-off points that represent the actual results from poverty mapping, users can change the cut-off points and do spatial analysis using the new levels of poverty incidence. Accordingly, poverty indicators are presented in dynamic maps, which can be combined or overlaid with graphs of other relevant variables. This interactive GIS application, can therefore be used as a tool for, and provides examples of, doing spatial analysis of poverty in a meaningful and interactive way.

Poverty Impact Analysis using CGE Modeling Framework

Overview of the Model. The general equilibrium model has played an important role in theoretical and empirical economic analysis. Several aspects of economics have been enriched and aided by past work on general equilibrium modeling. The value of this modeling approach is not as a universal mathematical structure, but rather as a diagnostic tool. It has been quite fruitful in the intuitive end of science, hypothesis creation, but rather less successful in normal science or in work of hypothesis falsification (Weintraub 1982).

The main characteristics of general equilibrium modeling and analysis are its endogenous price, sectoral consistency, and behavioral specifications for each economic actor included in the model. The model specifications are derived from microeconomics, reflecting its theoretically solid basis. It views the economy as a system of mutually interdependent markets and seeks to analyze the economy from the microeconomic viewpoint of individual markets considered simultaneously. Therefore it is a complete microeconomic model and, simultaneously, a detailed approach to macroeconomics.

Macroeconomics and general equilibrium analysis are likewise intertwined. The interrelationship is even more specific since macroeconomics can be thought of as a "general equilibrium theory with some of the many markets grouped together for expositional clarity and convenience (Weintraub 1974, 15)." Macroeconomics can be categorized into five markets of "consumer goods, investment goods, labor services, financial assets, and money (ibid.)." Therefore, a general equilibrium system may be viewed as a disaggregated macroeconomic model.

The fast development of computer technology, especially in the last three decades, has enabled modelers to find solutions even for very complex and large-scale general equilibrium models. From this fact, the CGE term emerged, replacing the commonly used term of applied (multisectoral) general equilibrium for models. This led to developments and applications of CGE modeling that made it one of the most innovative and flexible advances in applied economics in recent decades. It is an approach that attempts to simulate numerically the general structure of an economy (Greenaway et al. 1993).

The central idea of CGE modeling is to convert the Walrasian general equilibrium structure–formalized by Kenneth Arrow, Gerard Debreu, and others in the 1950s–from an abstract economy into realistic models of actual economies by specifying production and demand functions (including behavioral specifications of economic actors as well as the "accounting" equations for balancing the models) and incorporating data reflective of real economies. These types of models provide an ideal framework for appraising various effects of policy changes that are not well-covered by empirical macro models. The models have been widely applied to a range of policy considerations (Shoven and Whalley 1992). Table 3 summarizes the use of CGE modeling in DMCs for addressing various issues.

CGE's Features and Relevance for PIA. The CGE model is a flexible tool for modeling complicated problems. A carefully designed CGE model will have a transparent and theoretically consistent structure, and will be useful for policy analysis. The great strength of general equilibrium analysis is that it models the whole economy explicitly, albeit under restrictive assumptions. The model, however, also has some shortcomings since it relies heavily on secondary data and offers no formal facility for testing the model's structure. The underlying assumption that the benchmark data should be in equilibrium, since it is a solution to the model, implies the crucial relationship between the quality of data and results from model simulations. This is not to undermine the important role of functional specifications embodied in the model. Box 9 summarizes the problems of using the CGE model for PIA.

There are two approaches to translating the theoretical framework into a numerical model. The Johanson approach uses linear approximation in deriving the counterfactual solution from the initial equilibrium. The second approach derives the solution from the full model. The Johanson approach has been used for developing the ORANI[18] model of the Australian

18 ORANI is an applied general equilibrium model originally developed for Australian economy. The framework has now been applied to many countries including Brazil, China, Denmark, Indonesia, Ireland, Japan, Pakistan, Philippines, South Africa, Taipei,China, Thailand, Venezuela, and Viet Nam. For more information, see http://www.monash.edu.au/policy/oranig.htm.

Table 3 **Applications of Computable General Equilibrium Modeling in Developing Member Countries**

Country	Indonesia	Indonesia	Indonesia	Indonesia
Model	Sugiyarto, Blake, and Sinclair (2003)	Behrman, Lewis, and Lofti (1989)	Lewis (1991)	Devarajan and Lewis (1991)
Benchmark Data	1993	1980	1980 and then 1985	1985
Main Purpose	To examine the effects of globalization as a stand-alone case and in conjunction with tourism growth	To analyze macroeconomic, sectoral, and distributional consequences of price fluctuations in international markets for primary products	To examine tax policy and government revenue performance, the consistency of the medium-term plan, macroeconomic implication of real exchange rate management, and the structural impacts of export-oriented industrial growth	To examine the appropriateness of rule of thumb commonly used as guidance for conducting economic reform packages; namely; devaluation, trade and capital account liberalizations, and fiscal and monetary policies
Dimensionality	18 production activities, 8 groups of labor, 5 categories of capital, and 10 household groups	12 production sectors/activities, 5 factors, 4 households, 4 other institutions (government, firm, capital account, and the rest of the world)	18 production sectors/activities, 6 factors, 4 types of households, and 3 borrowing institutions	13 production sectors/activities, 5 factors, 4 types of households, and 4 other institutions
Functional Forms/ Main Characteristics	The tourism-CGE model 1) encapsulates the main characteristics of the economy, in terms of foreign tourism and globalization; 2) facilitates analysis of economy-wide effects and distributional implications of the two	Similar to the model of Lewis (1991)	Introduction of imperfect substitutability characteristics on the demand side and imperfect transformability on the production side for the export and domestic markets	Follows closely Lewis (1991). In addition, there is also a two sector analytic model for clarifying the impact of policy simulations
Simulation	Two main macroeconomic policy scenarios were considered: 1) partial globalization; 2) far-reaching globalization	Changing world prices of oil and agricultural products in the context of flexible and fixed exchange rate	See Behrman, Lewis and Lofti (1989); Devarajan and Lewis (1991); Devarajan, Ghanem, and Thierfelder (1997)	Devaluation, changing world prices and lowering tariff mean level and dispersion
Main Results/ Conclusions	Tourism growth amplifies the positive effects of globalization and lessens its adverse effects. Production increases and welfare improves, while adverse effects on government deficits and the trade balance are reduced	There are trade-offs in assessing the impacts of price instability since there is no case in which the impacts are only good or bad	See the summary of each model in Behrman, Lewis and Lofti (1989); Devarajan and Lewis (1991); Devarajan, Ghanem, and Thierfelder (1997)	The rule of thumb is based on models that bear virtually no resemblance to the economy in question. Therefore, they can be justified only on the grounds of administrative simplicity and reduced rent seeking, rather than on the argument that they improve economic welfare

(continued on next page)

Table 3 continued

Country	Indonesia	Indonesia	Indonesia	Indonesia
Model	Devarajan, Ghanem, and Thierfelder (1997)	Roland-Holst (1992)	Thorbecke et al. (1992)	Temenggung (1995)
Benchmark Data	1985	1980	1980	1985
Main Purpose	To examine whether the presence of labor unions strengthens or weakens the benefits to be gained from economic reform	To evaluate Indonesian adjustment policy over the period 1980–1986, with particular attention to the growth and distributional implications of adjustment	To compare alternative adjustment packages to the ones actually adopted by the government in terms of their effects of on the socioeconomic system (income distribution)	To examine the impacts of the tax sharing system currently adopted by the government
Dimensionality	Follows the Lewis 1991 model. Production sectors (30 activities) were split into two categories: Unionized (17 sectors), and non-unionized (13 sectors)	6 production sectors/activities, 8 factors, 8 types of households, and 4 other institutions (Government, firm, capital account, and the rest of the world)	14 production sectors, 9 factors (4 types of labor and 5 kinds of capital), 8 types of households, and other institutions	Two regions: Java and Outer Islands. In each region there are 2 factor accounts, 9 production sectors/ activities, and 10 types of households and other institutions
Functional Forms/ Main Characteristics	Follows closely the Lewis 1991 model with a modification in the labour market specification for introducing a labour union, which is assumed to have a Cobb-Douglas utility function	Based on the micro-macro general equilibrium model developed by Bourguignon, Branson, and de Melo (1990)	Integration of financial sector to portray the impact of stabilization policy through both the real and financial markets. Output is a CES function of a composite labor and capital (fixed in short-term and flexible in long-term)	Follows closely the Lewis 1991 model, but with the additional introduction of regional issues
Simulation	20% reduction in the government spending	Three alternative policies are considered, reflecting the actual fiscal policy adopted during the period concerned, trade reorientation, and using monetary policy for stabilization	Equi-proportional budget retrenchment, increased government investment and reduced government current expenditures, accelerated devaluation, and monetary contraction and expansion	Calculating multiplier effects as well as running a set of counterfactuals reflecting a presumably better tax policy
Main results/ Conclusions	Greater freedom of unions is superior to the current minimum wage policies and is also preferable on equity grounds	More efficacious policies could have been implemented, resulting in more moderate primary export dependence and less terms of trade instability. The policies reflect a deliberate attempt to shift the export orientation of Indonesia toward more diversified and sustainable trade patterns	The adopted adjustment strategy conformed best to the prevailing preference function of the government, which included among its major objectives growth, equity, and the restoration and maintenance of internal and external equilibrium	The existing tax policy, in which central government collects 'major' taxes, provides a means to strengthen economic performance (GDP growth and current account balance). A revenue sharing system favoring outer islands may however result in a better, regionally-oriented fiscal policy

(continued on next page)

Table 3 continued

Country	Indonesia	Indonesia	Indonesia	Nepal
Model	Azis (1996)	Wuryanto (1996)	Robinson, et al. (1997)	Cockburn (2002)
Benchmark Data	1985	1990	1990	1995
Main Purpose	To examine the impacts of economic reform on various macroeconomic variables and the income distribution	To examine the impacts of a more decentralized fiscal system on the Indonesian economy	Analysing economy-wide impacts of changes in production technology, protection and market structure on resource allocation, production and trade	To evaluate impacts of trade liberalization on conventional poverty and distributional indicators, specifically on individual households and how these impacts feed back into the general equilibrium of the economy
Dimensionality	30 production sectors/activities, 8 factors, 8 types of households, and 3 borrowing institutions	Two regions: Java and Outer Islands. In each region there are 2 factor accounts, 15 production sectors/activities, and 10 types of households and other institutions	34 activities/commodities, 12 factors, and 11 institutions	5 factors, 12 agents, 16 branches of production, 17 goods for domestic consumption, and 9 export goods
Functional Forms/ Main Characteristics	Imperfect substitutability on the demand side and imperfect transformability on the production side as well as short and long run characteristics. Introduction of two parameters: 'degree' (reflecting the intensity of government controls on capital flows) and 'risk' (to capture the fast emergence of the capital market)	Output is specified as a CES function of intermediate inputs and value added. The consumption of intermediate inputs is treated as a Leontief function with no substitution possibilities either intra- or inter-regionally	Incorporates a specification of the rice market and models the behaviour of the Indonesian Logistic Agency (BULOG). CES and CET functions are used to represent production and trade aggregation functions. Consumer expenditures are determined using Stone-Geary utility functions for each household	The method was able to bridge the gap between CGE models and poverty/distribution analysis by constructing a CGE model that explicitly models all households from a nationally representative household survey
Simulation	Comparative static (one period) and dynamic (multi-period) simulations	Changing the existing fiscal policy of the central government	An adverse productivity shock, a favourable productivity shock and a favourable productivity shock without BULOG interventions	Household data and a standard CGE model are combined to simulate the elimination of all tariffs
Main results/ Conclusions	The presumably actual policies adopted by the government are not optimal	Decentralizing the existing fiscal system would generate greater national economic growth and a lower amount of government foreign borrowing	There is inefficient allocation of resources within the agriculture sector and the rest of economy if BULOG maintains its price support programmes when there are significant increases in the rice productivity	Trade liberalization has quite complex poverty and distributional impacts, which can only be properly understood in this fully disaggregated model

(continued on next page)

Table 3 continued

Country	India	Thailand	China	Philippines
Model	Naastepad (2003)	Wattanakuljarus (2006)	Zhang (1998)	Cororaton, Cockburn, and Corong (2005)
Benchmark Data	Fiscal year 1989–1990	2001	1987	1994
Main Purpose	To evaluate the trade-offs in macroeconomic stabilization policies associated with budget deficit reductions	To investigate the economic and environmental impacts of tourism, specifically on social welfare, industry outputs, labor market, income distribution, and usages of land, forest and water	This study analyzes the macroeconomic effects of abating CO2 emissions by using a dynamic CGE model of the Chinese economy	To examine the poverty impacts of trade reform under the Doha Development Agenda, as well as more comprehensive trade reforms
Dimensionality	Real side: 3 types of production sectors [household (4 sectors), private corporate (2 sectors), and public sectors (4 sectors)] and 3 categories of private income Financial side: household (4 sectors), the private corporate (2 sectors), the government, the banks, non-bank financial institutions, and the central bank	81 activities, 81 commodities, 3 margins services, 18 types of occupations, one land, two capitals, one forest benefits, four classes of households, one corporation, the government, 8 types of taxes and subsidies, one savings/investment, one total tourism, 5 regional tourisms, ROW, and one inventory	10 producing sectors and is made up of 9 blocks, 4 energy use, 4 energy inputs, and one explicit time dimension	35 production sectors, with 13 sectors for agriculture, fishing and forestry, 19 for industry, and 3 for service sectors including government service
Functional Forms/ Main Characteristics	Incorporating credit rationing, recognizing the dual role of credit to finance working capital as well as investment, and allowing for endogenous shifts between credit-constrained and demand-constrained regimes	Adapted from Löfgren, Harris, and Robinson (2001)	Time-recursive dynamic CGE model (Gunning and Keyzer 1995)	Based on detailed economy-wide Computable General Equilibrium (CGE) model with an emphasis on the agricultural sector (no reference)
Simulation	Financial sector adjusts to production and prices in the real sector or production and prices adjust to the financial sector	10% tourism consumption expansion, 5% technical regress in primary factors of agriculture and piped water sector and 10% tourism price reduction to pricing promotion of the government	Corresponding reduction of CO_2 emissions in 2000 and 2010 and alteration in indirect tax rates	Global and local fiscal policy adjustment
Main results/ Conclusions	Macroeconomic effects of budget deficit reduction depend crucially on the interaction of: (i) the manner in which the deficit is reduced; (ii) sectoral supply and demand conditions; and (iii) credit creation process	Tourism expansion stimulates real GDP and improve current account deficits but it can also cause real exchange rate appreciation, trade balance deterioration, and inflation	A larger absolute cut in CO2 emissions will require a higher carbon tax and GNP drops by 1.5% and 2.8% and its welfare drops by 1.1% and 1.8%, indicating that the associated GNP and welfare losses tend to rise more sharply as the degree of the emission reduction increases	Poverty is found to increase slightly with the implementation of the prospective Doha scenario, especially in rural areas and among the unemployed, self-employed and rural low-educated

(continued on next page)

Table 3 continued

Country	Bangladesh and Zambia	Armenia	Vietnam	Singapore
Model	Fontana (2004)	Rutherford and Light (2004)	Nguyen Manh Toan (2005)	Siriwardana and Iddamalgoda (2003)
Benchmark Data	1994 and 1995	2002	2000	1998
Main Purpose	To assess how trade affects women, i.e., how trade expansion affects gender inequalities in terms of resource endowments, labour market characteristics and socio-cultural norms in two countries	To evaluate factors influencing the efficiency cost of raising revenue from different tax bases	To explore the links between trade liberalization and income distribution among household groups, that is, to investigate whether trade liberalization will increase or decrease inequality in the context of Viet Nam	To examine the impact of the Asian economic crisis and the effects of proposed policies. In particular, wage reduction, domestic demand stimulation, and exchange rate policies are examined
Dimensionality	10 price blocks, 19 production and commodity blocks, 11 institution blocks, and 10 system constraint blocks	24 sectors, 4 primary factors (capital, skilled and unskilled labor, and land), 25 industries, the government, and a single representative consumer	26 sectors, 8 household groups, and 13 factors of production	45 regions and 50 sectors in each region
Functional Forms/ Main Characteristics	Dervis, de Melo and Robinson (1982) while the underlying gender application is based on Fontana and Wood (2000)	Constant elasticity of substitution (CES) functions by Mathiesen (1985)	Multi-sector dynamic CGE model and the corresponding Social Accounting Matrix (SAM)	Comparative-static multi-regional CGE model comprising a system of linear equations of percentage change of variables and ORANI modeling of each region for GTAP
Simulation	Main experiment is the abolition of all tariffs	Different types of tax reforms and some scenarios for increasing tax revenue by between one half and two percent of GDP	Tariff reduction up to 5%, assumed to be offset by the introduction of a uniform increment in indirect tax rates, endogenously determined so as to maintain government revenue neutrality	Imposition of negative investment and factor employment shocks, that is, wage reduction policy, policies to stimulate domestic absorption via increased government and private demand, and devaluation
Main results/ Conclusions	Highlights how differences in resource endowments, labor market institutions, and socio-cultural norms shape the way in which trade expansion affects gender inequalities, resulting in more favorable effects in two	Highlights the efficiency cost of informal activity. The marginal cost of public funds from any of the direct and indirect tax instruments are increased when a substantial fraction of the tax base is able to avoid payments, or when individuals are more willing to substitute informal goods and services for formal goods and services	Trade liberalization negatively affects total national welfare. Rural-unemployed and farmer households, which is estimated to contain more than 70% of the country population, incur loss. On the contrary, urban self-employed households seem to gain the highest benefit from trade liberalization	Lowering the wage costs results to restoration of international competitiveness via depreciation of the real exchange rate. Real GDP growth is likely to return to pre-crisis levels. The policy increases employment

Sugiyarto (2000) developed CGE models based on the Indonesian SAMs in 1985, 1990, and 1993 to examine the economic effects and distributional implications of economic reform policies such as stabilization, trade liberalization, and tax reform. The first policy leads to economic contractions and welfare reduction but it has favourable impacts on income distribution since government consumption favours the higher income households. The trade liberalization brings benefits to the economy and also has favourable impacts on income distribution for rural households since urban households are the ones benefiting from the existing tariff protection. Comparing results of the three different years shows that the economy is getting more benefits from trade liberalization implying an increasing distortion in the economy. The sequencing simulations show that initial conditions are crucial in determining the results of any policy changes and the policy choices that can favourably be adopted. A sensible choice is to start with reducing distortions in the domestic market followed by trade liberalization and stabilization type policies. By having a less distorted domestic market, the benefits from trade and other reform policies can be better realized.

Sources: Authors' compilation.

Box 9 Problems in Using Computable General Equilibrium Models for Poverty Impact Analysis

Despite the benefits of having a computable general equilibrium (CGE) modeling framework for policy analysis, there are some obvious problems in the implementation of this technique for conducting poverty impact analysis (PIA).

- **Model development.** It is not easy to develop the model. Developing CGE model is relatively complicated and cumbersome. Its development requires substantial data that can only be generated from various established censuses and surveys as part of a national statistical system. In this context, CGE model development in a country with a weak statistical system seems very unlikely. A good indicator on this issue is the capability of the country's statistical office to (regularly) produce input-output tables and then a social accounting matrix (SAM).
- **Timeliness of data.** The data used for developing the model must be current and regular. It takes time to develop an input-output table or SAM, which are used for CGE modeling. In some countries, the development of an input-output table or SAM is only a one-off activity—this could make the corresponding model even more outdated.
- **Simulating program effects.** It is difficult, sometimes impossible, to accurately simulate the program effect in the model. One of the main reasons for this difficulty is that the program may produce many kinds of outputs that cannot all be fully translated into changes in the model. A simple infrastructure program to improve economic infrastructure, for instance, can be translated in many ways—such as into reductions in trade and transport margins, production costs, and other things. This problem is, however, not peculiar to the CGE model since other methods are beset with the same problem.
- **National coverage.** The model may not be relevant for projects and policies for administrative districts below the national level. The model usually covers projects and policies that are national in scope.
- **Poverty impact measurement.** The structure of the CGE model and available data may affect the type of poverty impact measures that can be generated by the model. In a CGE model with representative household groups, for instance, Foster-Greer-Thorbecke poverty and income distribution indicators cannot be generated without assuming a specific distribution on income such as lognormal distribution. In the absence of such an assumption, other measures of welfare such as equivalent variation, compensating variation, and real income or consumption are commonly used.
- **Classifications.** Classifications of household, workers, and sectors used in the CGE model may not be exactly in line with direct policy targeting of the government, donor, and other interested parties. In this case, the poverty and other indicators resulting from the model may not be as useful as they could be.

Source: Author's summary.

economy, while the second approach can be seen in most of the current CGE applications (Greenaway et al. 1993). The CGE models used in this book adopt the second method.

In the context of other modeling systems, CGE models combine the advantages of econometric, input-output and social accounting matrix (SAM)–type frameworks. Compared with fixed-price input-output or SAM-multiplier models, for instance, CGE's flexible price structure and behavioral equations can approximate long-term equilibrium adjustment in addition to short-term analyses. The CGE model also imposes consistency characteristics among sectors, which is lacking in macro econometric models (Azis 1996).[19]

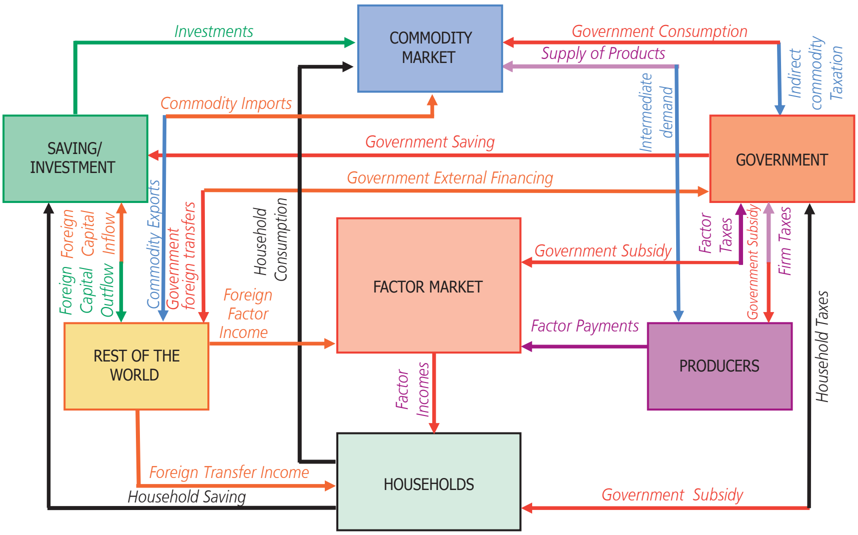
The structure of a CGE model is consistent with neoclassical economic theory but flexible enough to incorporate structural characteristics such as the introduction of factor and commodity substitution into the production and demand structure. The Walrasian system of equations of the model represents the equilibrium of factor, commodity, and foreign exchange markets. The system can simulate economic responses to changes in policy variables vis-à-vis the base scenario. The model's endogenous prices adjust to any exogenous changes until factor and commodity-market equilibrium conditions are satisfied and consistent with endogenous factor incomes.

Another consideration why CGE models are useful for PIA is that this framework explicitly accommodates households in the model. Among other features, the models show how aggregate income is distributed among various RHGs that make it possible to calculate welfare changes as a result of various policy changes or programs. The simultaneous feedback and link between product and factor markets is best captured by CGE models. Moreover, the types of economic interventions by international organizations such as ADB tend to generate multisectoral effects on the rest of economy that cannot be ignored.

Figure 6 provides an intuitive picture of the economy described by the CGE model. In this framework, households and government maximize their utility functions subject to their budget constraints, and producers maximize outputs subject to intermediate inputs and available factors. These factors include labor and capital, as well as production technology to specify the input requirements per unit of output. The producers supply goods and services in response to domestic and foreign demand and, in doing so, generate income for households and government from factors used in the production process. The factor incomes, in addition to other transfer incomes, are used to finance

19 Stochastic equations in any econometric model always contain residual errors or error terms.

Figure 6 **The Interlinked Nature of the Economy Represented in a Computable General Equilibrium Model**



Source: ADB PRISM (http://prism/adb_prism).

consumption expenditures and other expenses, including savings. Therefore, in addition to the economic transactions, the model also captures transfer payments among institutions in the form of taxes or subsidies and other transfers. The institutions in the model include households, government, enterprises, and the rest of the world.

All transactions are recorded in a consistent way in the sense that expenditure of an economic actor always corresponds to income for another actor, and vice versa. The model produces equilibrium solutions with aggregate spending being equal to total income since all consuming institutions spend all their respective incomes, including savings. In other words, there is no excess demand and supply in the model, and the equilibrium is achieved in all markets. Auxiliary equations can be added to depict departures from the standard neoclassical assumptions and to incorporate some structural characteristics of the economy (see Robinson 1989 and Taylor 1990 for examples of discussions on this issue).

Households in the model can be classified in different ways, depending on the modeling purpose and available data, as well as on the requirements of policy makers. For PIA, household classifications should ideally be based on PPM results to make the CGE modeling results consistent with other poverty-targeting efforts. A commonly used alternative is to classify households, based on their income level, into groups of quartiles, deciles, and so on, for easy calculation of household income distribution. Another common way to classify households is based on available information from various surveys and censuses such as the job and occupational status of the household head combined with other characteristics of education and skill level, as well as location in urban or rural areas. In some cases, the gender aspect of household head can also be incorporated in the classification as can be seen in the Philippine model discussed in this book. The general rule of thumb is that the more detailed the household classification, the better the model results–especially if the classification can then be used as the basis for policy targeting.

On the other hand, analyzing project impacts in partial equilibrium may not be adequate, as this approach does not take into account the sectoral links of an economy. The economy-wide approach cannot be replaced by a multi-market, partial-equilibrium approach, which may also be operationally more cumbersome.

CGE Model Applications. Policy analysis using CGE modeling is basically tracing the effect of a change introduced in the model by comparing two equilibrium states of the economy. First is the benchmark equilibrium state, which is calculated without changes in the model and second is the counterfactual, which is the outcome of all variables concerned after introducing the changes. The differences in equilibrium values before and after the changes are attributed to the interventions.

CGE modeling has been implemented to examine the economy-wide effects and distributional implications of a wide range of applied policy issues and interventions.[20] The effects of any changes introduced in the model can be examined at macro, sector, factor, and household levels. Moreover, the impact can be examined in a static and dynamic context, for short- and long-run scenarios, in isolation or in combination with other policies as shown in the applications of the CGE modeling in DMCs summarized in Table 3. Such flexibility has been found to be an important practical advantage in the use of CGE models.

A numerical CGE model is developed using mainly data from a SAM. (See Box 10 for a discussion on SAM.) Some models' parameters such as elasticities of substitution between different commodities and factors cannot be computed from the SAM and need to be estimated independently or

20 Examples are for structural adjustments, international trade, public finance, agriculture, and energy and environment. In addition, the model has also been used to examine various exogenous shocks such as changes in commodity and oil prices.

Box 10 **The Social Accounting Matrix**

A statistical accounting matrix (SAM) is basically a system of presenting the economic and social structure of a country (or region) at a particular time by defining the representative actors or economic agents in the underlying economy and recording their transactions. The transaction values are presented in a square matrix (as opposed to the double-entry format in standard T-type accounting reports) with its rows representing detailed receipts by each particular account and its columns recording the corresponding expenditures. Every income item entered has a corresponding expenditure entry, and the incoming and outgoing items of any account must always balance.

The SAM is essentially constructed to correspond to the underlying economy and entries in a SAM can be categorized into two groups: one that reflects flows across markets to represent transactions in the product and factor markets, and the other that reflects transfer payments from one agent to another.

There is, however, no standard SAM so that the disaggregation level and choice of representative actors depend entirely on the motivation underlying SAM's development and the availability of data. For poverty impact analysis, the classifications of factors (especially workers) and households should be relatively detailed to enable the models to capture the changes in factor income allocation and, therefore, welfare status of different household and worker groups.

In a statistical system, a SAM provides complementary economic indicators, which relate not only to the macroeconomic aggregates of the system of national accounts but also to the socioeconomic structure and distributional aspects of the economy. Accordingly, SAM can be thought of as a further development of input-output accounts, which concentrate only on the production side of the economy. It must be noted, however, that every SAM is only a static image or snapshot of an economy.

Nevertheless, SAM can provide the statistical basis for the development of plausible models when more than a static image is needed (King 1985). Table 4 provides a schematic representation of SAM for Indonesia as an example. As can be seen in the table, the matrix records a comprehensive transaction conducted by economic actors in the economy for a period of time that includes economic and transfer payments.

On the down side, constructing SAM can be very time consuming and burdensome, involving reconciliations of various data from the input-output tables, national income accounts, foreign trade, and other sources. If the basic data are not readily available, some specific surveys must first be conducted before developing a SAM.

Source: Author's summary.

borrowed from the literature. This is where the modeler's expertise and common sense play an important role.

The first operational general equilibrium model was developed for the Norwegian economy in 1960 using tractable log-linear specifications. Subsequent applications of CGE models developed by World Bank

Table 4 **Schematic Representation of the Indonesian Social Accounting Matrix (SAM)**

	EXPENDITURE								
	Factors	**Institution**	**Activities**	**TTM**	**Domestic Commodities**	**Imported Commodities**	**Capital**	**Net Indirect Tax**	**ROW**
Factors			Value Added						
Labor			Wages						
Capital			Profits/Rents						Remittance
Institution									
Households	Factor Income	Transfers							Transfers
Firm	Factor Income	Transfers							Transfers
Government	Factor Income	Direct Taxes						Indirect Tax Transfers	Transfers
Activities					Production Allocation				
TTM					Mark-up for TTM	Mark-up for TTM			
Domestic Commodities		Final Consumption	Intermediate Consumption	Transfers/ Consumption			Investment		Exports
Imported Commodities		Final Consumption	Intermediate Consumption				Investment		
Capital		Savings							
Net Indirect Tax					Indirect Tax Payment	Indirect Tax Payment			
ROW	Remittance	Transfers				Imports	Capital Outflows		

TTM = trade and transport margin, ROW = rest of the world
Source: Authors' summary.

researchers on the developing countries are summarized in Dervis, Melo, and Robinson (1982). Decaluwé and Martens (1988) compared the structure of 73 CGE applications in developing countries, including some DMCs. Table 3 summarizes CGE modeling applications in DMCs to address various issues such as the effects of globalization in conjunction with tourism growth, consequences of price fluctuations in international markets for primary products, tax policy and government revenue performance, and others.

To be able to conduct policy simulations and PIA with CGE models, the model first needs to be developed. In doing so, the main purpose of the modeling activities should be given utmost consideration since there is no single model that can answer all questions. In other words, there is no black box CGE model that is useful. The model has to be developed for a specific purpose and the level of aggregations in the production sectors, factors, and households, as well as the other structural features incorporated in the model, have to be carefully specified. Equally important to consider is how the kinds of policy instruments under examination are introduced in the model.

Any changes due to a combination of a new project or policy change, or both, as well as other external factors or shocks, will affect resource allocations in the economy. This is reflected in the changes in volume of sectoral output, uses of labor and capital, and factor and commodity prices which, in turn, affect household income distribution and poverty. The effects of changes on the RHGs in the model can be used as an indication of the household welfare condition. This approach, however, assumes that the policy changes will not alter the intra-group income distribution, which can be a restrictive feature in some cases.[21] This leads to the integration of a complete household data set in the CGE models that results in a CGE-microsimulation model.

CGE-Microsimulation Model. Unlike conventional CGE models, the CGE-microsimulation model incorporates actual households in the model. The link provides much more information, especially with regard to household income and poverty as their indicators can be developed more precisely. The approach has become feasible to implement with recent gains in computing efficiency.[22] The CGE-microsimulation model can calculate income distribution and poverty indicators that can not be conducted in CGE models with RHGs.

The CGE-microsimulation model has improved the capability of CGE models to measure the effect of policy reforms on poverty. Previous work focused on the efficiency effects rather than on income distribution and poverty

21 The issue is how representative is the representative household in the CGE models.

22 See Decaluwé et al. (2000); Cockburn (2002); and Cororaton (2003a and 2003b).

impacts of policy reforms.[23] CGE microsimulation has been increasingly used to address various issues on household income and poverty.

Two approaches have emerged from the integration of a complete household survey data set into CGE models. One is a top-down recursive approach, in which the economic effects of any changes introduced in the model are first computed with the conventional CGE models with representative households. The counterfactual equilibrium variables are then used in a separate micro-household simulation model to calculate the changes of poverty and income distribution indicators.[24] The microsimulation is not necessarily conducted in the general equilibrium context, providing greater flexibility[25] in tracking the effects of policy changes on poverty and income distribution than in conventional CGE models. The incomes and expenditures calculated in this way, however, will not be consistent with corresponding figures in the CGE model solution.

Another variation of this top-down approach is to use only changes in price vectors generated from the CGE model and impose the changes on the microsimulation model. This variation guarantees consistent results between CGE and microsimulation models. In other words, this approach is similar to replacing the RHGs of the CGE models with complete households from a survey. In the process, the complete households must be classified following exactly the same classification method used in developing the RHGs. All poverty and income distribution indicators can then be developed from the complete household data set.[26] The CGE microsimulation and the PRISM discussed in this book adopted this top-down but consistent approach (see also Chapter 9 and 10 of this book).

The second approach is a refinement of the top-down approach–it incorporates the possibility of bottom-up feedback. In this top-down, bottom-up approach, CGE results are transformed into the household microsimulation model. The solutions obtained from the microsimulation at the household level are then fed back to the CGE model and, through

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23 See, for example, Shoven, J. and J. Whalley, (1992); Dervis, K., J. de Melo, and S. Robinson (1982); and Clarete, R. and J. Roumasset (1986).

24 Dervis et al. (1982) have applied this approach, as well as de Janvry, Sadoulet, and Fargeix (1991a and 1991b); Chia, Wahba, and Whalley (1994); and Decaluwé et al. (2000).

25 As there is no consistency constraint, changes in the household behavior can also be introduced in the microsimulation model.

26 See Bourguignon, Robillard, and Robinson (2002); Mitton, Sutherland, and Weeks (2000); Bourguignon, Fournier, and Gurgand (2001); and Alatas and Bourguignon (2001).

a series of iterations, a convergence solution between CGE model and the microsimulation is attained.[27] This approach appears to be most useful for PIA as it continues to take advantage of the analytical strength of the CGE model. The numerical specification work in setting up the model, however, becomes more tedious because of the thousands of households that must be included in the calculation.

PRISM: An Interactive CGE-Microsimulation and GIS Model. PRISM is developed by basically linking a CGE-microsimulation model with a GIS application and then interfacing them in a user-friendly way (see also p.24). Therefore, PRISM is a modeling tool that maximizes the capability of the CGE-microsimulation model at the household level and the GIS application of poverty mapping for its poverty-impact components. All complexities of the modeling aspects of CGE-microsimulation and the GIS application have been hidden in the system and interfaced in a way that allows users to easily run simulations and conduct some online analyses, including PIA. For an introduction to PRISM, users can examine the economy-wide and poverty effects of the preset simulation scenarios, selected for their relevance, in each country incorporated in the system. The Philippines economy was selected as the prototype that can be expanded to include other countries.

The GIS application is basically a way of presenting geographical information using a map or picture, which can then be combined with color in different gradations to represent different levels of measurement.

As mentioned earlier, users can run online their own “what if” scenarios of important issues related to taxes, foreign sector economy, factor market, and household income. Once the simulation is completed, a notice that contains a refreshed link is sent out by the system to the users so that they can view the results independently or in comparison with the preset scenarios and other selected simulation results.

The impact analysis can be examined on macroeconomy, external sector, factor market, household income, and poverty. All simulation results are presented in graphs and tables that can easily be downloaded or copied to other computer program applications. Moreover, the poverty impacts are also presented in an interactive GIS map of a dual-window viewing system to enable a comparison of poverty impact analysis between two different simulations.

27 See Savard (2003) for discussion on this issue.

PART ONE

Application of Tools to Identify the Poor

CHAPTER 1

Predicting Household Poverty Status in Indonesia

Sudarno Sumarto, Daniel Suryadarma, and Asep Suryahadi

Introduction

Indonesia is the fourth most populous country in the world and it has a large poor population. Official poverty estimates indicate that in 2004 the poor numbered about 36 million, or 17 percent of the total population, with about two-thirds of the poor living in rural areas. The most widely used data for measuring poverty is household total consumption expenditure expressed in monetary terms. The use of expenditure data is particularly common in developing countries where expenditure data is less difficult to collect and more accurate than household income data.

Collecting household consumption expenditure data, however, requires plenty of time and effort. Respondents must be willing and patient enough to document their own expenditure over a period of time. For instance, in Indonesia, the recording of food expenditure is done over one week and the enumerators have to ensure that the respondents are correctly noting down their actual expenditure. In addition, some questions on nonfood items require respondents to remember expenditure incurred as far back as one year. In this case, reliability and accuracy of data become an important issue to settle.

Amid such empirical problems, a number of studies in developing countries have been focusing on proxy variables that measure expenditure and poverty. A proxy is calculated using several widely recognized methodologies employing household characteristics data that are auxiliary to poverty and are easier to collect. Examples of proxy variables are asset ownership and education level which can be used to rank households similar to the rank based on per capita consumption expenditure.

One of the more widely cited studies is that of Filmer and Pritchett (1998a), which used long-term household wealth to predict school enrolment in India. The authors employed principal components analysis (PCA) to come up with an asset index for each household. Meanwhile, Ward, Owens, and Kahyrara (2002) and Abeyasekera and Ward (2002) developed proxy predictors of expenditure and income of the poor in Tanzania through the use of the ordinary least squares regression method. A similar study was done by Geda et al. (2001), which uses data from Kenya. Another study is that of Gnawali (2005) that shows the connection between poverty and fertility in Nepal. The Gnawali study employs logistic regression to find out if a household is poor or not by regressing consumption expenditure on some household characteristics. To test the performance of models in predicting welfare, most of these studies compare the rank of households by expenditure with their rank based on the new index developed using PCA.

In most cases, an expenditure variable is used to directly measure poverty, and most studies that employ PCA or the multiple correspondence analysis method to come up with a proxy variable do not exactly aim to estimate expenditure but to capture the multidimensionality of poverty. In a nutshell, this concept argues that poverty does not only involve expenditure or income, but also other dimensions such as health, education, social status, and leisure. Among others, studies that adopt this approach include those of Asselin (2002) and Reyes et al. (2004).

Data and Method

Indonesia's National Socioeconomic Survey (Susenas) data set is used in this study. The Susenas is a nationally representative household survey and has two main components: *core* and *module*. The core component is conducted annually and collects data on household general characteristics and demographic information. The module component contains more detailed characteristics of the households. There are three modules: consumption; health, education, and housing; and social, crime, and tourism. Each module is conducted in turn every year, which means each module is repeated every three years.

Based on a literature study, there are three methods that are commonly used in creating non-income and consumption poverty predictors: (i) by deriving a correlate model of consumption; (ii) by deriving a poverty model with limited dependent variables; and (iii) by calculating a wealth index. In this study, the three methods are explored and compared to get the most appropriate method to determine poverty predictors for Indonesia. Furthermore, since it is widely recognized that conditions in urban and rural areas differ significantly, the best method is implemented separately for urban and rural areas.

Method 1: Consumption Correlate Model

When poverty is defined as a current consumption deficit, a household is categorized as poor if the per capita consumption of its members is lower than a normatively defined poverty line. Therefore, it is logical to search for poverty predictors based on variables that are significantly correlated to per capita household consumption. These variables can be obtained by deriving a correlate model of consumption, where the left-hand side is the per capita consumption while the right-hand side is a set of variables that are thought to be correlated with household consumption. The variables refer to the type of houses and other assets owned by the households, socio-demographic characteristics, and consumption of some specific items. Unlike in the determinant model, in the correlate model the endogeneity of the right-hand side variables is not a concern.[1] (See Appendix 1.1 for the list of the independent variables and their descriptions.)

The dependent variable used is nominal per capita expenditure deflated by implicit deflators for the poverty lines, which vary across provinces to capture the price difference across provinces. Thus, the deflated per capita expenditure is comparable across the country in real terms.

Once the correlates have been determined, the variables are incorporated into the full model and the collinearity of the independent variables to each other is checked. To filter out multicollinearity, a correlation coefficient of each pair of variables is calculated. One of two in a pair of variables is dropped if it is found to be highly correlated and then a regression is run.

Next, a stepwise regression procedure is run to select variables that are appropriate for retention in the model.[2] This procedure facilitates a parsimonious model that has a manageable number of variables but can significantly predict for and explain the variability of household consumption and, hence, poverty status. As this was conducted separately for urban and rural areas, final sets of variables may differ for urban and rural areas.

Finally, in predicting poverty, the performance of the remaining set of variables is tested empirically. For the first step, the variables are used to predict the per capita consumption level of all households in the sample. Second, the predicted per capita consumption is compared with the poverty

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1 Take, for example, the car-ownership variable. Generally, one would think that whether a household owns a car or not is determined by, among other factors, its socioeconomic level, and not the other way around. Therefore, car ownership is usually not included in the right-hand side of a consumption determinants model. However, car ownership is a good correlate or predictor of poverty. If a household owns a car, it is most likely that the household is not poor. Hence, this variable should be included in a consumption correlates model.

2 There are three other procedures that can help come up with a parsimonious model, namely, backward, forward, and the all possible regression procedures. The choice is based on the least, but meaningful and practical, number of variables.

line to determine the poverty status of each household. Third, the predicted poverty status is then cross tabulated with the actual poverty status to assess the reliability of the model in predicting poverty. In other words, specificity and sensitivity tests are implemented. A similar test is also conducted to test the reliability of the model in predicting hardcore poverty.[3]

Method 2: Poverty Probability Model

In this model, the dependent variable is a binary variable of household poverty status and the same set (as above) of potential predictor variables is used. The method is known as probit modeling, which is a variant of logit modeling based on different assumptions. Probit may be the more appropriate choice when the categories are assumed to reflect an underlying normal distribution of the dependent variable, even if there are just two categories.[4]

There are two things that need to be reiterated. First, the dependent variable takes the value of *1* when the respondent is poor and *0* when nonpoor. This means that, in interpreting the estimation result, it is important to remember that a positive coefficient means that the variable is correlated positively with the probability of being poor. This is not the case with Method 1, where a positive coefficient means that the variable increases expenditure and hence reduces the chance to be poor. Second, predicted value of the dependent variable is the probability of the observed households being poor. The interpretation of a probit coefficient, say *b*, is that a one-unit increase in the predictor leads to increasing the probit score by *b* standard deviations.

Those who prefer to use the first method of using household consumption correlates model to search for poverty predictors argue that a probit model involves unnecessary loss of information in transforming household consumption data into a binary variable. On the other hand, the use of the consumption correlate model to predict poverty also has certain weaknesses. First, estimating a model of consumption correlates does not directly yield a probabilistic statement about household poverty status. Second, the major assumption behind the use of the consumption correlate model is that consumption expenditure is negatively correlated with poverty. Therefore, factors that are found to be positively correlated with consumption are assumed to be automatically negatively correlated with poverty. However, some factors may be positively correlated with consumption but only for

3 Hardcore poverty is a status of those whose expenditure per capita is below the food poverty line, which means the person cannot satisfy the monthly dietary requirements even when she decides to spend her entire expenditure only on food.

4 See http://www2.chass.ncsu.edu/garson/pa765/logit.htm for a discussion on this issue.

those who are above the poverty line. However, in general, factors that are positively correlated with welfare are negatively correlated with poverty.

Similarly, a stepwise estimation procedure is also used to produce a manageable number of poverty predictors. As in the first method, specificity and sensitivity tests are also implemented. Total and hardcore poverty are also examined in this method.

Method 3: Wealth Index PCA

One of the indicators of household socioeconomic level is asset ownership. It is relatively easy to collect and can be used to facilitate the wealth ranking of households through the creation of a wealth index. Unfortunately, data on asset ownership is usually in the form of binary variables, indicating only whether a household owns a certain kind of asset or not. Creation of an appropriate wealth index requires data on the quality or price of each asset owned by a household to suitably weigh household assets. Hence, binary data poses a problem in ranking households by their socioeconomic levels.

To deal with this problem, the PCA method is used. In this method, the weight for each asset is determined by the data itself. PCA is a technique for extracting from a large number of variables those few orthogonal linear combinations of the variables that best capture the common information (Filmer and Pritchett 1998b). In effect, it is to reduce the dimensionality (number of variables) of the data set to summarize the most important (i.e., defining), parts while simultaneously filtering out noise. The first principal component is the linear index of variables with the largest amount of information common to all of the variables and each succeeding component accounts for as much of the remaining information as possible. Zeller (2004) stated that the major advantage of PCA is that it does not require a dependent variable (i.e., a household's consumption level or poverty status).

In calculating the PCA index, the method of Filmer and Pritchett (1998b) is adopted:[5]

$$A_j = f_1 \times (a_{j1} - a_1)/(s_1) + \ldots + f_N \times (a_{jN} - a_N)/(s_N) \qquad (1)$$

or simply

$$A_j = \sum_{i=1}^{N} \frac{f_i (a_{ji} - a_i)}{s_i}$$

5 They refer to it as Economic Status Index. Although Filmer and Pritchett (1998a, 1998b) cautioned that they are not proposing the wealth index be used as a proxy for current living standards or poverty analysis, they tested the index's robustness using current consumption expenditures and poverty rates data. Thus, if the index is as robust as they claimed, then it would not be a problem to use it as a proxy for current living standards.

where

f_i is the 'scoring factor' for the ith asset determined by the method

a_{ji} is the jth household's value for the ith asset and

a_{ji} and s_i are the mean and standard deviation respectively of the ith asset variable over all households

A_j = Asset index of the jth household.

Note that the mean value of the index is zero by construction since it is a weighted sum of the mean deviations. Based on the results of this analysis, households can be ranked from the lowest to the highest socioeconomic level. Testing the reliability of this wealth ranking on predicting poverty requires a cutoff point to separate the predicted poor from the nonpoor. Since there is no a priori poverty line that can be determined objectively in the PCA method, the cutoff point used is determined such that the poverty ratio predicted by the PCA method is the same as that derived from the actual consumption expenditure distribution. The additional value added from the PCA method lies in easy identification of the poor households through an asset index even when the overall percentage of poor might be the same as when PCA and consumption expenditure methods are used.

As in the first two methods, a cross tabulation is performed between the results of this approach and the poverty status based on the actual consumption expenditure.

The Poverty Line

The poverty line and food poverty line of Indonesia used in this study are the ones calculated by Pradhan et al. (2001). The food poverty line is based on a single national bundle of food producing 2,100 calories per person a day priced by nominal regional prices. This means that the differences in the value of this food poverty line across regions arise solely from price differences across regions. The nonfood poverty line component is estimated using the Engel law method. The total and food poverty lines used in this study are shown in Appendix 1.2.

Results

Correlate Model Method

When checking for the presence of multicollinearity, correlation coefficients of the final set of variables generated are found to be not higher than 0.7–implying the multicollinearity issue has been minimized. After running the stepwise procedure, the retained variables in the model (Table 1.1), provide R-squared equal to 44 percent. This result means that these variables can explain 44 percent variability in per capita consumption of urban households and 36 percent variability of rural households. The result is close to that in Ward, Owens, and Kahyrara (2002) where around 40 percent of variation is explained. Furthermore, most of the coefficients have signs as expected. However, the set of significant variables in urban areas is not the same as that in rural areas. In addition, as discussed below, the coefficients of some variables have opposite signs in urban and rural areas (See Appendix 1.3 for details).

Table 1.1 **Summary Results of Ordinary Least Squares Regression of the Consumption Correlates Model**

Item	Urban	Rural
Number of observations	23,847	34,649
Adjusted R-squared	0.44	0.36

Source: Authors' calculation based on 2004 SUSENAS.

Coefficients of the asset-ownership group of variables for urban areas are all positive, indicating that ownership of these various assets is correlated with a higher level of household welfare. In both urban and rural areas, the ownership of a car, refrigerator, motorcycle, and satellite dish are the variables with the highest correlations with consumption. Interestingly, households which raise chickens in rural areas have higher per capita consumption than those that do not, but raising chickens in urban areas is negatively correlated with per capita consumption.

Like asset ownership, the coefficients for household characteristics variables indicate that better housing materials are correlated with higher per capita consumption. In urban areas, a tile roof and a concrete wall are the two household characteristics that have the highest correlation coefficients with consumption, while the highest coefficients in rural areas are observed for households with an electrical connection to the house and flush toilets.

The correlation coefficients of variable age with consumption also differ in urban and rural areas. In rural areas, the age of the household head has a significant positive relationship. On the other hand, in urban areas, it is the age of the household spouse that has a significant, but negative, relationship.

The education level of the household head is a strong predictor of per capita consumption in both urban and rural areas. The higher the education level of the household head, the higher the per capita consumption. However, the marginal impact of each education level on consumption is much higher in urban areas than in rural areas.

In addition, the education level of a spouse is negatively correlated with consumption. This is an unexpected and puzzling result in both urban and rural areas. The marginal impact of each education level on consumption is also much higher in urban areas than in rural areas. In interpreting this negative correlation, it has to be remembered that the correlations are controlled by holding other variables constant. One possibility is that these negative coefficients may indicate that, all other things being equal, households with spouses that have higher education levels save more, hence they consume less.

In rural areas, the enrollment status of school-age children is also significantly related with consumption. In these areas, households which have at least one child aged 6–15 years who has dropped out of school have significantly lower per capita consumption.

In both urban and rural areas, larger household size is correlated with lower per capita consumption. The coefficients of the squared household-size variable indicate that the reduction in per capita consumption as household size gets larger occurs at a decreasing rate. Furthermore, higher dependency ratio–defined as the proportion of household members aged less than 15 years–of a household is also correlated with lower per capita consumption.

The working status of a spouse is positively correlated with per capita consumption. However, this correlation is only statistically significant for urban areas. Likewise, households which have children aged 6–15 years who are working also have higher per capita consumption and this is true in both urban and rural areas. In rural areas, having a household head working in the formal sector is also positively correlated with per capita consumption.

In both urban and rural areas, clothing turns out to have a strong correlation with consumption. Households in which each member has different clothing for different activities have higher per capita consumption. In rural areas, the use of modern medicine for curing sickness is also positively associated with per capita consumption.

Finally, the pattern of consumption itself is a strong predictor of the level of consumption. In urban areas, households in which each member eats at least twice a day have higher per capita consumption. Moreover, in both urban and rural areas, households that consume beef, eggs, milk, biscuits, bread, and bananas at least once in a week have higher per capita consumption. On the other hand, households in rural areas which consume *tiwul* (cassava flour), an inferior good, at least once a week have lower per capita consumption.

These estimation results are then used to predict per capita consumption of households given their characteristics. The accuracy of this predicted consumption is examined by cross tabulating it with actual consumption, where both the predicted and actual consumption are ranked and divided into three groups: bottom 30 percent, middle 40 percent, and top 30 percent. Table 1.2 shows the results of the cross tabulation for both urban and rural areas. If the household grouping based on predicted consumption perfectly matches the grouping by actual consumption, then all the diagonal cells will be 100 percent and off-diagonal cells will be 0.

Table 1.2 **Accuracy of Predicting Expenditure Using the Consumption Correlates Model**

Percentage (%) of Urban Consumption Expenditure				
			Predicted	
		Bottom 30%	*Middle 40%*	*Top 30%*
Actual	*Bottom 30%*	67.33	30.22	2.45
	Middle 40%	22.44	56.57	20.99
	Top 30%	2.75	27.67	69.57

Percentage (%) of Rural Consumption Expenditure				
			Predicted	
		Bottom 30%	*Middle 40%*	*Top 30%*
Actual	*Bottom 30%*	63.40	32.18	4.42
	Middle 40%	24.14	53.42	22.44
	Top 30%	4.41	29.93	65.67

Source: Authors' calculation.

In urban areas, 67.3 percent of households are correctly predicted to be in the bottom 30 percent, while only 2.5 percent of those households are wrongly predicted to be in the top 30 percent. Meanwhile, for those who are actually in the top 30 percent, 69.6 percent are predicted correctly, while about 2.7 percent are wrongly predicted to be in the bottom 30 percent. For the 40 percent in the middle, 56.6 percent are accurately predicted, while the remaining 43.0 percent are predicted almost equally split to be in the top or bottom 30 percent.

In rural areas, about 63.4 percent of people in the bottom 30 percent are predicted correctly, while 4.4 percent are wrongly predicted to be in the top 30 percent. On the other hand, 65.7 percent of those in the top 30 percent are accurately predicted and also 4.4 percent are wrongly predicted to be in the top 30 percent. Meanwhile, 53.4 percent of the middle group households are predicted to be where they are.

On an average, 64.5 percent of households' position in the per capita consumption groups is predicted correctly in urban areas and 60.8 percent in rural areas. As expected, prediction in urban areas is more accurate because of the higher coefficient of determination in the regression results.

Next, the accuracy of the model in predicting poverty is examined. Since poverty lines have been previously defined, the households with predicted expenditure below the poverty line are considered poor. Table 1.3 shows the result for poverty and Table 1.4 for hardcore poverty. Since the interest is in predicting poverty, the accuracy of predicting the nonpoor is less relevant. As shown in Table 1.3, in urban areas, around 49.6 percent of the poor are correctly predicted as poor; the result is slightly lower in rural areas, where 45.7 percent are correctly predicted. This indicates that predicted expenditure tends to underestimate poverty. Therefore, if predicted expenditure is used as a targeting tool for the poor in urban areas, there will be under-coverage of 50.4 percent for the share of poor who are wrongly predicted to be nonpoor, and about 7.3 percent of the nonpoor will benefit from the program.

Table 1.3 **Accuracy of Predicting Poverty Using the Consumption Correlates Model**

Percentage of Urban Poverty			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	92.73	7.27
	Poor	50.43	49.57

Percentage of Rural Poverty			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	92.12	7.88
	Poor	54.32	45.68

Source: Authors' calculation.

Meanwhile, Table 1.4 shows that the prediction results are even lower for hardcore poverty. Around 48.4 percent of the hardcore poor in urban areas and 33.5 percent of the hardcore poor in rural areas are correctly classified.

In conclusion, Method 1 produces quite robust results and is relatively accurate when used to predict consumption expenditure. However, the method performs less well when used to predict poverty as only around one half of the poor are predicted correctly.

Table 1.4 **Accuracy of Predicting Hardcore Poverty Using the Consumption Correlates Model**

Percentage of Urban Poverty			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	94.62	5.38
	Poor	51.55	48.45

Percentage of Rural Poverty			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	95.60	4.40
	Poor	66.52	33.48

Source: Authors' calculation.

Poverty Probability Method

The poverty probability method predicts poverty directly because of the nature of the dependent variable. The result of the poverty estimation for Indonesia is in Table 1.5, while the result of hardcore poverty estimation is in Table 1.6.

For the poverty estimation, the pseudo R-squared is 0.36 for urban areas and 0.29 for rural areas. For hardcore poverty estimation, the pseudo R-squared is 0.35 for urban and 0.28 for rural areas. In general, the coefficients in the results of the poverty probability model (Table 1.5) are consistent with those in the ordinary least squares regression results of the consumption correlates model (Table 1.4). For example, the asset ownership variables have positive coefficients in Table 1.4 which means that households that own various assets are more likely to have higher consumption expenditures. Meanwhile, in the results of the poverty probability model (Table 1.5), the coefficients of these asset ownership variables are negative, which means that households that own various assets are less likely to be poor. These results are hence consistent with each other.

There are, however, some exceptions. For example, in Table 1.4 the variable of owning a sewing machine is dropped as a result of stepwise regression in both urban and rural areas, implying that owning a sewing machine is not correlated significantly with the level of household per capita consumption. However, in Table 1.5 the coefficient of this variable is negative and significant for rural areas, which means that rural households that own sewing machines have a lower probability of being poor.

Furthermore, it is interesting to see the difference between poverty predictors and hardcore poverty predictors. Table 1.6 reveals that after implementing a stepwise procedure, fewer significant predictors for the hardcore poor are retained compared with those for the poor. For instance, the results indicate that relative to households with heads having education less than primary level, the higher the education level of the household head, the lower the probability of that the household is poor. For the hardcore poor, results indicate that only households whose heads are at least graduates from senior high school have significant lower probability of being hardcore poor.

The accuracy of predicting actual poverty using Method 2 can also be observed. The predicted value of the dependent variable is the probability of households to be poor given their characteristics. To classify households into predicted poor and predicted nonpoor, we need a threshold to separate these two groups of households. Following Pritchett, Suryahadi, and Sumarto

Table 1.5 **Results of the Poverty Probability Model**
(Dependent Variable: 1 = Poor, 0 = Otherwise)

Predictors	Urban Areas	Rural Areas
Asset Ownership		
this household owns a sewing machine		-0.118**
		[0.033]
this household owns a radio	-0.110**	-0.130**
	[0.030]	[0.018]
this household owns a television	-0.243**	-0.171**
	[0.032]	[0.022]
this household owns a refrigerator	-0.408**	-0.319**
	[0.051]	[0.063]
this household owns jewelry	-0.225**	-0.223**
	[0.028]	[0.019]
this household owns a satellite dish		-0.291**
		[0.071]
this household owns a bicycle or a boat		-0.159**
		[0.019]
this household owns a motorcycle	-0.544**	-0.471**
	[0.041]	[0.030]
this household owns a car	-0.488**	-0.380**
	[0.104]	[0.083]
Animal Ownership		
this household owns a cow		0.065**
		[0.022]
this household owns a chicken		-0.106**
		[0.017]
this household owns other animal	0.403**	
	[0.141]	
House Characteristics		
wall of the house is made from concrete	-0.206**	-0.137**
	[0.032]	[0.021]
floor of the house is dirt floor	0.214**	0.144**
	[0.049]	[0.023]
toilet type of the house is flush	-0.220**	-0.133**
	[0.031]	[0.023]
this household uses its own toilet	-0.105**	
	[0.032]	
this household has electricity	-0.232**	-0.194**
	[0.060]	[0.022]
this household's source of water is from protected well or water pump	-0.231**	-0.150**
	[0.036]	[0.019]
Household Characteristics		
household head age	-0.035**	-0.033**
	[0.006]	[0.004]
household head age squared	0.000**	0.000**
	[0.000]	[0.000]
spouse age		-0.002**
		[0.001]
household head finishes primary education	-0.111**	-0.082**
	[0.034]	[0.021]
household head finishes junior secondary education	-0.210**	-0.134**
	[0.043]	[0.034]
household head finishes senior secondary education	-0.271**	-0.245**
	[0.044]	[0.041]
household head finishes tertiary education	-0.640**	-0.517**
	[0.104]	[0.126]
spouse finishes primary education		0.087**
		[0.021]
household size	0.627**	0.649**
	[0.028]	[0.021]

(continued on next page)

Table 1.5 continued

Predictors	Urban Areas	Rural Areas
household size squared	-0.030**	-0.032**
	[0.002]	[0.002]
dependency ratio of this household is more than 0.5	0.284**	0.200**
	[0.041]	[0.027]
household head is working		-0.119**
		[0.036]
spouse is working	-0.110**	
	[0.028]	
household head is working in the formal sector		-0.099**
		[0.026]
at least one school-age child (6–15 years old) in this household has dropped out of school	0.172**	0.122**
	[0.042]	[0.025]
at least one school-age child (6–15 years old) in this household is working		-0.098**
		[0.033]
main source of income for this household is from agricultural sector	0.143**	0.094**
	[0.037]	[0.022]
every household member has different clothing for different activities	-0.295**	-0.389**
	[0.065]	[0.040]
when a member in this household is sick, s/he is treated with modern medicine		-0.113**
		[0.027]
Consumption Pattern		
this household consumed beef in the past week	-0.346**	-0.405**
	[0.056]	[0.053]
this household consumed egg in the past week	-0.328**	-0.325**
	[0.027]	[0.019]
this household consumed milk in the past week	-0.573**	-0.644**
	[0.047]	[0.045]
this household consumed biscuit in the past week	-0.207**	-0.205**
	[0.045]	[0.031]
consumed bread in the past week	-0.209**	-0.221**
	[0.032]	[0.022]
this household consumed banana in the past week	-0.139**	-0.291**
	[0.040]	[0.026]
this household consumed *tiwul* in the past week		0.162**
		[0.055]
Constant	-1.432**	0.172
	[0.174]	[0.107]
Province dummy variables included	Yes	Yes
Number of observations	23,847	34,649
Pseudo R-squared	0.362	0.288

** Significant at 1%; * Significant at 5%
[ ] Robust standard errors in bracket
Source: Authors' calculation based on 2002 SUSENAS.

(2000) and Suryahadi and Sumarto (2003a and 2003b), we use a 50 percent probability of being poor as the threshold. Hence, households which have 50 percent or higher probability to be poor are classified as predicted poor, while households which have less than fair probability to be poor are classified as predicted nonpoor. Using this 50 percent probability threshold, Tables 1.7 and 1.8 show, respectively, the cross tabulations between the actual and predicted poverty conditions.

Table 1.6 **Results of the Poverty Probability Model**
(Dependent Variable: 1= Hardcore Poor, 0 = Otherwise)

Predictors	Urban Areas	Rural Areas
Asset Ownership		
this household owns a sewing machine		-0.135**
		[0.044]
this household owns a radio	-0.124**	-0.152**
	[0.042]	[0.022]
this household owns a television	-0.322**	-0.159**
	[0.044]	[0.027]
this household owns a refrigerator	-0.332**	-0.305**
	[0.088]	[0.092]
this household owns jewelry	-0.213**	-0.248**
	[0.040]	[0.023]
this household owns a satellite dish		-0.448**
		[0.111]
this household owns a bicycle or a boat		-0.175**
		[0.023]
this household owns a motorcycle	-0.315**	-0.413**
	[0.064]	[0.042]
this household owns a car	-0.682**	
	[0.236]	
Animal Ownership		
this household owns a chicken		-0.101**
		[0.021]
House Characteristics		
wall of the house is made from concrete	-0.286**	-0.166**
	[0.043]	[0.026]
floor of the house is dirt floor		0.135**
		[0.026]
toilet type of the house is flush	-0.189**	
	[0.045]	
this household uses its own toilet	-0.148**	
	[0.045]	
this household has electricity		-0.237**
		[0.025]
this household's source of water is from protected well or water pump	-0.168**	-0.149**
	[0.047]	[0.022]
Household Characteristics		
household head age	-0.028**	-0.032**
	[0.008]	[0.005]
household head age squared	0.000**	0.000**
	[0.000]	[0.000]
spouse age		-0.002**
		[0.001]
household head finishes senior secondary education	-0.283**	-0.165**
	[0.066]	[0.052]
household head finishes tertiary education	-0.960**	
	[0.287]	
spouse finishes primary education		0.066**
		[0.023]
household size	0.509**	0.590**
	[0.039]	[0.023]
household size squared	-0.022**	-0.028**
	[0.003]	[0.002]
dependency ratio of this household is more than 0.5	0.325**	0.165**
	[0.053]	[0.030]
household head is working		-0.180**
		[0.042]
household head is working in the formal sector		-0.180**
		[0.033]

(continued on next page)

Table 1.6 continued

Predictors	Urban Areas	Rural Areas
at least one school-age child (6–15 years old) in this household has dropped out of school	0.141**	0.116**
	[0.052]	[0.026]
main source of income for this household is from agricultural sector	0.138**	0.101**
	[0.048]	[0.027]
every household member has different clothing for different activities	-0.382**	-0.366**
	[0.081]	[0.042]
when a member in this household is sick, s/he is treated with modern medicine		-0.152**
		[0.032]
Consumption Pattern		
every household member eats at least twice a day	-0.452**	-0.276**
	[0.118]	[0.073]
this household consumed beef in the past week	-0.455**	-0.494**
	[0.094]	[0.070]
this household consumed egg in the past week	-0.414**	-0.416**
	[0.040]	[0.025]
this household consumed milk in the past week	-0.627**	-0.689**
	[0.085]	[0.067]
this household consumed biscuit in the past week		-0.210**
		[0.040]
this household consumed bread in the past week	-0.249**	-0.195**
	[0.048]	[0.028]
this household consumed banana in the past week		-0.301**
		[0.034]
this household consumed *tiwul* in the past week		0.185**
		[0.057]
Constant	-1.506**	-0.081
	[0.231]	[0.140]
Province dummy variables included	Yes	Yes
Observations	23759	34649
Pseudo R-squared	0.352	0.28

** Significant at 1%; * Significant at 5%
[ ] Robust standard errors in bracket
Source: Authors' calculation based on 2002 SUSENAS.

Table 1.7 shows that 35.6 percent of the poor are predicted correctly in urban areas and less than 3.0 percent of the nonpoor are predicted to be poor. Meanwhile, in rural areas about 52.7 percent of the poor are predicted correctly, even though the percentage of the nonpoor predicted to be poor is also higher, 9.5 percent.[6] Prediction for urban areas is much less accurate than using Method 1, where almost 50 percent of the poor are correctly predicted. However, the prediction in rural areas is better than when using Method 1.

Table 1.8 shows that predicted hardcore poverty is even less accurate than predicted poverty. Comparing Table 1.8 with Table 1.4, Method 2 makes worse predictions than Method 1. Thus, the only instance where prediction

6 The authors readily admit that changing the 50 percent threshold of poverty probability will also change the accuracy. For example, by using 30 percent as the threshold, we get higher accuracy. However, using less than 50 percent as a threshold is hard to justify, thus, the authors opt to use the 50 percent threshold, which implies even chances for poor and nonpoor.

is better when using Method 2 than Method 1 is for predictions of poverty in rural areas.

Wealth Index PCA Method

Table 1.9 provides the scoring factor, mean, and standard deviation of each variable for urban areas, while Table 1.10 provides those for rural areas. The mean of the indexes in both areas are zero by construction.

The fifth column, scoring factor/standard deviation, is the increase in the wealth index if the household moves from *0* to *1* on a dummy variable. For example, a household in urban areas will increase its wealth index by 0.71 if it owns a car. Car ownership has the highest score, while living in a dirt-floor residence has the most negative score. For rural areas, the highest score is obtained with a spouse having a tertiary education, which increases the index by 1.1, and the lowest score is if the household is in the agricultural sector, which dropped the index to -0.47.

Table 1.7 **Accuracy of Predicting Poverty Using the Poverty Probability Model**

Percentage of Urban Poverty

		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	97.07	2.93
	Poor	64.44	35.56

Percentage of Rural Poverty

		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	90.49	9.51
	Poor	47.33	52.67

Source: Authors' calculation.

Table 1.8 **Accuracy of Predicting Hardcore Poverty Using the Poverty Probability Model**

Percentage of Urban Poverty

		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	99.66	0.34
	Poor	87.89	12.11

Percentage of Rural Poverty

		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	97.62	2.38
	Poor	73.67	26.33

Source: Authors' calculation.

Table 1.11 shows a cross tabulation between terciles of households based on the wealth index as a measure of predicted consumption expenditure and terciles of households based on actual per capita consumption expenditure for urban and rural areas. In urban areas, 51.1 percent of those in the bottom 30 percent and 54.6 percent of those in the top 30 percent are predicted correctly using Method 3. On the other hand, in rural areas 47.4 percent of those in the bottom 30 percent and 50.3 percent of those in the top 30 percent are accurately predicted. The accuracy of this approach is much lower than that achieved by Method 1, where more than 60 percent of each tercile is predicted correctly.

To measure the performance of this approach in predicting poverty, a threshold is needed to divide households into those that are predicted as poor and those predicted as nonpoor. Since there is no such threshold in the wealth index that can be calculated objectively, it is assumed that the

Table 1.9 **Summary Statistics and Eigen-value**
(First Principal Component), Urban Area

Predictors	Scoring Factor	Mean	Standard Deviation	Scoring Factor / Std Dev
this household owns a sewing machine	0.175	0.253	0.435	0.40
this household owns a radio	0.208	0.781	0.413	0.50
this household owns a television	0.286	0.729	0.445	0.64
this household owns a refrigerator	0.305	0.303	0.460	0.66
this household owns jewelry	0.226	0.604	0.489	0.46
this household owns a satellite dish	0.178	0.111	0.314	0.57
this household owns a bicycle or a boat	0.083	0.401	0.490	0.17
this household owns a motorcycle	0.233	0.294	0.456	0.51
this household owns a car	0.200	0.086	0.280	0.71
this household owns land	0.015	0.264	0.441	0.03
this household owns the house they're living in	0.038	0.871	0.335	0.11
roof of the house is made from tile	0.034	0.618	0.486	0.07
wall of the house is made from concrete	0.173	0.701	0.458	0.38
floor of the house is dirt floor	-0.149	0.046	0.210	-0.71
toilet type of the house is flush	0.235	0.702	0.457	0.51
this household uses its own toilet	0.251	0.697	0.460	0.55
this household has electricity	0.139	0.968	0.176	0.79
this household's source of water is from protected well or water pump	0.115	0.867	0.340	0.34
this household owns a cow	-0.055	0.019	0.137	-0.40
this household owns a goat	-0.048	0.019	0.135	-0.35
this household owns chicken	-0.053	0.152	0.359	-0.15
this household owns other animal	-0.009	0.005	0.074	-0.12
household head age	-0.001	44.740	13.639	0.00
spouse age	0.138	31.580	18.389	0.01
household head finishes primary education	-0.105	0.247	0.431	-0.24
household head finishes junior secondary education	-0.005	0.165	0.371	-0.01
household head finishes senior secondary education	0.138	0.290	0.454	0.30
household head finishes tertiary education	0.180	0.097	0.297	0.61
spouse finishes primary education	-0.050	0.240	0.427	-0.12
spouse finishes junior secondary education	0.055	0.144	0.351	0.16
spouse finishes senior secondary education	0.184	0.194	0.395	0.47
spouse finishes tertiary education	0.139	0.048	0.214	0.65
household size	0.128	4.335	1.870	0.07
dependency ratio of this household is more than 0.5	0.001	0.092	0.289	0.00
household head is working	0.056	0.846	0.361	0.15
spouse is working	0.073	0.352	0.478	0.15
household head is married	0.144	0.829	0.376	0.38
household head is working in formal sector	0.176	0.535	0.499	0.35
at least one school-age child (6–15 years old) in this household has dropped out of school	-0.054	0.077	0.266	-0.20
at least one school-age child (6–15 years old) in this household is working	-0.022	0.025	0.156	-0.14
main source of income for this household is from agricultural sector	-0.136	0.093	0.290	-0.47
every household member eats at least twice a day	0.024	0.987	0.113	0.21
every household member has different clothing for different activities	0.083	0.974	0.161	0.52
when a member in this household is sick, s/he is treated with modern medicine	0.091	0.926	0.262	0.35
this household consumed *gaplek* in the past week	-0.003	0.004	0.061	-0.05
this household consumed *tiwul* in the past week	-0.007	0.001	0.033	-0.21
this household consumed beef in the past week	0.159	0.147	0.354	0.45
this household consumed egg in the past week	0.143	0.634	0.482	0.30
this household consumed milk in the past week	0.188	0.247	0.431	0.44
this household consumed biscuit in the past week	0.072	0.130	0.336	0.21
this household consumed bread in the past week	0.075	0.280	0.449	0.17
this household consumed banana in the past week	0.089	0.180	0.384	0.23
PCA Index		0.000	2.207	

Std dev = standard deviation
Source: Authors' calculation.

Table 1.10 **Summary Statistics and Eigen-value** (First Principal Component), Rural Area

Predictors	Scoring Factor	Mean	Standard Deviation	Scoring Factor / Std Dev
this household owns a sewing machine	0.174	0.123	0.329	0.53
this household owns a radio	0.202	0.603	0.489	0.41
this household owns a television	0.301	0.377	0.485	0.62
this household owns a refrigerator	0.214	0.050	0.218	0.98
this household owns jewelry	0.202	0.463	0.499	0.41
this household owns a satellite dish	0.183	0.046	0.209	0.88
this household owns a bicycle or a boat	0.118	0.426	0.494	0.24
this household owns a motorcycle	0.240	0.163	0.369	0.65
this household owns a car	0.131	0.025	0.156	0.84
this household owns land	-0.062	0.722	0.448	-0.14
this household owns the house they're living in	-0.004	0.945	0.228	-0.02
roof of the house is made from tile	0.060	0.591	0.492	0.12
wall of the house is made from concrete	0.213	0.419	0.493	0.43
floor of the house is dirt floor	-0.164	0.217	0.412	-0.40
toilet type of the house is flush	0.269	0.264	0.441	0.61
this household uses its own toilet	0.1914	0.447	0.497	0.38
this household has electricity	0.216	0.736	0.441	0.49
this household's source of water is from protected well or water pump	0.168	0.504	0.500	0.34
this household owns a cow	-0.066	0.179	0.384	-0.17
this household owns a goat	-0.049	0.114	0.318	-0.16
this household owns a chicken	-0.035	0.465	0.499	-0.07
this household owns other animal	-0.013	0.014	0.117	-0.11
household head age	-0.072	45.905	14.043	-0.01
spouse age	0.069	32.770	18.249	0.00
household head finishes primary education	-0.003	0.339	0.474	-0.01
household head finishes junior secondary education	0.073	0.094	0.292	0.25
household head finishes senior secondary education	0.185	0.095	0.293	0.63
household head finishes tertiary education	0.140	0.019	0.136	1.03
spouse finishes primary education	0.039	0.300	0.458	0.09
spouse finishes junior secondary education	0.099	0.072	0.258	0.38
spouse finishes senior secondary education	0.170	0.055	0.228	0.75
spouse finishes tertiary education	0.108	0.010	0.098	1.10
household size	0.073	4.129	1.759	0.04
dependency ratio of this household is more than 0.5	-0.014	0.113	0.317	-0.05
household head is working	0.040	0.923	0.267	0.15
spouse is working	0.028	0.501	0.500	0.06
household head is married	0.115	0.855	0.352	0.33
household head is working in the formal sector	0.232	0.239	0.426	0.54
at least one school-age child (6–15 years old) in this household has dropped out of school	-0.072	0.148	0.355	-0.20
at least one school-age child (6–15 years old) in this household is working	-0.053	0.068	0.251	-0.21
main source of income for this household is from agricultural sector	-0.222	0.596	0.491	-0.45
every household member eats at least twice a day	0.029	0.986	0.116	0.25
every household member has different clothing for different activities	0.084	0.962	0.192	0.44
when a member in this household is sick, s/he is treated with modern medicine	0.108	0.892	0.311	0.35
this household consumed *gaplek* in the past week	-0.030	0.012	0.107	-0.28
this household consumed *tiwul* in the past week	-0.038	0.021	0.144	-0.26
this household consumed beef in the past week	0.118	0.048	0.215	0.55
this household consumed egg in the past week	0.163	0.368	0.482	0.34
this household consumed milk in the past week	0.169	0.088	0.283	0.60
this household consumed biscuit in the past week	0.072	0.103	0.303	0.24
this household consumed bread in the past week	0.077	0.208	0.406	0.19
this household consumed banana in the past week	0.054	0.144	0.351	0.15
PCA Index		0.000	2.180	

Std dev = standard deviation
Source: Authors' calculation.

Table 1.11 **Accuracy of Predicting Per Capita Consumption Expenditure Using the Wealth Index Principal Component Analysis**

Percentage of Urban Consumption Expenditure				
		Predicted based on wealth index		
		Bottom 30%	*Middle 40%*	*Top 30%*
Actual	*Bottom 30%*	51.10	41.52	7.38
	Middle 40%	25.79	45.69	28.52
	Top 30%	14.51	30.89	54.61

Percentage of Rural Consumption Expenditure				
		Predicted based on wealth index		
		Bottom 30%	*Middle 40%*	*Top 30%*
Actual	*Bottom 30%*	47.35	40.73	11.92
	Middle 40%	26.84	44.78	28.38
	Top 30%	16.85	32.90	50.25

Source: Authors' calculation.

threshold is the value of the wealth index at the percentile of the actual poverty rate. For example, if the poverty rate is X percent, then the threshold is the value of the wealth index at the X^{th} percentile. In other words, this is the threshold which will result in X percent predicted poverty rate, which is the same as the actual poverty rate. Using this threshold, Tables 1.12 and 1.13 show the cross tabulation between actual and predicted rates for poverty and hardcore poverty, respectively.

Table 1.12 **Accuracy of Predicting Poverty Using the Wealth Index Principal Component Analysis**

Percentage of Urban Poverty			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	90.14	9.86
	Poor	64.72	35.28

Percentage of Rural Poverty			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	78.12	21.88
	Poor	53.68	46.32

Source: Authors' calculation.

Table 1.12 reveals that only 35.3 percent of the poor in urban areas are predicted correctly, making the wealth index PCA the least accurate of the three approaches for predicting poverty. However, 46.3 percent of poor people in rural areas are predicted correctly, which is a higher rate than when Method 1 is used (45.7 percent) but lower when Method 2 is used (52.7 percent).

Table 1.13 **Accuracy of Predicting Hardcore Poverty Using the Wealth Index Principal Component Analysis**

Percentage of Urban Poverty			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	96.43	3.57
	Poor	81.68	18.32

Percentage of Rural Poverty			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	89.20	10.80
	Poor	68.14	31.86

Source: Authors' calculation.

Meanwhile, in predicting hardcore poverty, 31.9 percent of the hardcore poor in rural areas and 18.3 percent in urban areas are predicted correctly when the wealth index PCA is used (Table 1.13). Compared with the performance of the other approaches in predicting hardcore poverty, the accuracy of this approach is higher than Method 2 but lower than Method 1.

Conclusion

In the face of the difficulties in acquiring household expenditure and income data, three methods for predicting poverty were explored in this study. These three approaches were the consumption correlates model, poverty probability model, and wealth index PCA. In terms of predicting expenditure, the consumption correlates model is the best approach as it is able to predict correctly the poverty status of more than 60 percent of the respondents in both urban and rural areas.

In terms of predicting poverty and hardcore poverty, the results were mixed. In hardcore poverty prediction, the best approach was by far the consumption correlates model. In predicting poverty, the poverty probability model was the best predictor for rural areas (52.7 percent accurate), while for urban areas the consumption correlates model provided the best result (49.6 percent accurate). In conclusion, the consumption model is, all things being equal, the best approach to be used to find expenditure and poverty predictors.

A common thread in the predictions is that the better poverty prediction is, the more nonpoor are predicted to be poor. Thus, the method that makes the most accurate prediction, also predicts the most nonpoor to be poor.

Furthermore, empirical results show that variables with the strongest correlates, negative or positive, are car and refrigerator ownership, education level, household size, and consumption of milk and beef. In addition, playing relatively small but significant roles are house characteristics, access to facilities, and employment status of household members. Thus, for a rough assessment on whether a household is more likely to be poor or not in Indonesia, it would be best to gather information on asset ownership, education level, and consumption patterns.

Further avenues of research on this subject include finding methods to take into account the quality or prices of assets owned or food consumed, since quality can also distinguish nonnegligibly between poor and nonpoor households.

Appendix

Appendix 1.1 List of Variables Used to Estimate Expenditure and Poverty Predictors

Group	Variable	Description
Asset	own_sewing machine	this household owns a sewing machine
	own_radio	this household owns a radio
	own_tv	this household owns a television
	own_fridge	this household owns a refrigerator
	own_jewelry	this household owns jewelry
	own_satdish	this household owns a satellite dish
	own_bikeboat	this household owns a bicycle or a boat
	own_motorcycle	this household owns a motorcycle
	own_car	this household owns a car
	own_land	this household owns land
	own_house	this household owns the house they are living in
House	tile roof	roof of the house is made from tile
	concrete wall	wall of the house is made from concrete
	dirtfloor	floor of the house is made from dirt
	flushtoilet	toilet type of the house is flush
	own_toilet	this household uses its own toilet
	electric_light	this household has electricity
	protectedwatersrc	this household's source of water is from protected well or water pump
Farm	own_cow	this household owns a cow
	own_goat	this household owns a goat
	own_chicks	this household owns a chicken
	own_othanim	this household owns other animal
Household	age	household head age
	spage	spouse age
	elm	household head finishes primary education
	lsec	household head finishes junior secondary education
	usec	household head finishes senior secondary education
	ter	household head finishes tertiary education
	spelm	spouse finishes primary education
	splsec	spouse finishes junior secondary education
	spusec	spouse finishes senior secondary education
	spter	spouse finishes tertiary education
	fsize	household size
	deprhigh	dependency ratio of this household is more than 0.5
	headwork	household head is working
	spwork	spouse is working
	marr	household head is married
	formal	household head is working in the formal sector
	child_dropout	at least one school-age child (6–15 years old) in this household has dropped out of school
	child_work	at least one school-age child (6–15 years old) in this household is working
	in_agric	main source of income for this household is from agricultural sector
	eattwice	every household member eats at least twice a day
	clothes	every household member has different clothing for different activities
	usemodernmed	when a member in this household is sick, s/he is treated with modern medicine
Consumption	cgaplek	this household consumed *gaplek* (dried cassava) in the past week
	ctiwul	this household consumed *tiwul* (cassava flour) in the past week
	cbeef	this household consumed beef in the past week
	cegg	this household consumed *egg* in the past week
	cmilk	this household consumed milk in the past week
	cbiscuit	this household consumed biscuit in the past week
	cbread	this household consumed bread in the past week
	cbanana	this household consumed banana in the past week

Note: Variables are binary (0/1) variables, except age, spage, fsize.
Source: Authors' calculation based on 2002 SUSENAS.

Appendix 1.2 **Poverty Lines in February 1999**
(Rp per capita per month)

Province	Poverty Line		Food Poverty Line	
	Urban	Rural	Urban	Rural
Nanggroe Aceh Darussalam	74,064	70,280	60,733	60,003
North Sumatera	83,745	74,712	66,803	63,753
West Sumatera	85,409	78,762	69,668	66,416
Riau	92,970	82,420	73,812	70,654
Jambi	85,874	77,104	68,078	65,841
South Sumatera	86,154	80,033	68,830	67,585
Bengkulu	86,714	77,750	67,958	64,806
Lampung	89,018	78,725	70,959	64,635
Jakarta	103,279	n.a.	76,747	n.a.
West Java	95,017	86,143	71,868	69,287
Central Java	85,667	78,897	66,306	62,559
Yogyakarta	93,078	83,872	70,168	65,805
East Java	85,777	80,496	66,692	64,300
Bali	99,748	94,857	76,004	74,412
West Nusa Tenggara	88,654	85,369	70,746	70,043
East Nusa Tenggara	84,639	78,923	66,198	62,581
West Kalimantan	94,185	88,768	74,734	74,762
Central Kalimantan	96,364	85,670	78,133	75,145
South Kalimantan	86,907	83,294	70,770	69,687
East Kalimantan	96,989	93,340	74,451	75,178
North Sulawesi	87,165	81,905	69,331	67,417
Central Sulawesi	81,527	77,186	64,463	62,604
South Sulawesi	84,734	74,446	66,143	61,867
Southeast Sulawesi	87,269	80,415	67,273	65,338
Maluku	102,522	100,413	76,575	78,545
Papua	88,593	98,102	70,747	74,845

Rp = rupiah
Source: Pradhan et al. 2001.

Appendix 1.3 **OLS Regression Results of the Consumption Correlates Model**		
Predictors	**Urban Areas**	**Rural Areas**
Asset Ownership		
this household owns a radio	0.076**	0.059**
	[0.014]	[0.007]
this household owns a television	0.089**	0.070**
	[0.015]	[0.008]
this household owns a refrigerator	0.363**	0.269**
	[0.022]	[0.033]
this household owns jewelry	0.099**	0.071**
	[0.014]	[0.007]
this household owns a satellite dish	0.158**	0.172**
	[0.041]	[0.033]
this household owns a motorcycle	0.221**	0.262**
	[0.021]	[0.015]
this household owns a car	1.342**	0.722**
	[0.058]	[0.082]
Animal Ownership		
this household owns chicken	-0.077**	0.024**
	[0.016]	[0.008]
House Characteristics		
roof of the house is made from tile	0.102**	
	[0.023]	
wall of the house is made from concrete	0.157**	0.061**
	[0.014]	[0.009]
floor of the house is dirt floor		-0.054**
		[0.008]
this household's source of water is from protected well or water pump	0.078**	0.045**
	[0.015]	[0.009]
toilet type of the house is flush	0.093**	0.084**
	[0.014]	[0.011]
this household uses its own toilet	0.094**	0.031**
	[0.015]	[0.007]
this household has electricity		0.092**
		[0.008]
Household Characteristics		
household head age		0.015**
		[0.002]
household head age squared		-0.000**
		[0.000]
spouse age	-0.016**	
	[0.002]	
spouse age squared	0.000**	
	[0.000]	
household head finishes primary education	0.168**	0.030**
	[0.017]	[0.008]
household head finishes junior secondary education	0.245**	0.092**
	[0.022]	[0.019]
household head finishes senior secondary education	0.395**	0.150**
	[0.026]	[0.019]
household head finishes tertiary education	0.734**	0.292**
	[0.046]	[0.042]
spouse finishes primary education	-0.123**	-0.038**
	[0.021]	[0.009]
spouse finishes junior secondary education	-0.178**	-0.051**
	[0.029]	[0.018]
spouse finishes senior secondary education	-0.214**	
	[0.033]	
at least one school-age child (6–15 years old) in this household has dropped out of school		-0.022**
		[0.008]

(continued on next page)

Appendix 1.3 continued

Predictors	Urban Areas	Rural Areas
household size	-0.605**	-0.378**
	[0.020]	[0.009]
household size squared	0.036**	0.023**
	[0.002]	[0.001]
dependency ratio of this household is more than 0.5	-0.068**	-0.058**
	[0.024]	[0.008]
spouse is working	0.072**	
	[0.016]	
at least one school-age child (6–15 years old) in this household is working	0.170**	0.057**
	[0.046]	[0.011]
household head is working in the formal sector		0.053**
		[0.011]
every household member has different clothing for different activities	0.168**	0.144**
	[0.028]	[0.012]
when a member in this household is sick, s/he is treated with modern medicine		0.048**
		[0.010]
Consumption Pattern		
every household member eats at least twice a day	0.176**	
	[0.053]	
this household consumed beef in the past week	0.348**	0.232**
	[0.031]	[0.024]
this household consumed egg in the past week	0.078**	0.111**
	[0.015]	[0.008]
this household consumed milk in the past week	0.405**	0.353**
	[0.022]	[0.023]
this household consumed biscuit in the past week	0.155**	0.064**
	[0.026]	[0.013]
this household consumed bread in the past week	0.128**	0.069**
	[0.018]	[0.010]
this household consumed banana in the past week	0.120**	0.114**
	[0.024]	[0.012]
this household consumed *tiwul* in the past week		-0.052**
		[0.018]
Constant	2.987**	1.335**
	[0.070]	[0.043]
Province dummy variables included	Yes	Yes
Number of observations	23,847	34,649
R-squared	0.44	0.36

** Significant at 1%
[ ] Robust standard errors in brackets
Note: Dependent variable real per capita expenditure is transformed into logarithmic value.
Source: Authors' calculation based on 2002 SUSENAS.

CHAPTER 2

Poverty Predictor Modeling in Indonesia: A Validation Survey

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Introduction

The objective of this chapter was to assess and verify the explanatory or predictor variables used for determining the poor. The predictor variables were based on the earlier results of the poverty predictor modeling (PPM) exercise using Indonesia's National Socioeconomic Survey (SUSENAS) discussed in Chapter 1 of this book. The PPM results were used as the basis of the analysis. The verification process was done using a local assessment and survey. The overall results were then analyzed for their significance in determining poverty, especially their usefulness in identifying the poor and improving poverty targeting.

Data and Approaches

Data used in this study emanated from a 2005 sample survey[1] of households in Bogor, West Java, and Tangerang, Banten. The sample included 624 households selected from two groups, i.e., households which were covered in the SUSENAS and households which were not covered in the SUSENAS. For comparison, the secondary data of SUSENAS 2004 for the two districts selected were used as the benchmark for classifying the households into poor and nonpoor.

The poverty predictor variables examined in this study were classified according to the following characteristics:

- ownership of electronic equipment (radio, TV, etc.);
- level of education;
- consumption pattern (no consumption of milk, meat, biscuits, or bread in a week, do not get two meals a day);
- household dependency ratio of more than 0.5;

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1 The questionnaire used in the pilot survey can be downloaded at http://www.adb.org/Statistics/reta_6073.asp.

- household attributes (earth floor, impermanent walls, no sanitary facilities, no electricity, etc.);
- main source of income coming from informal sectors; and,
- level of health (cleanliness of clothing, medication).

These variables are similar to those used in the three methods discussed in the previous chapter which were found to be significant in explaining poverty.

In addition, as a complementary measure for deducing information about household poverty status, independent assessments based on four local sources were also used to better view and assess poverty. The perceptions about household poverty status are taken from respondents, respondents' neighbors, local authorities, and enumerators.

The respondent could be one of the most reliable sources of information in assessing whether he or she is poor or nonpoor. Neighbors are another source of information that are considered to be very reliable in judging a respondent's poverty status. The local authorities, as the bureaucracy closest to the respondent, are also an important source of information in this aspect.[2] Lastly, the assessment of the enumerators, who visit the households during the survey, is also important as they are an objective source of information. These assessments, to some extent, can be used for comparison. Among all these factors, the perception of the household respondent is considered most reliable and is given a greater weight (2) than the perceptions of the other three sources which are each given a weight of 1. Setting greater weight to the respondent's perception is deliberate; it aims to improve certainty in determining the poverty status of the respondent.

With this weighting system, the lowest poverty score would be 0, which means that all sources of information perceive that the respondent household is nonpoor. In contrast, the greatest score would be 5 if all sources perceive that the respondent household is poor. If the sum of the weights of perceived poverty is 3 or more, the household is classified as poor. The result of the weighting process for all respondents is presented in Table 2.1.

Using the perception method, 363 of the total 624 household samples were classified poor and 261 nonpoor—with all four sources mostly agreeing on the classification of the households as poor or nonpoor. For example, as many as 251 of the 363 poor households were assigned a local perception weight of 5, which implies that all the sources consider these households as

2 However, uncertainty may arise due to, for instance, the presence of conflicts of interest, which tend to distort the assessment of whether the respondent is really poor.

Table 2.1 **Assessing Poverty by Using the Weighted Perception Method**

Poverty Assessment from Local Perception	*Sum of the Weight of Perceived Poverty*	*Areas*		
		Rural	*Urban*	*Rural+Urban*
Nonpoor	0	70	86	156
	1	21	14	35
	2	33	37	70
Total		124	137	261
Poor	3	38	31	69
	4	24	19	43
	5	126	125	251
Total		188	175	363
Total Respondents		312	312	624

Source: Authors' calculation.

poor. Similarly, 156 of the 261 nonpoor households were classified as such by all the sources. While perception studies are regarded as subjective by many analysts, the consensus on the poverty status of the majority of households by all sources is noteworthy and points to the usefulness of such studies.

Data Analysis Method

Data collected from the field survey were analyzed through quantitative and qualitative methods to validate variables that could be used as predictors. The quantitative method is based on the application of the poverty line based on the household's expenditures and the qualitative method is based on the perceptions of the local people in identifying the poor.

Qantitative Approach

The identification of poverty predictor variables is done by using a logistic (logit) regression model with the household poverty status of poor and nonpoor as the dependent variable (see also the discussion on Method 2 in Chapter 1 of this book). The difference between logistic and probit is that logistic analysis is based on log odds while probit uses cumulative normal probability distribution. The logistic model can be derived from the logistic probability function or opportunity spread function.[3] The probability of a respondent being poor or nonpoor can be formulated as:

$$\pi_i = \frac{e^{g(x)}}{1+e^{g(x)}}$$

$$= \frac{1}{1+e^{-g(x)}}$$

3 Logistic regression calculates changes in the log odds of the dependent variable and not changes in the dependent variable itself as in ordinary least squares regression.

Where

π_i = likelihood of a respondent having the status of poor.

$g(x) = a + bX$

indicates how quickly the probability changes with changing a single unit of X. Because the relation between X and π_i is nonlinear, the parameter b does not have a straightforward interpretation as it does in the ordinary linear regression.[4]

By taking the natural logarithm from the ratio between the probability of a respondent having the status of poor and that of nonpoor, it then follows that:

$$\ln\frac{\pi_i}{1-\pi_i} = g(x)$$

Such an equation can be determined using the maximum likelihood estimation technique specific for the logistic model which is provided in several statistics and econometrics computer programs such as Microfit (Pesaran and Pesaran 1997).

To meet the logit model requirement, the poverty status assessment results using the weighting system must be recategorized into two categories (binary scale), i.e., poor and nonpoor. Nonpoor respondents are those who have scores of 0–2, while poor respondents are those with scores of 3–5. To classify them as binary-scale variables, the nonpoor respondent is assigned the score of 0, and the poor respondent is given the score of 1. Once this is done, the estimation for validation purposes can then be conducted.

The estimation of the logit model is divided into two, for two respondent groups:

- the logit model for all respondents whose poverty status appraisal was based solely on the perception of the local community and enumerator, and
- the logit model for respondents whose poverty status appraisals are consistent between the local community's perception and the poverty-line assessment based on household expenditures.

Logit model estimations for both groups are then further defined by location: rural, urban, and total. Such divisions are made to identify the

4 See http://luna.cas.usf.edu/~mbrannic/files/regression/Logistic.html.

possibility of a difference of poverty predictors between urban and rural areas. In rural and urban area regression equations, the variable *district* is added as dummy variable; in the combination regression equation, the variable *area* is added as its dummy variable to mean either rural or urban.

Variables used in the validation are the same as those used in the initial stage of PPM. These variables were classified according to:

- ownership of farm animals, which comprise livestock (cattle, buffalo, horses, or pigs), goats, sheep, lambs, poultry (chickens or ducks), and fish;
- ownership of assets such as electronic equipment (radios or tape players, TVs, and satellite dishes), refrigerators, and telephones; vehicles (bicycles, motorcycles, cars or trucks, and carriages); and tools for production (hand tractors, crop machines, pumps, etc.);
- ownership of sanitary facilities (toilets), clean- and potable-water facilities, electrical connections, and cooking facilities;
- physical condition of the house based on floor area, and materials of the floor, walls and roof;
- household characteristics such as age, family size, members with formal education, members who are elementary school dropouts, working members, average educational attainment, dependency ratio, and occupation of the head of the family (formal or informal); and
- consumption pattern for food and nonfood items or characteristic such as rice, meat, eggs, and fish per week; clothes bought in a year; incidence of illness among members in the past six months or the previous year; and the practice of seeking medication when ill.

For each regression, a stepwise procedure is used to minimize the number of variables included in the model. Tests on reliability in predicting poverty status are also done by using cross tabulation between the predicted poverty status as a result of logit model and the status based on the local perception.

Qalitative Approach

The qualitative approach is performed to explain the various characteristics of the respondents, which comprise ownership of livestock, poultry, fish, and assets; physical condition of the house and facilities; household characteristics; and food consumption, health, and nutrition. Qualitative analysis is implemented using cross tabulation between respondents' poverty status, various characteristics, and respondents' perception.

Results

Poverty Classification and Verification

Poverty verification in this study is based on two assessment approaches: local perception and household expenditure using predetermined poverty indicators. For each approach, classifying the household respondents into poor and nonpoor is attempted.

Poverty Verification Based on Local Perception. Table 2.2 shows that based on local perception, 58.2 percent of household respondents are considered poor. Of this number, 30.1 percent were perceived to be in rural areas while 28.1 percent were in urban areas. Corollary to this, the perception is that there are more nonpoor households in the urban areas (22.0 percent) than in the rural areas (19.9 percent).

Table 2.2 **Classifying Poor and Nonpoor Households by Using the Local Perception Approach**

Respondent Status	*Area*		
	Rural	*Urban*	*Rural+Urban*
Poor	188	175	363
	30.1 %	28.0 %	58.2 %
Nonpoor	124	137	261
	19.9 %	22.0 %	41.8 %
Total	312	312	624
	50.0 %	50.0 %	100.0 %

Source: Authors' calculation.

Poverty Verification Based on Household Expenditures. Recalculating the actual poverty line is considered necessary because of the dynamic nature of the conditions of poverty. It is acknowledged that, after a year, the condition of a household may change as a result of a change in the household's expenditures. Taking this into account, the verification of the SUSENAS data for 2004 is also based on the expenditures of the household.

Poverty verification based on household expenditures is measured by taking the average threshold of monthly household expenditure per capita, which is Rp130,927[5] for Bogor and Rp132,108 for Tangerang in 2004. This implies that households with per capita expenditures lower than the thresholds for each of these districts will be considered poor, thus, these thresholds are in effect pseudo poverty lines.

The results of poverty verification based on household expenditures as shown in Table 2.3 indicate that 58.7 percent of household respondents are poor, and 41.3 percent are nonpoor. Furthermore, the number of poor households in rural areas (36.2 percent) is higher than in urban areas (22.4 percent) and the number of nonpoor households in rural areas (13.8 percent) is less than in urban areas (27.6 percent).

5 Rp stands for rupiah; US$1 is roughly about Rp9,000 (2004).

Poverty Verification Based on Both Assessment Approaches. The consistency, or the lack of it, of the poverty verification results based on local perception and household expenditures can be tracked when the results are presented in a single matrix. A cross tabulation of the results from the two different assessment methods is thus presented in such a matrix in Table 2.4. The table shows that based on local perception and household expenditure assessments, 43.1 percent of the households in rural and urban areas combined are poor and 26.3 percent are nonpoor. The rest of the observations show inconsistent results between the two assessment approaches. About 15.1 percent of the households are poor based on local perception, but they are considered nonpoor based on expenditure. On the other hand, 15.5 percent of the households are perceived as nonpoor by the local community, but, based on expenditure, they are considered poor. It is clear from these observations that results using expenditure data to identify the poor will differ by about 15.0 percentage points compared with the result using local perception, and vice versa.

Table 2.3 **Classifying Poor and Nonpoor Households by Using the Expenditure Approach of the Pilot Survey**

Respondent Status	Area		
	Rural	Urban	Rural+Urban
Poor	226	140	366
	36.2%	22.4%	58.7%
Nonpoor	86	172	258
	13.8%	27.6%	41.3%
Total	312	312	624
	50.0%	50.0%	100.0%

Source: Authors' calculation.

Table 2.4 further reveals that verification results of SUSENAS data for 2003/04 are consistent in the estimation of the proportion of poor based on pilot survey. Verification results based on local perception show the 58.2 percent of the respondents are actually poor and 41.8 percent are nonpoor. While verification based on recalculating household expenditures (using the pseudo poverty line) has fairly similar results: 58.7 percent of the households are poor and 41.3 percent are nonpoor.

Table 2.4 **Classifying Poor and Nonpoor Households by Using the Local Perception and Household Expenditure of the Pilot Survey Approaches**

		Household Expenditures		
		Poor	Nonpoor	Total
Local Perception	Poor	269	94	363
		43.1%	15.1%	58.2%
	Nonpoor	97	164	261
		15.5%	26.3%	41.8%
	Total	366	258	624
		58.7%	41.3%	100.0%

Source: Authors' calculation.

Poverty Estimation. The results of poverty estimation in rural and urban areas are, interestingly, consistent with the verification of SUSENAS data for 2004 and in the assessment approaches based on local perception and household expenditures. Even though there are slight differences, the three assessment methods are in general relatively consistent, as seen in Table 2.5.

Verification using the 2004 data shows that 48.7 percent of households (25.8 percent in rural and 22.9 percent in urban areas) are classified as

Table 2.5 **Classifying Poor and Nonpoor Households by Using SUSENAS Data, Local Perception, and Household Expenditures of the Pilot Survey Approaches**

Area	SUSENAS			Household Expenditures			Local Perceptions		
	Poor	Nonpoor	Total	Poor	Nonpoor	Total	Poor	Nonpoor	Total
Rural	25.8	24.2	50.0	36.2	13.8	50.0	30.1	19.9	50.0
Urban	22.9	27.1	50.0	22.4	27.6	50.0	28.0	22.0	50.0
Rural+Urban	48.7	51.3	100.0	58.7	41.3	100.0	58.2	41.8	100.0

SUSENAS = National Socioeconomic Survey
Source: Authors' calculation.

poor (with low-expenditure households as a proxy for poverty). However, the results are slightly different if the verification is conducted using results of recalculations based on household expenditures or local perception. About 58.7 percent households are considered poor based on expenditure assessment, i.e., 36.2 percent in rural and 22.4 percent in urban areas. The results from using local perception verification have similar results: 58.2 percent of households are considered poor, i.e., 30.1 percent in rural and 28.0 percent in urban areas.

The above information also confirms the dynamic aspect of poverty. There is a difference of about 10 percentage points between the results of the verification from pilot survey using the data and the recalculation of the poverty line based on household expenditures. About 48.7 percent households are poor according to the SUSENAS data, but 58.7 percent are poor according to the assessment based on expenditure. This means that in one year, i.e., from the 2002 SUSENAS to the 2004 SUSENAS, about 10 percent of households experienced a fall in their total expenditures and became poor. This highlights the vulnerability of people who are above but close to the poverty line.

When the SUSENAS data is verified using the results of local-perception assessment, there is a slight difference in the ratio of poor and nonpoor household groups. Based on the 2004 data, about 48.7 percent of households are poor; but, based on local perception, 58.2 percent households are considered poor. This means that 10 percent of the households considered nonpoor in the 2004 are perceived as poor by the local communities.

Predictability of Poverty Variables

Estimation Results of the Local Perception Logit Model. The results of a logistic regression model of respondents' poverty status based only on local perception (Appendix 2.1) show that the logistic models for rural, urban, and total respondents have a relatively small pseudo R-squared value. The retained predictors only explain 44.1 percent of the respondents' poverty status in rural areas and 52.3 percent in urban areas. The combination of rural and urban respondents resulted in an even smaller pseudo R-squared value (38.1 percent). Small R-squared values are, however, usually found in regression models with dichotomous variables. In predicting power, the result shows 83.3 percent is true for the model for rural areas, 86.5 percent for urban areas and 79.5 percent for the total. The following is a summary on the predictability of the retained variables.

Asset Ownership. The variables for ownership of refrigerators, TVs, and motorcycles have positive values and are significant for rural areas, while the ownership of TVs and motorcycles are significant for the urban areas. The regression for total respondents shows that the three asset-ownership variables are also significant and consistent. Since the variables are specified in terms of nonpossession of these assets, the positive values mean that households which do not have refrigerators, TVs, and motorbikes have a higher probability of being poor compared with those who have these assets.

House Characteristics. House characteristics in rural and urban areas are very different. In rural areas, the type of wall in a house has positive values, meaning that if a house does not have a brick concrete wall the household is more likely to be poor. In urban areas, the significant variable is floor area. The more spacious the house, the less likely the household is poor.

House Facility. Toilet ownership is significant in the three models and has positive values. This implies that the poor are less likely to have a toilet and nonpoor households tend to have their own toilet.

Household Characteristics. The retained variables for the model for rural areas are: a family member dropped out from elementary school, the head of family works in the informal sector, and the household dependency ratio is no more than 0.5. The first variable has a positive effect on rural poverty. The last two variables are significant in equations for both rural and urban areas as well as for total respondents. On the other hand, variables that are significant and have positive values in urban areas are: having household members who did not complete their primary education and the square of the number of working household members. A household's size has a significant and positive effect on poverty, while the number of household members with schooling has a negative effect for rural and urban areas combined. Therefore, poor households are identified as having many family members, a member or members who have dropped out of primary school, a relatively small number of working household members or a high dependency ratio, and a main wage earner who is working in the informal sector.

Consumption, Food, Nutrition, and Health. In the last group of variables, having insufficient rice (staple food) and not having eaten meat, eggs, and fish in the reference period are a positive and significant poverty predictor variable in all areas. The use of medical facilities and paramedics is also a significant poverty predictor variable with a positive coefficient in rural and urban areas combined.

Characteristics of Location. The location characteristic is a significant dummy variable. Findings shows that a rural community in Bogor has a lower probability of being poor than a rural community in Tangerang. On the other hand, an urban community in Bogor has a higher probability to be classified as poor than an urban community in Tangerang. The difference could be related to the characteristics of the two districts. Bogor is basically agrarian, with ample employment opportunities in the rural area. Tangerang, on the other hand, is basically industrial, with better employment opportunities in urban areas. This finding highlights the importance of taking characteristics of region and location into account in developing the poverty predictor model.

Estimation Results of the Perception-Expenditure Logit Model. The perception-expenditure logit model refers to the logit model estimation for respondents whose poverty status based on their expenditure is consistent with the local community's perception. The results (Appendix 2.2) are similar to the results from the poverty estimation model in terms of variable and estimation procedures.

Analyzing respondents with consistent perception-expenditure results from the model, shows that the pseudo R-square value increased compared with the previous estimate of 38.1 percent. In rural areas, the model can be used to explain 66.4 percent of the respondents' poverty status; in urban areas, 76.6 percent can be explained; and, for all respondents, 66.3 percent can be explained. In addition, there are some new predictor variables that resulted from this model. The variables of ownership of cows in rural areas and sheep in urban areas were found to be significant in predicting poverty.

The variables of TV and motorbike ownership remain significant in rural areas. In urban areas, however, the ownership of telephones, radios or tape recorders, and motorbikes are significant. For total respondents, however, the ownership of a radio or tape recorder becomes insignificant.

House ownership was not significant among rural, urban, or total respondents and so it was not used as a poverty predictor variable in the perception-expenditure model. On the other hand, the use of simple cooking utensils powered by wood is a poverty indicator in rural areas. In urban areas, the ownership of toilet is a significant predictor variable, which is consistent with the finding from the poverty estimation discussed in the previous section

Household-specific variables show that family size, education level of household members, and household-head employment are important poverty predictor variables. Having rice and eating meat, eggs, and fish in the past week are consistent with the previous estimation result. A new variable on health appears in urban areas: a household whose members are frequently sick has a higher probability of being poor.

In general, the estimate for the perception-expenditure model results in some main poverty predictors such as:

- non-ownership of electronics (TV, radio, or tape recorder), refrigerator, telephone, or motorbike;
- house has no personal toilet and the household uses simple cooking utensils fired by wood in rural areas;
- large family size, small number of household members in school, and low average education level of household members;
- family earner works in the informal sector and relatively small number of working household members (high dependency ratio, less than 0.5) and;
- not owning sufficient staple food (rice), nutrition deficiency (unable to consume meat, eggs, and fish at least once a week), and poor health and inability to visit a general practitioner or hospital for medical care.

Compared with the SMERU result based on the SUSENAS data, several variables out of the seven indicators of poverty are consistent except household characteristics. In this study, family size is an important poverty indicator compared with the SMERU result. In addition, household's inability to have sufficient rice and use of firewood as a fuel are also poverty predictors in rural areas in this study but not in SMERU.

Accuracy of the Predictor Variables. The capability of predictor variables to explain poverty can also be seen by comparing the actual poverty status of the household with the predicted poverty status. The predictive value for the dependent variable is distributed as *0* or *1*, thus, requiring households to be classified as poor or nonpoor. This means a clustering process can be done automatically using the Microfit computer program. In this context, households with more than 50 percent probability of being poor are classified as poor and, conversely, nonpoor if the probability is less than 50 percent.[6]

By cross tabulating the actual and predicted household poverty status, two sets of results can be obtained. The first is shown on Table 2.6 based on

6 This classification technique is commonly applied in econometrics (Verbeek 2000). The classification used here is slightly different than the classification used in the study by Sumarto, Suryadarma, and Suryahadi (Chapter 1 of this book). In that study, households with more than 50 percent poverty probability were classified as poor (see also Sumarto 2004).

local community's perception and the second is shown in Table 2.7 based on consistent perception-expenditure respondents.

Table 2.6 indicates that 47.8 percent of total households in rural and urban areas together are classified as poor and 29.5 percent as nonpoor. The accuracy and effectiveness of poverty indicators can be obtained by adding the primary diagonal elements in the table. For example, the effectiveness of the poverty indicator[7] for rural areas is 83.4 percent–the sum of the percentage of households that were predicted to be nonpoor and were actually nonpoor (29.2 percent) and the percentage that were predicted to be poor that were actually poor (54.2 percent). For urban and total respondents, therefore, the effectiveness of the poverty indicator is 86.6 percent, and 77.3 percent, respectively. The numbers demonstrate the combined accuracy of predicting the poor and nonpoor. Note that 9.9 percent and 7.4 percent of households, who are actually nonpoor, were predicted to be poor in rural and urban areas, respectively. On the other hand, 6.7 percent and 6.1 percent of households who are actually poor, were predicted as nonpoor in rural and urban areas, respectively.

Table 2.6 **Predicting Poor and Nonpoor Using the Logit Model for All Respondents**

		Predicted					
		Rural		*Urban*		*Rural + Urban*	
		Nonpoor	*Poor*	*Nonpoor*	*Poor*	*Nonpoor*	*Poor*
Actual	*Nonpoor*	29.2%	9.9%	36.9%	7.4%	29.5%	12.3%
	Poor	6.7%	54.2%	6.1%	49.7%	10.4%	47.8%

Source: Authors' calculation.

Table 2.7 **Predicting Poor and Nonpoor Using the Logit Model for Respondent with Consistent Poverty Status Based on Perception-Expenditure Approaches**

		Predicted					
		Rural		*Urban*		*Rural+Urban*	
		Nonpoor	*Poor*	*Nonpoor*	*Poor*	*Nonpoor*	*Poor*
Actual	*Nonpoor*	20.3%	4.5%	35.9%	13.4%	32.3%	5.5%
	Poor	2.5%	72.8%	4.3%	46.3%	3.5%	58.7%

Source: Authors' calculation.

In the group of respondents having consistent poverty status based on perception and expenditure, the effectiveness of prediction is higher, i.e., 93.1 percent, 82.2 percent, and 91.0 percent for rural, urban, and total respondents, respectively. As a result, the prediction margin of error is minimized at 7 percent for rural and total households, and 17.8 percent for urban households. Based on this result, the effectiveness of significant variables in the logit model is quite high and could be used as poverty predictors in rural and urban areas.

7 This refers to the sum of the primary diagonal elements in Table 2.6.

Appendix

Appendix 2.1 **Results of Logit Model Using SUSENAS Data**
(Dependent Variable: 1 = Poor, 0 = Otherwise)

Predictor	Rural	Urban	Rural-Urban
Asset Ownership			
household has no refrigerator (1 = yes, 0 = otherwise)	2.5497 * (2.7777)	-	0.99917 ** (2.3669)
household has no television (1 = yes, 0 = otherwise)	.94076* (2.7540)	1.2358* (2.9711)	0.75323* (3.1516)
household has no motorcycle (1 = yes, 0 = otherwise)	1.7534* (3.5333)	1.2285** (2.2257)	1.3661 * (4.1772)
House Characteristics			
area of the floor of the house (in m2)	-	-0.0081** (-2.0726)	-
wall of the house is not made from concrete brick (1 = yes, 0 = otherwise)	1.4996* (4.2669)	-	0.63639 * (2.8749)
House Facility			
household has no toilet (1 = yes, 0 = otherwise)	0.78152 ** (2.0539)	1.4393* (3.6155)	1.0624* (4.4039)
Household Characteristics			
Household size (in person)	-	-	0.23871* (3.0599)
household members schooling (in person)	-	-	-0.26253*** (-1.9314)
average household education did not finish primary school (1 = yes, 0 = otherwise)	-	1.2100* (2.8863)	1.0800* (4.6711)
household members have dropped out of primary school (1 = yes, 0 = otherwise)	0.91053 ** (2.1784)	-	-
square of number of household members who are working (in person)	-	0.18311* (2.9057)	-
head of household work in informal sector (1 = yes, 0 = otherwise)	2.1656* (4.7848)	1.6854* (3.5813)	0.67244** (2.0749)
dependency ratio of this household is less than 0.5 (1 = yes, 0 = otherwise)	0.9246** (2.1262)	1.9828* (3.9781)	0.90756* (3.3196)
Consumption, Food, Nutrition and Health			
this household has insufficient rice consumption (1 = yes, 0 = otherwise)	2.2314** (2.5507)	0.89972 (1.5858)	1.6790* (4.0677)
household that has not consumed meat, egg or fish in the past week (1 = yes, 0 = otherwise)	2.3752* (4.3885)	1.5896* (3.1905)	0.72304** (2.4352)
treated at the local health centre (Puskesmas). medical aide (mantri), midwife (bidan) or traditionally (1 = yes, 0 = otherwise)	-	0.72577*** (1.8511)	-
Dummy Variable for District and Rural-Urban Area			
dummy variable for district (1 = Bogor, 0 = otherwise)	-1.4041* (-3.5623)	2.1659* (4.4066)	-
dummy variable for rural-urban area (1 = rural, 0 = otherwise)	-	-	-0.52526 (-2.2028)
Constant	-6.6374* (-5.6238)	-6.4282* (-6.6906)	-5.1900* (-8.3197)
Goodness of fit	0.83333	0.86538	0.79487
Pseudo R-squared	0.44112	0.52338	0.38120
Numbers of Observation	312	312	624

*** Significant at 10%; ** Significant at 5%; * Significant at 1%
SUSENAS = National Socioeconomic Survey
Source: Authors' calculation based on 2004 SUSENAS.

Appendix 2.2 **Logit Model Results with Consistent Poverty Status Based on Perception and Expenditure Approaches (Dependent Variable: 1 = Poor, 0 = Otherwise)**

Variable	Rural	Urban	Rural-Urban
Animal Ownership			
household has no goat (1 = yes, 0 = otherwise)	-	1.9877** (2.2427)	-
household has no cow or buffalo (1 = yes, 0 = otherwise)	2.6187** (2.3838)	-	-
Asset Ownership			
household has no telephone (1 = yes, 0 = otherwise)	-	5.8899* (3.3749)	3.1160* (2.6862)
household has no radio and tape recorder (1 = yes, 0 = otherwise)	-	1.8490* (2.9378)	-
household has no refrigerator (1 = yes, 0 = otherwise)	-	-	2.4053* (2.8421)
household has no television (1 = yes, 0 = otherwise)	1.7068 ** (2.2640)	-	.84419 ** (2.0015)
household has no motorcycle (1 = yes, 0 = otherwise)	2.3037** (2.1901)	5.2100* (3.1299)	2.1997 * (3.4043)
House Facility			
household uses firewood (1 = yes, 0 = otherwise)	2.6151* (3.5262)	-	-
Household has no toilet (1 = yes, 0 = otherwise)	-	2.4252* (3.1952)	0.95967** (2.4583)
Household Characteristics			
household representative age (in year)	-	-	0.0249*** (1.9341)
household size (in person)	1.2020* (3.6570)	1.1673* (4.5025)	0.86228* (5.1340)
household members at school (in person)	-1.1316** (-2.3962)	-	-0.58246** (-2.1169)
average household education not graduating primary school (1 = yes, 0 = otherwise)	1.6499** (2.4445)	-	0.72488*** (1.8308)
head of family has worked in informal sector (1 = yes, 0 = otherwise)	3.2554* (3.0022)	6.2795* (4.4332)	2.8647* (4.4632)
Dependency ratio of this household is less than 0.5 (1 = yes, 0 = otherwise)	-	-	0.86421*** (1.8269)
Consumption, Food, Nutrition and Health			
household insufficient rice consumption (1 = yes, 0 = otherwise)	3.3702** (2.2405)	-	2.0157* (2.6448)
household has not consumed meat, egg or fish in the past week (1 = yes, 0 = otherwise)	1.6757** (1.9750)	3.6518* (3.4965)	1.6350* (2.6765)
household member sick in the past year (1 = yes, 0 = otherwise)	-	2.2932* (2.9120)	.81583*** (1.8044)
treated at village clinic, medical aide (mantri), nurse or traditionally (1 = yes, 0 = otherwise)	-	.	0.96881** (2.1529)
Dummy Variable for Regency			
dummy variable for regency (1 = Bogor, 0 = otherwise)	-4.2598* (-3.7720)	0.5729* (2.8348)	-
Constant	-10.7518* -4.3221)	-27.7208* (-5.1578)	-15.9654* (-6.9889)
Goodness of fit	0.93069	0.93506	.90993
Pseudo R-squared	0.66390	0.75600	.66315
Numbers of Observation	202	231	433

*** Significant at 10%; ** Significant at 5%; * Significant at 1%
Source: Authors' calculation.

CHAPTER 3

Identifying Poverty Predictors Using China's Rural Poverty Monitoring Survey

Sangui Wang, Pingping Wang, and Heng Wang

Introduction

As the world's largest developing country, the People's Republic of China (PRC) has a large rural poor population. Using the official poverty line and household income data, the number of rural poor people was estimated at 19 million by the end of 2005. Using a higher poverty line (close to the $1-a-day standard), the number of poor is estimated to be 82 million (KI 2007). Estimation based on household consumption expenditure leads to a much higher number of rural poor (Wang, Li, and Ranshun 2004).

Though rural poverty reduction has been dramatic because of continuing economic growth and targeted poverty reduction interventions sponsored by different government institutions in the past two decades, major challenges exist in identifying the poor for more effective poverty intervention schemes. Because there is no reliable household-level information in terms of income and expenditure available for local areas, the PRC has long been relying on geographic targeting (at county and village levels) for its poverty reduction programs. This has led to severe undercoverage and leakage problems in program and project implementation (Sangui 2005). Alternative ways to easily identify individual poor households for more effective poverty targeting are urgently needed in the PRC.

Poverty predictor modeling (PPM), established by using household survey data and modern econometric analysis, is one alternative that can be applied to individual poverty targeting (Ward, Owens, and Kahyrara 2002). This chapter discusses the methods and processes of PPM for the PRC. The main purpose of this modeling exercise was to estimate the correlates of poverty at the household level. For practical reasons, poverty predictor variables included–and eventually found significant in the modeling exercise–were non-income and other expenditure indicators that are easily collected.

Data and Methods

Data

In this study, the data set from the 2002 China Rural Poverty Monitoring Survey (CRPMS) collected annually by the Rural Survey Organization (RSO) of the National Bureau of Statistics was used to establish the poverty predictors. CRPMS is conducted in rural areas, hence, data can better reflect the living conditions and household characteristics of the poor than other existing but inaccessible data sets in the country. In addition, survey results provide more program- and policy-relevant information needed in the modeling.

The questionnaire used in the CRPMS is similar to the one used in the Rural Household Survey, which has been the source of official poverty statistics in rural PRC. It includes detailed household and individual information on income and expenditures, household demographics, production, assets, education, and employment. Additional information on rural infrastructure and poverty programs are also collected at the village and household levels. The data collected from CRPMS have mainly, since 2000, been used by RSO to produce an annual Rural Poverty Monitoring Report.

The 2002 CRPMS has a large sample size of 50,000 households. Excluding the households with missing values, the total sample would be 45,960 households. For comparison and robustness tests of the regression models, the sample was split into two subsamples: Data1 and Data2. Village codes were randomly assigned to the sample villages and the splitting of the sample was done by assigning those with odd village codes to Data1 and those with even village codes to Data2. Through the existing sampling design, each poor county with 5–10 sample villages and 10 households in each village are randomly sampled for the survey. Since the village codes are randomly assigned to the sample villages, the splitting of sample households can be considered a random process.

After splitting the codes, Data1 had 22,845 sample households and Data2 had 23,115 sample households. Their mean per capita consumption expenditures were CNY1,414.76[1] and CNY1,423.69, respectively. The process of identifying the best model was applied to both data sets.

Methods Adopted

Two types of econometric models were used for this PPM effort. The first one was the most commonly used multiple regression model that examines

1 CNY stands for yuan.

the relationship between household expenditure and poverty based on individual, household, and community characteristics. The result identified specific variables (predictors) that were significantly correlated with household living–standard variables (i.e., consumption expenditure or income). The second one was a logistic regression model that predicted the probability of a household being poor or not.

The multiple linear regression models took the form of:

$$y_i = \alpha + \sum \beta_k x_{ki} + e_i$$

Where:

y_i - the dependent variable

x_{ki} - independent variables/predictors

α - the model intercept

β_k - regression coefficients

e_i - random errors

Logistic regression models took the form of:

$$\ell n(\frac{p_i}{1-p_i}) = \alpha + \sum_{k=1}^{k} \beta_k x_{ki}$$

Where:

$p_i = P(y_i = 1 | x_{1i}, x_{2i}, ..., x_{xki})$ is the probability of an event given $x_{1i}, x_{2i}, ..., x_{ki}$.

$\frac{p_i}{1-p_i}$ is the odds of experiencing an event.

As in the PPM for Indonesia (see Chapters 1 and 2 of this book), the regression analysis used a stepwise procedure at the 5-percent level of significance to limit the number of independent variables included in the model. For the multiple regression procedure, a number of diagnostic checks and tests were applied to evaluate the adequacy of the model: normal plots, residual plots, and scatter plots, and the assessment of the variance inflation factor (VIF) for the multicollinearity test. A variable was dropped from the model if the VIF of the variable was greater than 10.

For logistic regression, the goodness-of-fit test was used to check the accuracy of the model. The Hosmer-Lemeshow test (Wang and Zhigang 2001) was also used because the number of covariate patterns was almost the same as the number of observations. This was attributed to a number of continuous independent variables that were employed. The test was carried out by computing the percentile distribution of the predicted probabilities (10 groups based on percentile ranks) and then computing a Pearson chi-square that compares the predicted to the observed frequencies (in a 2 X 10 table). Lower values (and nonsignificance) indicate a good fit of the model to the data.

To examine predictability of the method, sensitivity and specificity (accuracy) tests and graph sensitivity and specificity versus probability cutoffs for identifying the best cutoff points were also used for the two methods.

Identification of Variables

In search of candidate independent variables (predictors) from more than 500 indicators collected by RSO, the empirical study focused on variables which are theoretically and empirically correlated with household welfare variables and poverty status, and are easy to collect. Since there was no intention to estimate the determinants (causality) of household welfare or poverty status, the endogeneity of the independent variables was not a concern.

The identified candidate variables were roughly classified into five groups: household demographics, characteristics of household head, assets and natural resources, activities and access to services, and community characteristics. (Candidate variables selected for the estimation are listed in Appendix 3.1.)

Household income and consumption expenditure data were both collected by the RSO in the CRPMS. However, expenditure was considered to be a better measure of both current and long-term welfare and was employed as the dependent variable in the multiple regression model. Because individuals prefer to smoothen the consumption trend over time, expenditure tends to vary less from year to year than income. Another reason for choosing expenditure is that there are negative values of income in the sample, that is, when household production costs exceed revenues. With negative values, logarithmic transformation is impossible.

For logistic regression, the binary dependent variable is anchored to the consumption expenditure data. When the per capita expenditure of a household is below the poverty line, the household is classified as a poor household, and nonpoor if otherwise.

The official rural poverty line in the PRC is used to classify all the sample households into poor and nonpoor. This is estimated by the RSO and used to calculate the poverty headcount ratio every year. There are two poverty lines, an absolute poverty line and a low-income poverty line. The latter is close to the purchasing power parity–adjusted $1-a-day poverty line of the World Bank. The PRC's poverty lines are not adjusted for regional price differences and the lines are uniform for the whole country. In 2002, the low-income poverty line was CNY869 and the absolute poverty line was CNY627.

Transformation of Variables

To decide whether a transformation of the dependent variable (household consumption expenditure per capita) was necessary, a regression procedure was applied to both untransformed and log form per capita expenditure. Accordingly, it was found that the natural logarithm form increased the R-squared and adjusted R-squared.[2] Thus, the log of per capita expenditure was used in this study.

As for the independent variables, three types of transformation were undertaken: natural logarithm, square rooting, and reciprocation. Inspecting the scatter plot of each transformed-type variable against the log per capita expenditure and the resulting adjusted R-squared, some variables were used in transformed form as indicated in Table 3.1. The rest of the variables were left untransformed.

Table 3.1 **Transformation Scheme for Independent Variables to Reduce Measurement Error**

Variables	Transformation
• Housing acreage	Square root
• Amount of grain stored at home per capita	Square root
• Amount of grain stored at home per capita	Square root
• Number of family members staying at home for six months or more	Natural logarithm

Source: Authors' summary based on the modelling development results.

Results

Multiple Regression Models

Table 3.2 shows the summary results of the stepwise regression for Data1 and Data 2. Models for Data1 and Data2 can only explain 46.2 percent and 46.7 percent, respectively, of the variations in per capita consumption

2 Because the dependent variables are not the same, we can not compare the R-squared directly. But we can calculate the comparable R-squared by transforming the Yi and predicted Yi (Y) and using the formula

$$A_j = \sum_{i=1}^{N} \frac{f_i(a_{ji} - a_i)}{s_i}$$

we find that the comparable R-squared of the log-transformed regressions are much higher (around 0.46) than that of the untransformed regressions (around 0.39).

expenditure. This is actually higher than that of the PPM study for Indonesian data but lower than what has been reported for Viet Nam (see details of the results in Appendixes 3.2 and 3.3).

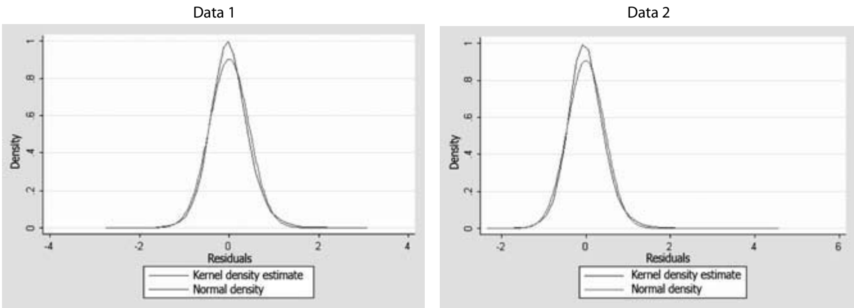
Table 3.2 **Summary Results of Stepwise Ordinary Least Squares Regression for Model Building**

Item	Data1	Data2
Number of observation	22,845	23,315
F-statistics	273.58	282.63
Probability > F	0.0000	0.0000
Adjusted R-squared	0.4621	0.4373

F where the means of multiple normally distributed populations have the same standard deviations.
Note: Data1 and Data2 are subsamples of data used in the model building.
Source: Authors' calculation based on 2002 CRPMS.

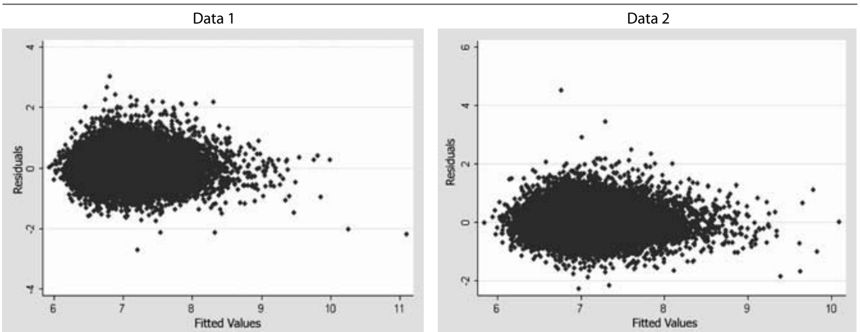
As exhibited in Figure 3.1, distributions of residuals for Data1 and Data2 show that the former is normal while the latter is approximately normal. Next, residual plots in Figure 3.2 reveal that there is no pattern of heteroscedasticity in both Data1 and Data2. This means that on transformation, the assumption of constancy of variance has been satisfied

Figure 3.1 **Normality Plot of Residuals of the Ordinary Least Squares Regression for Data1 and Data2**



Source: Authors' calculation.

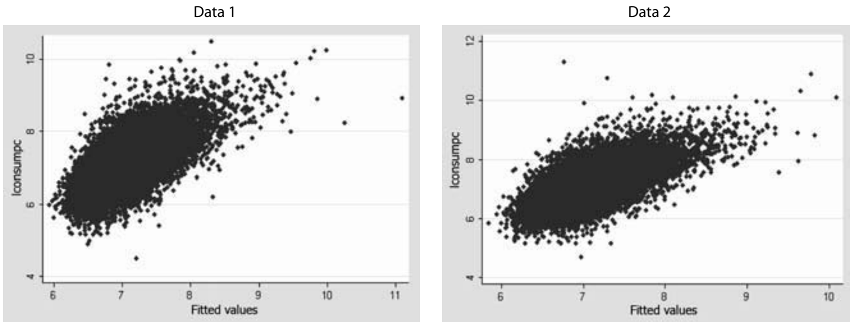
Figure 3.2 **Residual Plot of the Ordinary Least Squares Regression for Data1 and Data2**



Source: Authors' calculation.

by the predicted values of per capita consumption. Figure 3.3 shows that the plotted predicted values as against the actual per capita expenditure not only validated homoscedasticity but also proved nonexistence of outliers

Figure 3.3 **Scatter Plot of Actual Per Capita Consumption Against Predicted Values for Data1 and Data2**



Source: Authors' calculation.

and the independence of the error terms. Results of the VIF (Table 3.3 and 3.4) for the two data sets, revealed that none of the variables generated VIF values greater than 10. Hence, multicollinearity was ruled out and none of the variables were dropped.

Household Demographic Characteristics. This section discusses the results on regression coefficients with an age effect of household members on per capita expenditure. Holding other factors constant, for a household with more members 15–60 years old, the increase in expenditure per capita is higher than a household with more members aged 0–14 years or over 60 years old. Hence, a household with more members aged 15–60 years old is less likely to be poor. This is because individuals of ages 15–60 years are usually more productive than their younger or older counterparts and, hence, can contribute to the household's income pool, which allows household members to consume more.

The composition of households also correlates with the level of expenditure of its members. A household with three generations tends to consume more per member compared with all other kinds of households and is less likely to be poor. In rural PRC, traditional families have three generations under one roof. Not only does this arrangement allow for household savings, but income from rural production of the young and the savings of the old are also shared among the household members.

Also, assuming all other variables stay the same, household consumption per capita is usually higher and the household is less likely to be poor in a household with a larger number of school-age children. A household that can afford to send their children to school is relatively more affluent compared with a comparable household in rural areas where household members have to work on agricultural farms.

Table 3.3 **Variance Inflation Factor of the OLS Regression Using the Data1 Subsample**

Variable	VIF	1/VIF	Variable	VIF	1/VIF
_Ib5_6	7.84	0.12759	_Ipro_43	1.43	0.70040
_Ib5_3	7.07	0.14139	_Ipro_14	1.40	0.71543
_Ib5_4	6.88	0.14538	_Ipro_50	1.39	0.72190
ln_p	5.23	0.19117	c21	1.38	0.72445
_Ib5_2	4.06	0.24601	_Ipro_34	1.37	0.73115
age15_60	4.01	0.24913	b22	1.37	0.73244
age0_14	3.81	0.26217	b19	1.34	0.74477
_Ic13_3	3.79	0.26364	_Ipro_63	1.27	0.78529
b13	3.51	0.28524	a6	1.27	0.78571
_Ipro_65	3.41	0.29307	fuel	1.25	0.79744
b30	3.37	0.29684	b41	1.25	0.80238
_Ic13_2	3.29	0.30366	b26	1.24	0.80784
c7	2.94	0.34025	b21	1.23	0.81521
_Ipro_53	2.48	0.40315	_Ia1_2	1.22	0.81714
_Ib5_7	2.38	0.41949	_Ipro_64	1.20	0.83210
age60	2.29	0.43744	_Ic13_5	1.18	0.84799
_Ic13_4	2.28	0.43893	a57	1.17	0.85573
_Ib5_5	2.06	0.48471	b31	1.17	0.85672
b24	1.97	0.50688	c4	1.16	0.86432
ro_n_b10	1.93	0.51734	b17	1.15	0.86834
studt	1.93	0.51849	leadbus	1.14	0.87359
_Ipro_52	1.87	0.53348	_Ipro_46	1.14	0.87636
b23	1.83	0.54784	a50	1.14	0.87971
a20	1.75	0.57264	b18	1.13	0.88148
spouse	1.68	0.59467	b47pc	1.11	0.89794
a15	1.62	0.61848	b3	1.10	0.90509
b20	1.61	0.62231	_Ipro_22	1.10	0.90640
c5	1.59	0.62851	b7	1.10	0.91096
_Ipro_45	1.58	0.63247	b8	1.08	0.92897
_Ipro_42	1.53	0.65362	b45pc	1.07	0.93294
landpc	1.52	0.65961	b34	1.07	0.93350
_Ipro_41	1.49	0.67194	cashr	1.07	0.93470
b15	1.48	0.67449	bigevent	1.04	0.96371
ro_n_b73	1.45	0.68817	b25	1.03	0.96814
_Ipro_36	1.44	0.69421	_Ic13_6	1.02	0.97819
_Ipro_15	1.44	0.69628	b4	1.02	0.97910
Mean VIF	**1.99**				

Source: Authors' calculation based on 2002 CRPMS.

Household Head Characteristics. Male-headed households and age of the household head are negatively correlated with per capita consumption. This shows that male-headed households and head's age are contributory factors to increasing the number of poor. Interestingly, married household heads are more likely to be out of poverty than those who are not married.

Table 3.4 **Variance Inflation Factor of the OLS Regression Using the Data2 Subsample**

Variable	VIF	1/VIF	Variable	VIF	1/VIF
_Ib5_6	7.80	0.12818	c21	1.38	0.72622
_Ib5_3	6.98	0.14320	_Ipro_34	1.37	0.72877
_Ib5_4	6.81	0.14674	b22	1.35	0.74336
ln_p	5.31	0.18848	b19	1.33	0.75057
age0_14	4.05	0.24663	_Ipro_63	1.30	0.76988
age15_60	4.01	0.24911	b28	1.29	0.77374
_Ib5_2	3.96	0.25282	b47pc	1.28	0.77881
_Ipro_65	3.95	0.25332	a20	1.28	0.78034
_Ic13_3	3.79	0.26367	b26	1.26	0.79170
c7	3.51	0.28500	a6	1.26	0.79494
_Ic13_2	3.28	0.30470	_Ipro_64	1.25	0.80105
_Ipro_53	2.61	0.38265	fuel	1.25	0.80177
age60	2.40	0.41722	b23	1.23	0.81284
_Ib5_7	2.33	0.42994	b21	1.21	0.82877
laborr	2.29	0.43671	b31	1.17	0.85164
_Ic13_4	2.26	0.44185	b29	1.17	0.85285
studt	2.26	0.44340	_Ic13_5	1.17	0.85290
_Ib5_5	2.08	0.48185	c4	1.17	0.85681
ro_n_b10	1.99	0.50294	b72	1.16	0.86201
_Ipro_52	1.97	0.50793	b3	1.16	0.86441
landpc	1.83	0.54774	b17	1.16	0.86489
spouse	1.71	0.58535	a50	1.15	0.87159
_Ipro_45	1.70	0.58956	a57	1.14	0.87478
b20	1.65	0.60720	leadbus	1.14	0.87893
c5	1.61	0.61958	b18	1.13	0.88687
ro_n_b73	1.59	0.62696	_Ipro_46	1.13	0.88722
_Ipro_42	1.57	0.63705	b39	1.09	0.91404
b14	1.56	0.64043	b8	1.09	0.91454
_Ipro_41	1.56	0.64122	b34	1.09	0.91867
_Ipro_43	1.49	0.66998	cashr	1.07	0.93064
_Ipro_23	1.49	0.67229	b45pc	1.04	0.96378
_Ipro_15	1.46	0.68309	bigevent	1.04	0.96439
_Ipro_36	1.46	0.68456	b4	1.03	0.97133
_Ipro_50	1.45	0.68756	_Ic13_6	1.03	0.97352
_Ipro_14	1.45	0.69171	b46pc	1.02	0.98023
b13	1.40	0.71204	b25	1.02	0.98161
Mean VIF	**1.96**				

Source: Authors' calculation based on 2002 CRPMS.

In terms of education, a household with members with tertiary education or higher would have higher per capita expenditure and therefore is less likely to be poor compared with households whose members' level of education is low or nonexistent. This shows that gains from education in rural PRC can be manifested in the ability of the household head to provide for a higher standard of living.

Housing and Other Assets. Holding other factors constant, a household that has a telephone, truck, or TV usually has higher per capita expenditure and is less likely to be poor compared with a household that does not have these assets. Having a truck that can be used for economic activities, such as agricultural production, and having telephones and TVs suggests that a household can afford to spend on items beyond their basic needs.

However, having big animals (livestock) or sheep or goats could indicate for a lower per capita expenditure and the household with these assets is more likely to be poor compared with a household that does not have them. Typically, raising animals would imply savings due to the long gestation period of the animals. On the other hand, animals used for economic activities like a draught animal would increase the per capita consumption of the household.

In addition, a household that resides in larger houses and can store more grain has higher per capita consumption and is less likely to be poor. Other assets that suggest relatively nonpoor characteristics in a household are toilets, barns for livestock, and acreage.

Natural Resources. Land resources are positively correlated with household consumption, while environmental deterioration indicated by the difficulty of collecting fuels has a negative relationship with household consumption. Households engaged in large-scale agricultural production or business, or having family members who are village leaders or working outside the village, have a higher consumption level. In addition, households devoting more land to cash crops also have higher consumption.

Activities and Access to Services. Households that participate in insurance programs, use gas or coal for cooking, and have a big event taking place within the year also have higher consumption expenditures. However, households without any income sources (*Wu Bao Hu* in Chinese), participating in cooperative medical service, or having more family members staying at home have a lower consumption level.

A household that actively participates in community activities, such as being the village head or engaging in business, tends to consume more per household member and is less likely to be poor. High per capita consumption is also evident in big events such as weddings or funerals, or if the household has insurance. Expectedly, if the ratio of sown areas of cash crops to total sown areas in the community is higher, the household is less likely to be poor.

Community Characteristics. A number of community indicators are significantly correlated with household consumption. For instance, households living in villages designated as poor villages or those which encountered natural disasters have, as expected, low per capita consumption. Meanwhile, access to roads has also strong correlation with higher per capita consumption.

Predictability of the Ordinary Least Squares Method

To test the predicting capability of the ordinary least squares (OLS) models, Data1 was divided into three groups: bottom one-third, middle one-third and top one-third of the array of observations ranked according to actual and predicted per capita consumption expenditure. Table 3.5 shows that only 62 percent of the households that actually belong to the bottom one-third category were correctly predicted by the model, while the rest that were supposed to belong to the middle and top one-third were predicted to be under the bottom one-third category as well. Meanwhile, 43 percent of households in the middle one-third and 66 percent in the top one-third were correctly predicted by the model. Similar results can be observed when using Data2.

Table 3.5 **Accuracy of Predicted Expenditure**
Percent

Data1		Predicted		
		Bottom 33%	*Middle 33%*	*Top 33%*
Actual	*Bottom 33%*	62.15	30.11	7.73
	Middle 33%	30.11	43.27	26.63
	Top 33%	7.75	26.62	65.63

Data2		Predicted		
		Bottom 33%	*Middle 33%*	*Top 33%*
Actual	*Bottom 33%*	63.10	29.71	7.19
	Middle 33%	29.19	45.01	25.79
	Top 33%	7.70	25.28	67.03

Source: Authors' calculation based on 2002 CRPMS.

Likewise, to further test the predicting capability of the OLS model, households were divided into two groups, poor and nonpoor, depending on whether their per capita consumption expenditure was below or above the official poverty lines. With the low-income poverty line, about 51 percent of the households were predicted to be poor by the model, while almost 88 percent of the households were predicted to be nonpoor. Using the absolute poverty line, 98 percent of households were predicted to be nonpoor. The accuracy of predicting the poor was low at just 14 percent, indicating that it is very difficult to correctly predict the extreme poor using OLS regression (Tables 3.6 and 3.7). Again, similar results can be observed using Data2.

Logistic Regression Models

Summary results of the stepwise procedure for the logit model using the low-income poverty line for Data1 and Data2 were obtained (Table 3.8). As previously discussed, the Hosmer-Lemeshow test was used to test the goodness of fit of the model because some variables have sparse observations. The test revealed that the probability values are 0.4728 for Data1 and 0.1272 for Data2. Both statistics are lower than the expected probability, indicating that the models fit well with the data. See details of the results in Appendix 3.4–3.5.

The retained or significant variables in the logit regression after the stepwise procedure are almost the same with those of OLS regression but with opposite signs. This means that variables with negative coefficients would likely reduce the probability that a household is poor, and vice versa. Only a few variables that are significant in OLS regression are not significant in logit regression.

Table 3.6 **Accuracy of Predicted Poverty Status by Using the Low-Income Poverty Line**

Data1			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	87.55	12.45
	Poor	49.03	50.97

Data2			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	87.98	12.02
	Poor	49.15	50.85

Source: Authors' calculation based on 2002 CRPMS.

Table 3.7 **Accuracy of Predicted Poverty Status by Using the Absolute Poverty Line**

Data1			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	98.51	1.49
	Poor	85.79	14.21

Data2			
		Predicted	
		Nonpoor	*Poor*
Actual	*Nonpoor*	98.31	1.69
	Poor	85.29	14.71

Source: Authors' calculation based on 2002 CRPMS.

Table 3.8 **Summary Results of Stepwise Logit Regression for Model Building**

	Data1	**Data2**	**Absolute Poverty in Data1**
Number of observations	22,845	23,315	23,315
Hosmer-Lemeshow	7.61	12.58	8.06
Adjusted R-squared	0.4728	0.1272	0.4275

Note: Data1 and Data2 are subsamples of data set used for model building.
Source: Authors' calculation based on 2002 CRPMS.

Predictability of the Logit Method

To measure the accuracy of the prediction model, a number of indicators generated from the model were examined. Accuracy indicators vary with the choice of probability cutoff points. Table 3.9 shows the result taking 0.50

as the probability cutoff point while Table 3.9 shows the result taking 0.38 as the best probability cutoff point. The best cutoff point is determined by examining the sensitivity and specificity graph (Figure 3.4).

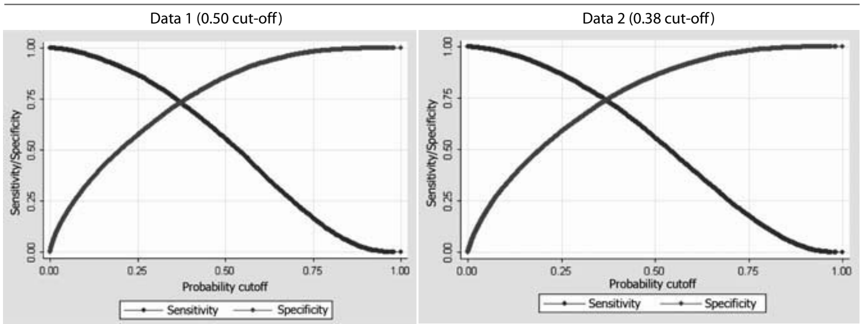
Table 3.9 **Accuracy of Predicted Poverty Status by Using Logit Regression and Low-Income Poverty Line**

	Probability Cutoff of 0.5 (Percent)		Probability Cutoff of 0.38 (Percent)	
	Data1	*Data2*	*Data1*	*Data2*
Sensitivity	55.59	55.73	72.09	72.61
Specificity	85.73	85.97	74.10	75.23
Positive predictive value	66.86	67.13	59.05	60.12
Negative predictive value	78.84	79.07	83.67	84.23
False positive rate for true nonpoor	14.27	14.03	25.90	24.77
False negative rate for true poor	44.41	44.27	27.91	27.39
False positive rate for classified poor	33.14	32.87	40.95	39.88
False negative rate for classified nonpoor	21.16	20.93	16.33	15.77
Correctly classified	75.44	75.70	73.41	74.34

Source: Authors' calculation based on 2002 CRPMS.

Table 3.9 shows that by using a probability cutoff of 0.50 and the low-income poverty line in Data1, about 56 percent percent of the poor households are correctly predicted (sensitivity), while 86 percent of nonpoor households are accurately predicted by the model (specificity). Positive predictive value measures the percentage of correctly predicted poor households to the total predicted poor households, while the negative predictive value measures the ratio of correctly predicted nonpoor to the total predicted nonpoor. The false positive rate for the true nonpoor indicates that 14 percent of nonpoor households are inaccurately predicted as poor households, while the false negative rate for the true poor indicates that 44 percent of poor households are inaccurately predicted as nonpoor households. The false positive rate for classified poor shows that 33 percent of the total predicted poor households are inaccurate, while 21 percent of the total predicted nonpoor households are not correct as shown by the false negative rate for classified nonpoor. The

Figure 3.4 **Sensitivity and Specificity of the Logit Regression**



Source: Authors' calculation.

overall accuracy of prediction is 75 percent. The general result for Data2 is again close to Data1.

Using the probability cutoff point of 0.38, on the other hand, reveals that the accuracy of poor household prediction is higher, that is, 72 percent, while the accuracy of nonpoor household prediction is less, that is, 74 percent. Meanwhile, the false prediction of the poor is less and the false prediction of the nonpoor is higher. The overall accuracy of prediction is also a little bit lower, that is 73 percent.

The stepwise procedure for the logit model is also implemented using the official absolute poverty line for Data1.[3] Table 3.10 reveals that, using the official absolute poverty line for defining the poverty status, only 17 percent of the poor households are correctly predicted if the 0.50 probability cutoff point was used. A simulation was also done using a different probability cutoff (Table 3.10). The simulation showed that prediction accuracy can increase by using a much lower probability cutoff point (0.16 in the simulation), but the false rate for predicting poor also increases (to a high of almost 70 percent in the simulation). The best cutoff point is determined by again examining the sensitivity and specificity graph in Figure 3.5. (See Appendix 3.6 for details.)

Table 3.10 **Accuracy of Predicted Poverty Status by Using Logit Regression and Official Absolute Poverty Line and Data 1**

	Probability Cutoff of 0.5	Probability Cutoff of 0.16
Sensitivity	17.41	73.17
Specificity	98.19	74.24
Positive predictive value	61.20	31.78
Negative predictive value	87.87	94.40
False positive rate for true non-poor	1.81	25.76
False negative rate for true poor	82.59	26.83
False positive rate for classified poor	38.80	68.22
False negative rate for classified non-poor	12.13	5.60
Correctly classified	86.80	74.09

Source: Authors' calculation based on 2002 CRPMS.

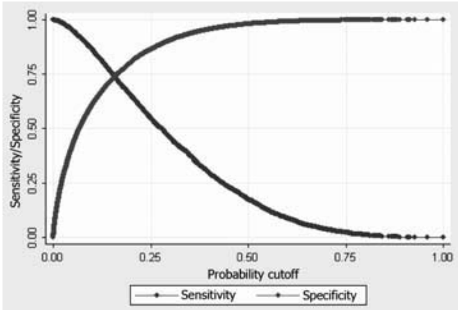
Summary and Conclusion

In the final selection of the poverty predictors, all independent variables that are significant in both OLS and logistic models were chosen. (See Appendix 3.7.)

Both the multiple linear regression models and the logistic regression model can accurately predict, by over 50 percent, which households are

[3] The process was not conducted only for Data1 since the results of using Data 2 were negligibly different, as shown in previous results (See details in Appendix 3.8.).

Figure 3.5 **Sensitivity and Specificity of the Logit Regression Using the Absolute Poverty Line for Data1**



Source: Authors' calculation.

poor. The logistic regression model performs a little bit better than the OLS regression model in terms of predicting the poverty status of the households. Moreover, the logistic model is more flexible for choosing a probability cutoff point for higher prediction accuracy of the poor. The cost of doing so, however, is an increase of false prediction, which will lead to a spillover problem in program targeting. The modeling results show that predicting the extremely poor is very difficult.

To determine the accuracy of logit models for predicting which households are poor, the appropriate cutoff point is 0.38.

Appendix

Appendix 3.1 Candidate Variables Selected

Variable Name	Description
Welfare Indicators	
consumpc	Consumption expenditure per capita (yuan/person)
con_poor	Is the household consumption expenditure below the poverty line? 1=yes, 0=no
inc_poor	Is the household net income below the poverty line? 1=yes, 0=no
Household Head Characteristics	
C4	Sex of the household head, 1=male, 0=female
C5	Age of the household head
spouse	Whether the household head got married? 1=yes, 0=no
C7	Can household head speak Chinese? 1=yes, 0=no
C13	Education attainment of the household head
Household Demographics	
Age0_14	Number of family members aged 0–14 years
Age15_60	Number of family members aged 15–60 years
Age60	Number of family members over 60 years old
studt	Number of school age children in school
drops	Number of school age children dropped out of school
C16	Are there any disabled adults at home? 1=yes, 0=no
laborr	Ratio of labor to household members
B5	Family structure
Housing and Other Assets	
B13	Whether has big animals? 1=yes, 0=no
B14	Whether has pigs? 1=yes, 0=no
B15	Whether has sheep or goats? 1=yes, 0=no
B16	Whether has poultry? 1=yes, 0=no
B17	Whether has a radio? 1=yes, 0=no
B18	Whether has a refrigerator? 1=yes, 0=no
B19	Whether has a TV? 1=yes, 0=no
B20	Whether has a bicycle? 1=yes, 0=no
B21	Whether has a motorcycle? 1=yes, 0=no
B22	Whether has a telephone? 1=yes, 0=no
B25	Whether has a car or truck? 1=yes, 0=no
B26	Whether has a hand tractor? 1=yes, 0=no
B27	Whether has a large-or medium-sized tractor? 1=yes, 0=no
B28	Whether has a cart? 1=yes, 0=no
B29	Whether has other agricultural tools? 1=yes, 0=no
B30	Whether has a draught animal? 1=yes, 0=no
B31	Whether has a production animal? 1=yes, 0=no
B34	Whether has a toilet? 1=yes, 0=no
B72	Is grain enough for consumption? 1=yes, 0=no
n_b73	Grain stored at home at the end of the year (kg/person)
n_b75	Grain stored for consumption at home at the end of the year (kg/person)
NB12	Whether the house is built with bricks or concrete? 1=yes, 0=no
n_b10	Square meters of living house per capita
B23	Square meters of production (business) house
B24	Square meters of barn for livestock
Natural Resources	
landpc	Cultivated land per capita, mu/per person
B45pc	Forest land per capita (mu/person)
B46pc	Orchard land per capita (mu/person)
B47pc	Grassland areas per capita (mu/person)
B48pc	Water areas under cultivation per capita (mu/person)
B49pc	Wasteland areas per capita (mu/person)
B39	Whether is it difficult to access drinking water? 1=yes, 0=no
B41	Whether it become more difficult to collect fuels? 1=yes, 0=no
Activities and Access to Services	
n_p	Number of household members staying at home for 6 months or more
B3	Whether engaged in large-scale agricultural production? 1=yes, 0=no
leadbus	Is any family members the village leader or engaged in business? 1=yes, 0=no
C21	Are there any household members who work outside? 1=yes, 0=no
cashr	Ratio of sown areas of cash crop to total sown areas
fuel	Whether use coal or gas for cooking? 1=yes, 0=no
B4	Whether a "wu bao hu" without any income sources, 1=yes, 0=no
B6	Whether participated in cooperatives? 1=yes, 0=no
B7	Whether participated in cooperative medical service? 1=yes, 0=no
B8	Whether has insurance? 1=yes, 0=no
C6	Does the household belong to ethnic minority groups? 1=yes, 0=no
B35	Whether has electricity? 1=yes, 0=no
bigevent	Whether has a big event such as wedding, funeral, etc. 1=yes, 0=no
Community Characteristics	
A1	Village physiognomy
A6	Number of natural villages with a road for motor vehicles
A14	Distance to the countryseat, km
A15	Distance to the town where the township government locates, km
A20	Distance to the nearby market, km
A50	Whether had a natural disaster in the village? 1=yes, 0=no
A57	Whether being designated as a poor village? 1=yes, 0=no

Source: Based on Household Survey Questionnaire.

Appendix 3.2 **Results of Stepwise Ordinary Least Square Regression Using Data1**
(Dependent Variable: Log Per Capita Expenditure)

Variable Name	Description	Coefficient	Standard Error	P>|t|
Household Demographics				
age0_14	Number of family members aged 0–14 years old	0.047	0.006	0.000
age15_60	Number of family members aged 15–60 years old	0.104	0.005	0.000
age60	Number of family members over 60 years old	0.095	0.007	0.000
studt	Number of school age children in school	0.077	0.004	0.000
_Ib5_2	Households with a couple and one child	0.175	0.016	0.000
_Ib5_3	Households with a couple and two children	0.229	0.017	0.000
_Ib5_4	Households with a couple and three children or more	0.216	0.019	0.000
_Ib5_5	Households with father or mother and the children	0.206	0.025	0.000
_Ib5_6	Households with three generations	0.242	0.019	0.000
_Ib5_7	Other kinds of households	0.210	0.023	0.000
Household Head Characteristics				
c4	Sex of the household head	-0.066	0.017	0.000
c5	Age of the household head	-0.001	0.000	0.001
spouse	Whether the household head got married?	0.122	0.015	0.000
c7	Can household head speak Chinese?	0.089	0.019	0.000
_Ic13_2	Household head with primary school education	0.041	0.011	0.000
_Ic13_3	Household head with middle school education	0.084	0.012	0.000
_Ic13_4	Household head with high school education	0.112	0.014	0.000
_Ic13_5	Household head with technical secondary school education	0.181	0.029	0.000
_Ic13_6	Household head with college education and above	0.309	0.088	0.000
Housing and Other Assets				
ro_n_b10	Square root of housing acreage	0.037	0.003	0.000
b23	Square meters of production (business) house	0.000	0.000	0.007
b24	Square meters of barn for livestock	0.001	0.000	0.001
b13	Whether has big animals?	-0.045	0.011	0.000
b15	Whether has sheep or goats?	-0.034	0.009	0.000
b17	Whether has a radio?	0.020	0.007	0.004
b18	Whether has a refrigerator?	0.075	0.015	0.000
b19	Whether has a TV?	0.094	0.008	0.000
b20	Whether has a bicycle?	0.022	0.007	0.004
b21	Whether has a motorcycle?	0.086	0.010	0.000
b22	Whether has a telephone?	0.146	0.009	0.000
b25	Whether has a truck?	0.093	0.032	0.004
b26	Whether has a hand tractor?	0.035	0.009	0.000
b30	Whether has a draught animal?	0.038	0.011	0.001
b31	Whether has a production animal?	0.036	0.008	0.000
b34	Whether has a toilet?	0.062	0.025	0.013
ro_n_b73	Square root of the amount of grain stored at home per capita	0.004	0.000	0.000
Natural Resources				
b41	Whether it becomes more difficult to collect fuels?	-0.030	0.007	0.000
landpc	Cultivated land per capita	0.007	0.001	0.000
b45pc	Forest land per capita	0.007	0.001	0.000
b47pc	Grassland areas per capita	0.000	0.000	0.000
Activities and Access to Services				
ln_p	Log of family members staying at home for 6 months or more	-0.936	0.017	0.000
b3	Whether engaged in large-scale agricultural production?	0.057	0.018	0.002
leadbus	Is any family member the village leader or engaged in business?	0.089	0.011	0.000
c21	Any household members working outside?	0.088	0.008	0.000
cashr	Ratio of sown areas of cash crop to total sown areas	0.139	0.017	0.000
fuel	Whether use coal or gas for cooking?	0.032	0.007	0.000
b4	Whether a "wu bao hu" without any income sources	-0.150	0.061	0.014
b7	Whether participated in cooperative medical service?	-0.040	0.019	0.041
b8	Whether has insurance?	0.060	0.010	0.000
bigevent	Whether has a big event?	0.195	0.008	0.000
Community Characteristics				
_Ia1_2	Hilly areas	0.022	0.008	0.006
a6	Number of natural villages with a road for motor vehicles	0.002	0.001	0.022
a15	Distance to the town where the township government is located	0.001	0.000	0.033
a20	Distance to the nearby market	0.002	0.000	0.000
a50	Whether had a natural disaster in the village?	-0.034	0.007	0.000
a57	Whether designated as a poor village?	-0.047	0.006	0.000
Provincial Dummy				
_Ipro_14	Shanxi	-0.086	0.014	0.000
_Ipro_15	Inner Mongolia	0.103	0.017	0.000
_Ipro_22	Jilin	-0.060	0.026	0.022
_Ipro_34	Anhui	0.177	0.017	0.000
_Ipro_36	Jiangxi	0.240	0.017	0.000
_Ipro_41	Henan	0.112	0.014	0.000
_Ipro_42	Hubei	0.288	0.016	0.000
_Ipro_43	Hunan	0.299	0.017	0.000
_Ipro_45	Guangxi	0.308	0.016	0.000

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Appendix 3.2 continued

Variable Name	Description	Coefficient	Standard Error	P>|t|
_Ipro_46	Hainan	0.284	0.037	0.000
_Ipro_50	Chongqing	0.271	0.019	0.000
_Ipro_52	Guizhou	0.223	0.014	0.000
_Ipro_53	Yunnan	0.155	0.013	0.000
_Ipro_63	Qinghai	0.340	0.025	0.000
_Ipro_64	Ningxia	0.144	0.026	0.000
_Ipro_65	Xinjiang	0.291	0.023	0.000
_cons		6.974	0.053	0.000

Number of obs = 22845
F(72, 22772) = 273.58
Prob > F = 0.0000
Adj R-squared = 0.4621

P |t| = probability of accepting the null hypothesis (Ho)
Source: Authors' calculation based on 2002 CRPMS.

Appendix 3.3 **Results of Stepwise Ordinary Least Square Regression Using Data2**
(Dependent Variable: Log Per Capita Expenditure)

Variable Name	Description	Coefficient	Standard Error	P>|t|
Household Demographics				
age0_14	Number of family members aged 0–14 years old	0.032	0.006	0.000
age15_60	Number of family members aged 15–60 years old	0.096	0.005	0.000
age60	Number of family members over 60 years old	0.068	0.007	0.000
Studt	Number of school age children in school	0.076	0.004	0.000
_Ib5_2	Households with a couple and one child	0.154	0.016	0.000
_Ib5_3	Households with a couple and two children	0.197	0.017	0.000
_Ib5_4	Households with a couple and three children or more	0.186	0.019	0.000
_Ib5_5	Households with father or mother and the children	0.143	0.025	0.000
_Ib5_6	Households with three generations	0.221	0.019	0.000
_Ib5_7	Other kinds of households	0.187	0.023	0.000
laborr	Ratio of labor to household members	-0.064	0.019	0.001
Household Head Characteristics				
c4	Sex of the household head	-0.045	0.017	0.008
c5	Age of the household head	-0.001	0.000	0.011
spouse	Whether the household head got married?	0.106	0.015	0.000
c7	Can household head speak Chinese?	0.075	0.021	0.000
_Ic13_2	Household head with primary school education	0.039	0.011	0.000
_Ic13_3	Household head with middle school education	0.086	0.011	0.000
_Ic13_4	Household head with high school education	0.114	0.014	0.000
_Ic13_5	Household head with technical secondary school education	0.216	0.028	0.000
_Ic13_6	Household head with college education and above	0.239	0.071	0.001
Housing and Other Assets				
ro_n_b10	Square root of housing acreage	0.030	0.003	0.000
b23	Square meters of production (business) house	0.001	0.000	0.000
b13	Whether has big animals?	-0.014	0.007	0.044
b14	Whether have pigs?	0.032	0.008	0.000
b17	Whether has a radio?	0.034	0.007	0.000
b18	Whether has a refrigerator?	0.039	0.014	0.006
b19	Whether has a TV?	0.103	0.008	0.000
b20	Whether has a bicycle?	0.037	0.007	0.000
b21	Whether has a motorcycle?	0.095	0.009	0.000
b22	Whether has a telephone?	0.123	0.008	0.000
b25	Whether has a truck?	0.133	0.032	0.000
b26	Whether has a walking tractor?	0.020	0.009	0.036
b28	Whether has a cart?	-0.027	0.010	0.007
b29	Whether have other agricultural tools?	0.049	0.008	0.000
b31	Whether has a production animal?	0.033	0.008	0.000
b34	Whether has a toilet?	0.082	0.022	0.000
ro_n_b73	Square root of amount of grain stored at home per capita	0.004	0.000	0.000
Natural Resources				
b39	Whether is it difficult to access drinking water?	-0.018	0.008	0.019
landpc	Cultivated land per capita	0.009	0.001	0.000
b45pc	Forest land per capita	0.001	0.001	0.039
b46pc	Orchard land per capita	0.020	0.006	0.001
b47pc	Grassland areas per capita	0.001	0.000	0.000
Activities and Access to Services				
ln_p	Log of family members staying at home for 6 months or more	-0.933	0.017	0.000
b3	Whether engaged in large-scale agricultural production?	0.104	0.018	0.000
leadbus	Is any family members the village leaders or engaged in business?	0.087	0.010	0.000
c21	Any household members working outside?	0.091	0.007	0.000
cashr	Ratio of sown areas of cash crop to total sown areas	0.104	0.017	0.000
b72	Is self-produced grain enough for consumption?	0.035	0.009	0.000
fuel	Whether use coal or gas for cooking?	0.041	0.007	0.000
b4	Whether a "wu bao hu" without any income sources	-0.175	0.060	0.003
b8	Whether has insurance?	0.061	0.010	0.000
bigevent	Whether has a big event?	0.186	0.008	0.000
Community Characteristics				
a6	Number of natural villages with road for motor vehicles	0.002	0.001	0.001
a20	Distance to the nearby market	0.002	0.000	0.000
a50	Whether had a natural disaster in the village?	-0.035	0.006	0.000
a57	Whether designated as a poor village?	-0.018	0.006	0.003
Provincial Dummy				
_Ipro_14	Shanxi	-0.034	0.015	0.021
_Ipro_15	Inner Mongolia	0.101	0.017	0.000
_Ipro_23	Heilongjiang	0.053	0.021	0.011
_Ipro_34	Anhui	0.223	0.017	0.000
_Ipro_36	Jiangxi	0.303	0.017	0.000
_Ipro_41	Henan	0.147	0.014	0.000
_Ipro_42	Hubei	0.388	0.016	0.000
_Ipro_43	Hunan	0.352	0.017	0.000
_Ipro_45	Guangxi	0.320	0.016	0.000
_Ipro_46	Hainan	0.289	0.037	0.000

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Appendix 3.3 continued

Variable Name	Description	Coefficient	Standard Error	P>|t|
_Ipro_50	Chongqing	0.278	0.019	0.000
_Ipro_52	Guizhou	0.237	0.014	0.000
_Ipro_53	Yunnan	0.175	0.013	0.000
_Ipro_63	Qinghai	0.311	0.025	0.000
_Ipro_64	Ningxia	0.088	0.026	0.001
_Ipro_65	Xinjiang	0.338	0.024	0.000
_cons		6.873	0.038	0.000

Number of obs = 23115
F(72, 23042) = 282.63
Prob > F = 0.0000
Adj R-squared = 0.4673

Source: Authors' calculation based on 2002 CRPMS.

Appendix 3.4 **Results of Stepwise Logit Regression Using Data1**
(Dependent Variable: Poor = 1, Nonpoor= 0)

Variable Name	Description	Coefficient	Standard Error	P>|z|
Household Demographics				
age0_14	Number of family members aged 0–14 years old	-0.173	0.038	0.000
age15_60	Number of family members aged 15–60 years old	-0.377	0.032	0.000
age60	Number of family members over 60 years old	-0.346	0.044	0.000
studt	Number of school age children in school	-0.320	0.023	0.000
_Ib5_2	Households with a couple and one child	-0.762	0.096	0.000
_Ib5_3	Households with a couple and two children	-1.052	0.101	0.000
_Ib5_4	Households with a couple and three childern or more	-1.008	0.114	0.000
_Ib5_5	Households with father or mother and the children	-0.859	0.149	0.000
_Ib5_6	Households with three generations	-1.178	0.115	0.000
_Ib5_7	Other kinds of households	-1.028	0.130	0.000
Household Head Characteristics				
c5	Age of the household head	0.007	0.002	0.000
spouse	Whether the household head got married?	-0.363	0.080	0.000
c7	Can household head speak Chinese?	-0.535	0.112	0.000
_Ic13_3	Household head with middle school education	-0.179	0.038	0.000
_Ic13_4	Household head with high school education	-0.338	0.063	0.000
_Ic13_5	Household head with technical secondary school education	-0.332	0.166	0.045
_Ic13_6	Household head with college education and above	-1.601	0.763	0.036
Housing and Other Assets				
ro_n_b10	Square root of housing acreage	-0.154	0.017	0.000
b23	Square meters of production (business) house	-0.004	0.001	0.000
b15	Whether has sheep or goats?	0.220	0.050	0.000
b17	Whether has a radio?	-0.109	0.038	0.005
b18	Whether has a refrigerator?	-0.214	0.090	0.018
b19	Whether has a TV?	-0.384	0.043	0.000
b21	Whether has a motorcycle?	-0.391	0.058	0.000
b22	Whether has a telephone?	-0.555	0.052	0.000
b26	Whether has a hand tractor?	-0.107	0.052	0.040
b31	Whether has a production animal?	-0.182	0.042	0.000
b35	Whether has electricity?	-0.169	0.084	0.043
ro_n_b73	Square root of the amount of grain stored at home per capita	-0.028	0.004	0.000
ro_n_b75	Square root of the amount of grain stored at home for consumption per capita	0.009	0.004	0.047
Natural Resources				
b39	Whether is it difficult to access drinking water?	0.122	0.043	0.005
b41	Whether it becomes more difficult to collect fuels?	0.107	0.037	0.004
landpc	Cultivated land per capita	-0.040	0.007	0.000
b45pc	Forest land per capita	-0.046	0.012	0.000
b47pc	Grassland areas per capita	-0.009	0.001	0.000
b49pc	Wasteland areas per capita	-0.091	0.022	0.000
Activities and Access to Services				
ln_p	Log of family members staying at home for 6 months or more	3.803	0.142	0.000
leadbus	Is any family members the village leaders or engaged in business?	-0.398	0.066	0.000
c21	Any household members working outside?	-0.509	0.044	0.000
Cashr	Ratio of sown areas of cash crop to total sown areas	-0.616	0.099	0.000
b72	Is self-produced grain enough for consumption?	0.107	0.049	0.030
Fuel	Whether use coal or gas for cooking?	-0.226	0.041	0.000
b7	Whether participated in cooperative medical service?	0.239	0.103	0.020
b8	Whether has insurance?	-0.239	0.060	0.000
bigevent	Whether has a big event?	-0.515	0.045	0.000
Community Characteristics				
a6	Number of natural villages with a road for motor vehicles	-0.011	0.004	0.008
a15	Distance to the town where the township government is located	-0.007	0.002	0.002
a50	Whether had a natural disaster in the village?	0.196	0.037	0.000
a57	Whether designated as a poor village?	0.199	0.035	0.000
Provincial Dummy				
_Ipro_14	Shanxi	0.348	0.077	0.000
_Ipro_15	Inner Mongolia	-0.395	0.098	0.000
_Ipro_23	Heilongjiang	-0.303	0.116	0.009
_Ipro_34	Anhui	-0.730	0.100	0.000
_Ipro_36	Jiangxi	-1.493	0.113	0.000
_Ipro_41	Henan	-0.460	0.077	0.000
_Ipro_42	Hubei	-1.351	0.102	0.000
_Ipro_43	Hunan	-1.362	0.099	0.000
_Ipro_45	Guangxi	-1.288	0.090	0.000
_Ipro_46	Hainan	-1.344	0.194	0.000
_Ipro_50	Chongqing	-1.277	0.116	0.000
_Ipro_52	Guizhou	-0.984	0.073	0.000
_Ipro_53	Yunnan	-0.558	0.066	0.000
_Ipro_63	Qinghai	-1.199	0.142	0.000
_Ipro_64	Ningxia	-0.468	0.143	0.001
_Ipro_65	Xinjiang	-1.415	0.134	0.000
_cons		-0.316	0.209	0.130

number of observations = 22845
number of groups = 10
Hosmer-Lemeshow chi2(8) = 7.61
Prob > chi2 = 0.4728

Source: Authors' calculation based on 2002 CRPMS.

Appendix 3.5 Results of Stepwise Logit Regression Using Data2
(Dependent Variable: Poor = 1; Nonpoor = 0)

Variable Name	Description	Coefficient	Standard Error	P>|z|
Household Demographics				
age0_14	Number of family members aged 0–14 years old	-0.090	0.038	0.018
age15_60	Number of family members aged 15–60 years old	-0.309	0.032	0.000
age60	Number of family members over 60 years old	-0.171	0.048	0.000
Studt	Number of school age children in school	-0.338	0.023	0.000
c16	Are there any disabled adults at home?	-0.118	0.051	0.020
_Ib5_2	Households with a couple and one child	-0.687	0.095	0.000
_Ib5_3	Households with a couple and two children	-0.909	0.099	0.000
_Ib5_4	Households with a couple and three children or more	-0.850	0.113	0.000
_Ib5_5	Households with father or mother and the children	-0.619	0.144	0.000
_Ib5_6	Households with three generations	-1.012	0.113	0.000
_Ib5_7	Other kinds of households	-0.831	0.131	0.000
Household Head Characteristics				
c4	Sex of the household head	0.198	0.099	0.046
c5	Age of the household head	0.004	0.002	0.037
Spouse	Whether the household head got married?	-0.354	0.083	0.000
_Ic13_2	Household head with primary school education	-0.197	0.058	0.001
_Ic13_3	Household head with middle school education	-0.422	0.062	0.000
_Ic13_4	Household head with high school education	-0.535	0.079	0.000
_Ic13_5	Household head with technical secondary school education	-0.829	0.183	0.000
Housing and Other Assets				
ro_n_b10	Square root of housing acreage	-0.118	0.017	0.000
b23	Square meters of production (business) house	-0.004	0.001	0.000
b13	Whether has big animals?	0.078	0.039	0.047
b14	Whether have pigs?	-0.203	0.044	0.000
b17	Whether has a radio?	-0.152	0.038	0.000
b19	Whether has a TV?	-0.471	0.042	0.000
b20	Whether has a bicycle?	-0.191	0.043	0.000
b21	Whether has a motorcycle?	-0.352	0.057	0.000
b22	Whether has a telephone?	-0.553	0.051	0.000
b25	Whether has a truck?	-0.461	0.194	0.018
b26	Whether has a hand tractor?	-0.122	0.053	0.022
b28	Whether has a cart?	0.129	0.057	0.022
b29	Whether have other agricultural tools?	-0.265	0.050	0.000
b31	Whether has a production animal?	-0.157	0.043	0.000
b34	Whether has a toilet?	-0.427	0.151	0.005
ro_n_b73	Square root of the amount of grain stored at home per capita	-0.021	0.003	0.000
Natural Resources				
landpc	Cultivated land per capita	-0.045	0.007	0.000
b45pc	Forest land per capita	-0.035	0.014	0.014
b46pc	Orchard land per capita	-0.292	0.075	0.000
b47pc	Grassland areas per capita	-0.005	0.001	0.000
Activities and Access to Services				
ln_p	Log of family members staying at home for 6 months or more	3.572	0.141	0.000
b3	Whether engaged in large-scale agricultural production?	-0.303	0.105	0.004
leadbus	Is any family member the village leader or engaged in business?	-0.385	0.065	0.000
c21	Any household members working outside?	-0.581	0.044	0.000
cashr	Ratio of sown areas of cash crop to total sown areas	-0.323	0.100	0.001
b72	Is self-produced grain enough for consumption?	-0.124	0.049	0.011
fuel	Whether use coal or gas for cooking?	-0.197	0.041	0.000
b4	Whether a “wu bao hu” without any income sources	0.658	0.323	0.042
b8	Whether has insurance?	-0.235	0.058	0.000
bigevent	Whether has a big event?	-0.540	0.046	0.000
Community Characteristics				
_Ia1_3	Mountainous areas	-0.098	0.044	0.025
a20	Distance to the nearby market	-0.007	0.002	0.000
a50	Whether had a natural disaster in the village?	0.190	0.036	0.000
a57	Whether designated as a poor village?	0.076	0.035	0.028
Provincial Dummy				
_Ipro_14	Shanxi	0.296	0.077	0.000
_Ipro_15	Inner Mongolia	-0.495	0.099	0.000
_Ipro_23	Heilongjiang	-0.425	0.116	0.000
_Ipro_34	Anhui	-1.022	0.106	0.000
_Ipro_36	Jiangxi	-1.574	0.112	0.000
_Ipro_41	Henan	-0.528	0.081	0.000
_Ipro_42	Hubei	-1.704	0.107	0.000
_Ipro_43	Hunan	-1.747	0.103	0.000
_Ipro_45	Guangxi	-1.148	0.090	0.000
_Ipro_46	Hainan	-1.358	0.197	0.000
_Ipro_50	Chongqing	-1.279	0.116	0.000
_Ipro_52	Guizhou	-1.001	0.079	0.000
_Ipro_53	Yunnan	-0.696	0.068	0.000
_Ipro_63	Qinghai	-0.992	0.140	0.000
_Ipro_65	Xinjiang	-1.130	0.093	0.000
_cons		0.131	0.218	0.548

Number of observations = 23115
Hosmer-Lemeshow chi2(8) = 12.58
Prob > chi2 = 0.1272

Source: Authors' calculation based on 2002 CRPMS.

Appendix 3.6 **Results of Stepwise Logit Regression Using the Absolute Poverty Line and Dataset1** (Dependent Variable: Poor = 1, Nonpoor = 0)

Variable Name	Description	Coefficient	Standard Error	P>|z|
Household Demographics				
age15_60	Number of family members aged 15–60 years old	-0.238	0.027	0.000
age60	Number of family members over 60 years old	-0.180	0.052	0.001
Studt	Number of school age children in school	-0.314	0.028	0.000
Drops	Number of school age children dropped out of school	0.179	0.075	0.018
c16	Are there any disabled adults at home? 1=yes, 0=no	-0.129	0.065	0.046
_Ib5_2	Households with a couple and one child	-0.689	0.136	0.000
_Ib5_3	Households with a couple and two children	-0.927	0.101	0.000
_Ib5_4	Households with a couple and three children or more	-0.898	0.152	0.000
_Ib5_5	Households with father or mother and the children	-0.790	0.120	0.000
_Ib5_6	Households with three generations	-0.999	0.154	0.000
_Ib5_7	Other kinds of households	-0.770	0.172	0.000
Household Head Characteristics				
c5	Age of the household head	0.007	0.002	0.002
Spouse	Whether the household head got married?	-0.255	0.099	0.010
c7	Can household head speak Chinese?	-0.347	0.127	0.006
_Ic13_3	Household head with middle school education	-0.268	0.050	0.000
_Ic13_4	Household head with high school education	-0.290	0.087	0.001
Housing and Other Assets				
ro_n_b10	Square root of housing acreage	-0.162	0.023	0.000
b24	Square meters of barn for livestock	-0.008	0.001	0.00
b14	Whether have pigs?	-0.125	0.056	0.026
b15	Whether has sheep or goats?	0.136	0.062	0.029
b19	Whether has a TV?	-0.468	0.053	0.000
b21	Whether has a motorcycle?	-0.362	0.080	0.000
b22	Whether has a telephone?	-0.671	0.076	0.000
b26	Whether has a hand tractor?	-0.198	0.070	0.005
b27	Whether has a large or medium sized tractor? 1=yes, 0=no	0.333	0.137	0.015
B28	Whether has a cart? 1=yes, 0=no	0.146	0.068	0.031
b35	Whether has electricity?	-0.344	0.095	0.000
ro_n_b73	Square root of the amount of grain stored at home per capita	-0.030	0.004	0.000
Natural Resources				
b39	Whether is it difficult to access drinking water?	0.161	0.054	0.003
b41	Whether it becomes more difficult to collect fuels?	0.130	0.048	0.007
Landpc	Cultivated land per capita	-0.072	0.010	0.000
b45pc	Forest land per capita	-0.066	0.021	0.002
b47pc	Grassland areas per capita	-0.014	0.003	0.000
b49pc	Wasteland areas per capita	-0.160	0.043	0.000
Activities and Access to Services				
ln_p	Log of family members staying at home for 6 months or more	3.128	0.144	0.000
leadbus	Is any family members the village leaders or engaged in business?	-0.283	0.092	0.002
c21	Any household members working outside?	-0.606	0.059	0.000
Cashr	Ratio of sown areas of cash crop to total sown areas	-0.505	0.129	0.000
b4	Whether a "wu bao hu" without any income sources, 1=yes, 0=no	0.942	0.363	0.010
bigevent	Whether has a big event?	-0.389	0.060	0.000
Community Characteristics				
a20	Distance to the nearby market, km	-0.009	0.002	0.000
a50	Whether had a natural disaster in the village?	0.245	0.049	0.000
a57	Whether designated as a poor village?	0.232	0.045	0.000
Provincial Dummy				
_Ipro_14	Shanxi	0.205	0.092	0.026
_Ipro_15	Inner Mongolia	-0.568	0.145	0.000
_Ipro_34	Anhui	-1.191	0.161	0.000
_Ipro_36	Jiangxi	-1.904	0.198	0.000
_Ipro_41	Henan	-0.440	0.105	0.000
_Ipro_42	Hubei	-1.586	0.167	0.000
_Ipro_43	Hunan	-2.046	0.172	0.000
_Ipro_45	Guangxi	-1.763	0.141	0.000
_Ipro_46	Hainan	-1.739	0.292	0.000
_Ipro_50	Chongqing	-1.785	0.207	0.000
_Ipro_52	Guizhou	-1.497	0.111	0.000
_Ipro_53	Yunnan	-0.699	0.095	0.001
_Ipro_62	Gansu	-0.304	0.094	0.000
_Ipro_63	Qinghai	-1.359	0.192	0.000
_Ipro_64	Ningxia	-0.879	0.197	0.000
_Ipro_65	Xinjiang	-1.629	0.167	0.000
_cons		-0.727	0.296	0.014

number of observations = 22819

number of groups = 10

Hosmer-Lemeshow chi2(8) = 8.06

Prob > chi2 = 0.4275

Source: Authors' calculation based on 2002 CRPMS.

Appendix 3.7 Identified Poverty Predictors

Variable Name	Description
Household Demographics	
age0_14	Number of family members aged 0–14 years old
age15_60	Number of family members aged 15–60 years old
age60	Number of family members over 60 years old
studt	Number of school age children in school
c16	Are there any disabled adults at home? 1=yes, 0=no
laborr	Ratio of labor to household members
b5	Family structure
Household Head Characteristics	
c4	Sex of the household head, 1=male, 0=female
c5	Age of the household head
spouse	Whether the household head got married? 1=yes, 0=no
c7	Can household head speak Chinese? 1=yes, 0=no
c13	Education attainment of the household head
Housing and Other Assets	
n_b10	Square meters of housing per capita
b23	Square meters of production (business) house
b24	Square meters of barn for livestock
b13	Whether has big animals? 1=yes, 0=no
b14	Whether has pigs? 1=yes, 0=no
b15	Whether has sheep or goat? 1=yes, 0=no
b17	Whether has a radio? 1=yes, 0=no
b18	Whether has a refrigerator? 1=yes, 0=no
b19	Whether has a TV? 1=yes, 0=no
b20	Whether has a bicycle? 1=yes, 0=no
b21	Whether has a motorcycle? 1=yes, 0=no
b22	Whether has a telephone? 1=yes, 0=no
b25	Whether has a car or truck? 1=yes, 0=no
b26	Whether has a hand tractor? 1=yes, 0=no
b28	Whether has a cart? 1=yes, 0=no
b29	Whether has other agricultural tools? 1=yes, 0=no
b30	Whether has a draught animal? 1=yes, 0=no
b31	Whether has a production animal? 1=yes, 0=no
b34	Whether has a toilet? 1=yes, 0=no
b35	Whether has electricity? 1=yes, 0=no
b72	Is grain enough for consumption? 1=yes, 0=no
n_b73	Grain stored at home at the end of the year (kg/person)
n_b75	Grain stored for consumption at home at the end of the year (kg/person)
Natural Resources	
landpc	Cultivated land per capita, mu/per person
b45pc	Forest land per capita (mu/person)
b46pc	Orchard land per capita (mu/person)
b47pc	Grassland areas per capita (mu/person)
b49pc	Wasteland areas per capita (mu/person)
b39	Whether is it difficult to access drinking water? 1=yes, 0=no
b41	Whether it becomes more difficult to collect fuels? 1=yes, 0=no
fuel	Whether use coal or gas for cooking? 1=yes, 0=no
Activities and Access to Services	
b3	Whether engaged in large scale agricultural production? 1=yes, 0=no
Leadbus	Is any family members the village leaders or engaged in business? 1=yes, 0=no
n_p	Number of household members staying at home for 6 months or more
c21	Are there any household members who work outside? 1=yes, 0=no
Cashr	Ratio of sown areas of cash crop to total sown areas
b4	Whether a “wu bao hu” without any income sources, 1=yes, 0=no
b7	Whether participated in cooperative medical service? 1=yes, 0=no
b8	Whether has insurance? 1=yes, 0=no
bigevent	Whether has a big event such as wedding, funeral, etc. 1=yes, 0=no
Community Characteristics	
a1	Village physiognomy
a6	Number of natural villages with a road for motor vehicles
a15	Distance to the town where the township government is located, km
a20	Distance to the nearby market, km
a50	Whether had a natural disaster in the village? 1=yes, 0=no
a57	Whether being designated as a poor village? 1=yes, 0=no
pro	Provincial code

Source: Authors’ calculation based on 2002 CRPMS.

CHAPTER 4

Poverty Predictor Modeling in the People's Republic of China: A Validation Survey

Pingping Wang

Introduction

Based on poverty predictors identified in Sangui, Pingping, and Heng (2005) and listed in Appendix 3.1, a short questionnaire was developed and used in a pilot survey to determine whether or not the poor in a particular location could be identified without conducting an income and expenditure survey. If the tool could be used to identify the poor, it would be useful for evaluating the impact of a poverty reduction project on a target area. To be able to validate the results of the survey, the questionnaire included questions on the respondents' income and expenditures. A comparison was also carried out on the accuracy of the assessment of households' poverty status based on results of different assessors.

Data and Methods

Sample Size and Data Gathering

The pilot survey[1] was conducted in five counties in the province of Yunnan in the People's Republic of China (PRC). The coverage area was along the Asian Development Bank–financed Kunming-Dali expressway. A total of 1,000 households spread over 50 villages were interviewed. In each county, there were 10 villages and 200 households selected. In each village, 20 households were selected, of which 10 households were from the sample coverage of the China Rural Poverty Monitoring Survey (CRPMS), while the rest were newly selected samples. A total of 45 villages with 450 households were taken from the CRPMS while 5 villages and 550 households were non-CRPMS.

Field supervisors had made several trips to check and ensure that the enumerators followed the guidelines of the survey manual, directly assess the

1 The questionnaire used in the pilot survey can be downloaded at http://www.adb.org/Statistics/reta_6073.asp.

poverty status of the households according to the poverty predictors, observe the reaction of respondents to the survey questions, and discuss the survey with government staff of counties and townships, village heads, villagers, owners and employees of enterprises, farmers, etc.

The pilot survey also identified the poverty status of households based on judgments of village heads, neighbors, enumerators, and the households themselves.

Income and living expenditure data were collected through daily recording and were regarded as *actual* data in this study. The result was compared with the perception of household poverty status based on the independent assessments.

Validation Method

As a preliminary step, the significance of the predictors of household poverty status was first validated using the results from the pilot survey data and the existing national poverty monitoring survey, that is, the CRPMS. The coefficients of poverty predictors of the ordinary least squares (OLS) model for the subsample group Data1 in Sangui, Pingping, and Heng (2005) were applied to 450 sample households from the CRPMS to predict the per capita living expenditure for the said sample. The result was regarded as *predicted* data in this study.

Next, the levels of predicted and actual per capita expenditure were compared with poverty lines CNY700,[2] CNY1,000, and CNY1,500 to determine the measures of poverty status. CNY700 was an approximation of the official rural poverty line, which was CNY668 in 2004. CNY1,000 was an approximation of the current official poverty line for the low-income group, which was CNY924 in 2004 and was about $1-a-day at purchasing power parity prices. Finally, CNY1,500 was an approximation of the proposed poverty line for the rural upper-income group. Also, data were divided into low-, middle-, and high-income groups based on per capita expenditure and predicted and actual data were compared. Cross tabulation of actual and predicted poverty measures as well as income groups would reveal the accuracy of the poverty predictors.

The next task was to build the new OLS regression and logit models using the results of the pilot survey and the significant predictor variables previously mentioned. For OLS regression, predicted per capita consumption derived from the survey was then compared to the three poverty lines mentioned above to again determine the measures of poverty status. Actual and predicted measures were again cross tabulated to reveal accuracy. For the logit model,

2 CNY stands for Chinese Yuan.

sensitivity and specificity coefficients were directly computed to determine the accuracy of the prediction.

In eliminating the bias of self-reporting, the respondent's welfare status was also evaluated by three other individuals: village head, the respondent's neighbor, and the survey enumerator. The respondent was rated by evaluators according to the following categories: poor, low-income, and nonpoor.

For the final step of validation, means of measures of poverty predictors for poor and nonpoor were subjected to a test of mean difference using a t-test.

Results

Poverty-Predictor Accuracy Based on 450 CRPMS Households

Applying the coefficients of poverty predictors of the OLS model to 450 sample households from the CRPMS would reveal that expected value of per capita consumption is quite close to the actual daily reporting of individual consumption with minimum variance (Table 4.1).

Table 4.1 **Statistical Summaries of Per Capita Expenditure**

Variable	*Number*	*Mean (CNY)*	*Standard Error*
Actual	450	1664.57	1180.49
Predicted	450	1673.26	615.26

Source: Authors' calculation based from 2002 CRPMS.

As shown in Table 4.2, as the poverty line increases, the accuracy of predicting the poor household increases, while the reverse is observed in predicting the nonpoor. It might be noted that everyone with per capita consumption above CNY700, is predicted as nonpoor, which implies that there could be serious prediction problems if the poverty line used is too low. This is in line with the finding of this book's Chapter 3.

Table 4.2 **Poverty Status Using the CNY700, CNY1000, and CNY1500 Poverty Lines—Actual Versus Predicted**

		Predicted				
		700 CNY	*1000 CNY*		*1500 CNY*	
		Nonpoor	*Nonpoor*	*Poor*	*Nonpoor*	*Poor*
Actual	*Nonpoor*	100.0	98.5	1.5	73.2	26.8
	Poor	100.0	88.1	11.9	44.7	55.3

Source: Authors' calculation based on 2002 CRPMS.

To further validate the model, the households' per capita expenditure was divided into low, middle, and high groups.[3] The empirical result shows that poverty among the low-income group can be predict ed at 61 percent, while the high-income group can only be predicted at 59 percent. The middle group seems to have low prediction capability (Table 4.3).

Table 4.3 **Comparing Households Based on Per Capita Expenditure—Actual Versus Predicted**

		Predicted			
		Low	*Middle*	*High*	*Total*
Actual	*Low*	61.30	28.70	10.00	100.00
	Middle	22.70	46.00	31.30	100.00
	High	16.00	25.30	58.70	100.00
	Total	100.00	100.00	100.00	-

Source: Authors' calculation based on 2002 CRPMS.

Poverty Predictor Accuracy of Households in the Pilot Survey

From the OLS estimation, the model generated predicted per capita expenditures, which were then compared with the three poverty lines. As shown in Table 4.4, increasing poverty lines increase the likelihood of accurately predicting the poor but the reverse is observed in predicting the nonpoor.

Table 4.4 **Classifying Poor and Nonpoor Using the Per Capita Expenditure—Actual Versus Predicted**

		Predicted Based on Per Capita Living Expenditure					
		700 CNY		*1000 CNY*		*1500 CNY*	
		Nonpoor	*Poor*	*Nonpoor*	*Poor*	*Nonpoor*	*Poor*
Actual	*Nonpoor*	98.8	1.20	91.0	9.0	72.1	27.9
	Poor	68.8	31.30	59.0	41.0	23.5	76.5

Source: Authors' calculation based on 2002 CRPMS.

Logistic regression was also used to predict whether a household was poor or not. Here, poverty was measured using CNY1,500 per capita expenditure as the poverty line. The dependent variable was whether the household was poor (with per capital expenditure below CNY1,500), where *1* is poor and *0* is nonpoor.

Accordingly, as shown in Table 4.5, the percentage of poor correctly predicted was about 82 percent and the percentage of nonpoor correctly predicted was around 76 percent. This indicates that logistic regression is more powerful than OLS regression in terms of predicting poverty. The

3 All households were divided equally based on predicted per capita consumption as well as actual per capita consumption.

probability of incorrectly predicting the poor (poor that were actually not poor), is 24 percent while the probability of the opposite case is 18 percent.

Table 4.5 **Accuracy of Predicted Poverty Status Using the Logit Model with CNY1,500 Poverty Line**
(percent)

Sensitivity	82.04
Specificity	76.14
Positive predictive value	80.09
Negative predictive value	78.36
False positive rate for true nonpoor	23.86
False negative rate for true poor	17.96
False positive rate for classified poor	19.91
False negative rate for classified nonpoor	21.64
Correctly classified	79.32

Probability cut off of 0.20
Source: Authors' calculation based on 2002 CRPMS.

An Alternative Approach for Identifying the Poor

Using the evaluators' judgment of the respondents' poverty status, results reveal that while the respondents themselves perceive that most of them belong to low-income or poor groups, the evaluators perceive the respondents to be in low-income or nonpoor groups (Table 4.6). Thus, there was an upward bias in estimating the number of poor based on respondents' own perceptions.

Table 4.6 **Classification of Poor and Nonpoor Based on Different Assessors**
(percent)

Assessors	*Poor*	*Low-Income*	*Nonpoor*	*Total*
Village head	7.50	20.60	71.90	100.00
Enumerator	5.50	19.40	75.10	100.00
Neighbor	7.50	20.70	71.80	100.00
Respondent: based on income	10.70	76.70	12.60	100.00
Respondent: based on expenditure	19.40	74.20	6.40	100.00

Source: Authors' calculation based on 2002 CRPMS.

Using the 1,000 household responses, the local perception of poverty was matched with the identified poverty predictors. A respondent was categorized as poor if and only if all evaluators rated the respondent as such. If the respondent rated himself or herself as poor and the rest of the evaluators did not, the respondent was classified as nonpoor. This method classified 138 households as poor category, while 119 households were classified as nonpoor. The predictors were considered to be reliable if they were present in poor households but not in nonpoor households.

Table 4.7 shows the mean values of the poverty predictor variables from the survey results. The last column shows the t-Statistics of the differences in the means of the nonpoor and poor. A predictor was eliminated if the difference was not significantly different from 0 at a 95 percent confidence level, that is, when both poor and nonpoor households were locally perceived to have the same characteristics.

For further refinement, those that did not provide substantial information on the differences between poor and nonpoor were also eliminated. For instance, the average number of residents per household for the nonpoor was 4.56 and for the poor it was 4.22. Although their t-statistic for mean difference was high enough, the predictor does not notably distinguish between the two groups.

Table 4.7 also shows that some identified poverty predictors that have positive coefficients from the linear regression model developed in Sangui, Pingping, and Heng (2005)–indicating that the higher value of the predictor increases the log of per capita expenditure of a household–turned out to be more apparent among poor households than in nonpoor ones. Family structure, where the household has other members apart from immediate family, is an example of such a poverty indicator. The coefficient for the linear regression was positive when only 5 percent among the nonpoor households have other members, whereas it was 14 percent among the poor households.

The new sets of predictors provide indicators of the household's poverty status. Of the 1,000 households, 15 percent have at least one of the demographic characteristics, 84 percent possess at least one of the assets common to poor households, 99 percent have heads that were either single or have a high school education or less (up to none at all), and 21 percent live in mountainous areas. There were only 42 households that met all of the four criteria above and almost half of them were identified to be poor by at least one of the evaluators.

Table 4.8 presents the percentage distribution of households classified as poor according to the group of predictors. Notable is the high percentage (83 percent) of the population that were categorized as poor because they have at least one of the assets common to poor households and have household heads that are either single or have low education levels. There was a small percentage of the population who were classified as poor because of their household demographics and because they live in mountainous areas.

Table 4.7 **Mean of Poverty Predictors and T-Statistics of the Mean Difference**

Household Characteristics	PPM Coefficient +/-	Mean		t-Statistics
		Nonpoor	Poor	
Household Demographics				
Number of residents		4.56	4.22	2.10
Aged 0–14 years	+	1.49	1.40	0.94
Aged 15–60 years	+	3.31	2.86	3.21
Aged over 60 years old	+	1.26	1.32	-0.57
Staying at home for 6 months or more	-	4.19	4.12	0.39
Number of school-age children in school	+	1.48	1.42	0.59
Family structure:				
Has parents and no children	+	0.03	0.00	1.45
Has parents and one child	+	0.13	0.13	0.09
Has parents and two children	++	0.27	0.29	-0.34
Has parents and three children or more	++	0.03	0.00	1.45
Has either one of the parents and children	++	0.00	0.06	-2.50
Has three generations	++	0.45	0.34	1.72
Has other members	++	0.05	0.14	-2.32
Has disabled adults at home	ns	0.02	0.19	-4.62
Ratio of labor to household members	-	0.67	0.61	2.32
Activities and Access to Services				
Celebrates big events	++	0.21	0.27	-1.05
Engaged in large-scale production	+	0.05	0.02	1.21
A household member is the village leader	+	0.28	0.03	5.60
Number of members that work outside the village	+	1.53	1.26	1.88
Ratio of cash crop areas to total sown areas	+	0.26	0.23	0.92
Has grain that is enough for consumption	+	0.99	0.94	2.28
Uses coal or gas for cooking	+	0.65	0.28	6.25
Has no income sources (Wu Bao Hu)	-	0.00	0.00	-
Participates in cooperative medical service	-	0.06	0.00	2.48
Has insurance	+	0.37	0.11	5.00
Asset Ownership				
Has big animals	-	0.69	0.65	0.65
Has pigs	+	0.68	0.90	-4.53
Has sheep or goat	-	0.04	0.18	-3.68
Has a radio	+	0.44	0.25	3.25
Has a refrigerator	+	0.19	0.02	4.46
Has a TV	+	0.99	0.67	7.76
Has a bicycle	+	0.72	0.29	7.49
Has a motorcycle	+	0.28	0.07	4.52
Has a telephone	+	0.63	0.18	8.12
Has a car or truck	+	0.11	0.00	3.61
Has a hand tractor	+	0.06	0.02	1.40
Has other agricultural tools	+	0.26	0.29	-0.65
Has draught animal	+	0.38	0.59	-3.38
Has production animal	+	0.40	0.24	2.69
Has toilet	+	0.91	0.68	4.96
Has electricity	ns	1.00	0.97	2.02
Amount of grain stored at home at the end of the year (kg/person)	+	332.40	295.24	1.45

(continued on next page)

Table 4.7 continued

Household Characteristics	PPM Coefficient +/-	Mean Nonpoor	Mean Poor	t-Statistics
Amount of grain stored for consumption at home at the end of the year (kg/person)	ns	220.18	165.02	3.05
Floor area of house per household member (square meters)	+	36.37	31.52	2.12
Area of house allotted for production (square meters)	+	51.37	46.60	0.76
Area of barn for livestock (square meters)	ns	34.06	29.10	1.76
Has difficult access to drinking water	-	0.11	0.34	-4.44
Finds collecting fuels getting more difficult	-	0.47	0.61	-2.34
Natural Resources				
Area of cultivated land per capita	+	1.16	1.05	1.50
Area of forest land per capita	+	1.61	2.36	-0.91
Area of orchard land per capita	ns	0.40	0.40	-0.02
Area of grassland areas per capita	+	0.15	0.10	1.29
Wasteland areas per capita	ns	1.06	0.77	0.42
Household Head Characteristics				
Sex of the household head is male		0.92	0.93	-0.32
Age of the household head	-	44.77	42.57	1.70
Marital status:				
Single	-	0.01	0.10	-2.98
Married	+	0.96	0.83	3.70
Divorce		0.01	0.06	-2.00
Household head can speak Chinese	+	0.99	0.99	-0.10
Educational attainment:				
Without formal education	+	0.01	0.12	-3.49
With primary school education	+	0.33	0.54	-3.40
With middle school education	+	0.52	0.29	3.85
With high school education	+	0.10	0.20	2.30
With college education or higher	++	0.01	0.00	0.68
Village Characteristics				
Village physiognomy:				
Has plate land	+	0.60	0.47	2.04
Has hilly areas	+	0.32	0.06	5.45
Has mountainous areas	ns	0.06	0.45	-8.04
Number of natural villages with a road for motor vehicles	+	10.47	15.97	-5.43
Distance to the town where the township government is located (km)	+	2.13	2.74	-4.52
Distance to the nearby market (kilometers)	+	2.44	2.80	-2.59
Natural disaster occurs in the village	-	0.85	0.52	5.85
Village designated as poor by the National Poverty Reduction Project	-	0.37	0.15	4.01

ns = not (statistically) significant
Source: Authors' calculation based on the household survey used by Sangui, Pingping, and Heng.

Table 4.8 **Distribution of Households Identified as Poor**
(Percent)

Identified Poor by:	*Household Demographics*	*Asset Ownership*	*Household Head Characteristics*	*Village Characteristics*
Household Demographics	14.7	11.7	14.7	4.4
Asset Ownership	11.7	83.5	83.0	20.5
Household Head Characteristics	14.7	83.0	99.3	20.9
Village Characteristics	4.4	20.5	20.9	21.1

Source: Authors' calculation based on the household survey with N=1,000 households as generated by Sangui, Pingping, and Heng.

Conclusion

Although every country's poverty situation is unique, the underlying determinants of poverty generally point to a household having low income or facing limited access to income sources. The poverty predictors generated in this study suggest that households are poor because they either have low income or difficult access to income sources. The first can be attributed to having fewer income earners, which was evident form the poor households' characteristics. The second can be attributed to the households' inability to generate higher income because of low education levels that limit them from engaging in other gainful economic activities, or the households' geographic location that prevents them from having access to wider markets for their products and services.

In addition, some predictors, such as those under asset ownership, were outcomes rather than determinants of income status. For instance, a household with a radio, refrigerator, TV, bicycle, motorcycle, telephone, among other assets, was generally classified as nonpoor. Poor households, on the other hand, generally have sheep or goats, or have difficulty accessing drinking water and fuel. The capability of households to purchase relatively more expensive assets signify higher income compared with those who cannot afford them. On the other hand, the inability of households to acquire easier access to drinking water, for instance, signifies lower income compared with those who can afford household appliances.

The poverty predictors thus covered indicators of both causes and effects of poverty. Because the predictors were initially derived by correlating the household's per capita consumption expenditure and the household's characteristics, they reflect the relevance of purchasing power as a factor in defining poverty. In addition, because they were also derived using local perceptions of poverty, the predictors likewise reflect the multidimensional aspects of poverty that include not only the level of income but also other factors that make a household socially and economically disadvantaged.

The households classified as poor by community characteristics, for instance, were poor because they were located in mountainous areas and were not able to generate as much farm income as those households located on flatter land. The cost of living in mountainous regions is usually higher and, hence, some of the households classified as nonpoor by a common poverty line may in fact be poor in this region. The predictors, therefore, go beyond the numeric definition of poverty set by poverty lines.

In terms of the accuracy of the poverty predictor model, the empirical study suggests that the logistic regression model is more accurate than the multiple regression technique. With the given set of predictors or variables to characterize the poor and nonpoor, a survey is an effective instrument to monitor and evaluate the impact of poverty-related projects in the PRC. However, for the purpose of evaluating the effectiveness of the project, the identified poverty predictor variables should be incorporated in the instrument before the start of any poverty reduction project or program.

CHAPTER 5

Identifying Poverty Predictors Using Household Living Standards Surveys in Viet Nam

Linh Nguyen

Introduction

Poverty predictor modeling (PPM) based on a regression-type analysis of household income and expenditure and other variables (predictors) from household surveys of living standards, has been receiving more attention from researchers and practitioners. This interest comes from the fact that PPM provides an easy and low-cost way to collect baseline and follow-up poverty measures for monitoring progress and evaluating the poverty impact of development projects and policies. But while PPM is popular, the reliability of this methodology has yet to be checked.

In Viet Nam, there have been a number of efforts to develop and use poverty predictor models for poverty mapping (Minot 1998, Minot and Baulch 2002 and 2003, MOLISA 2005). These studies were mostly intended for use in poverty targeting and budget transfers. There has been no effort, however, to apply the approach to ex-ante poverty estimates of participatory assessments of various policies. Moreover, there has been no attempt to use data sets of the subsequent comparable household surveys to assess how good the predictors really are.

The approach presented in this study is an attempt to develop a practical alternative to the time-consuming and expensive collection of income and expenditure data for assessing poverty at local levels. In Phase 1 of the study, data from 2002 living standards surveys of Viet Nam's General Statistical Office were used to examine the relationship between poverty and a household's characteristics using a multiple regression modeling technique. This technique detects variables or predictors that have correlated effects on a household's living standards and, consequently, its poverty status. In Phase 2, significant predictors were tested using a 1997/98 living standards survey to check the consistency and stability of the models across time. In Phase 3, another regression modeling procedure was implemented for two provinces in the North Central Coast subregion to further test the methodology and to check whether the poverty predictors would be different at more a disaggregated level. Finally, in Phase 4, reliable and easy-to-collect poverty predictors within the regression model were used to generate a short questionnaire[1] for frequent implementation or for data collection at local levels.[2]

Data and Methods

Data

For Phases 1 and 2, the work uses the 1997/98 Viet Nam Living Standard Survey (VLSS) and the 2002 Viet Nam Household Living Standard Survey (VHLSS), both implemented by the General Statistical Office. These surveys provide data on income, expenditure, and other characteristics of households such as demography, education, health, assets, housing, etc. They are fairly well-organized, have high-quality data, and can be a good source of information for poverty analysis and assessment at the national and even at the provincial levels.

The 2002 VHLSS data were crucial to this work. The information was used to derive the basic poverty predictor model and to test the stability of the model. The survey had a general sample size of 75,000 households and collected information about household living standards and basic communal socioeconomic conditions including income and expenditures. Income data came from all 75,000 households, but expenditure data were from only 30,000 households.

The total sample used in the study was composed of 29,510 households. For comparison, the sample was split into urban and rural data sets. There were 22,601 rural households in the sample, while the rest were urban. To test the stability of the model across the whole data set, the rural and urban data sets were further split into a learning data set and a validation data set. This was done by randomly drawing a subsample of 50 percent of the total sample as the learning data set for both rural and urban areas. The other 50 percent subsample was used as the validation data set. The learning and validation data sets had to be very similar to each other to ensure the comparability of the two models' statistics. Summary statistics of the 2002 VHLSS rural data set are presented in Table 5.1.

1 The questionnaire used in the pilot survey can be downloaded at http://www.adb.org/Statistics/reta_6073.asp.

2 Aside from predictors, some questions were also included in the questionnaire to create variables for specific studies relating to poverty.

Method for Phase 1

Table 5.1 **Summary Statistics of the 2002 Viet Nam Household Living Standard Survey of Rural Area**

Variable	Samples	Mean	Standard Deviation
Learning	11,299	2,838.758	1,672.116
Validation	11,302	2,842.604	1,633.516

Source: Author's calculation.

The Model. The ultimate goal of this study was to build a good regression model to examine the relationship between household expenditure and household characteristics using the 2002 VHLSS. Multiple regression modeling was the method employed in the study in the following form:

$$\textit{Dependent Variable} = \beta_0 + (\textit{Independent Variable}_i \times \beta_i) + e_i$$

The dependent variable was the household's annual expenditure per capita or one of its transformations, rather than income as a measure of household living standards, to ensure international comparability.[3] The right-hand side variables were household characteristics from survey data, also called poverty predictors. The model's parameters were as follows: β_0 was the model intercept or constant, while β_i were respective regression coefficients. Finally, e_i were random errors that included effects of all variables on the dependent variable other than the ones explicitly considered in the model.

The commonly used method, weighted least squares, was used in this study to estimate model parameters (β_0 and β_i) by minimizing the sum of random errors e_i across households using the sampling weight. It worked by incorporating extra nonnegative constants or weights associated with each data point into the fitting criterion. The size of the weight indicated the precision of the information contained in the associated observation.

Optimizing the weighted fitting criterion to find the parameter estimates allowed the use of weights to determine the contribution of each observation to the final parameter estimates. It was important to note that the weight for each observation was given relative to the weights of the other observations; so different sets of absolute weights could have identical effects.[4]

A model-building procedure was implemented on the learning data set until a satisfactory model of poverty predictors was achieved. Next, the predictor variables were created based on the validation data set, which was in turn used as a basis for creating the poverty predictor model. Finally, the statistics of the two models for the learning and validation data sets were compared. If these statistics were similar, then the model was considered

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3 Income is usually more underestimated than expenditure in household surveys, which is another reason for using expenditure in the model.

4 See http://www.itl.nist.gov/div898/handbook/pmd/section1/pmd143.htm.

stable across the data set. If they were not similar, the whole process would be repeated for another regression model for the learning data set until the model statistics for the two data sets were similar.

Hence, model building was done for four subsamples: urban and rural areas, both disaggregated by learning and validation data sets. The model was first constructed for the rural subsample, then the same procedure was applied for the urban subsample.

Variable Selection. For the dependent variable, the choice was between annual expenditure per capita and some of its transformations. A number of transformations such as natural logarithm, logarithm, square root, etc., were generated and examined. The natural logarithm of annual per capita expenditure (log of PCE) was eventually selected as the dependent variable since this type of transformation most closely follows the normal distribution.

For independent variables, a list was created for all possible variables using household characteristics that were believed to affect household living standards. From the 2002 VHLSS household questionnaire, 60 variables of this type were chosen including region, household size, number of household members under or above certain ages, household assets (black-and-white TV, colored TV, rice cooker, motorbike, etc.), occupation of the head, and number of unemployed members. Many variables relating to households' agricultural activities such as number and proportion of people working in agriculture and size of land areas were also used since these activities were very important aspects in the lives of people in rural areas. Since the aim of the study was to predict the dependent variable and not to estimate the determinants (causality) of household living standards, the endogeneity of the independent variables was not a concern.

From the list of independent variables, only easy-to-collect variables were chosen to meet the requirement of creating a short questionnaire (which was built in Phase 2) that could be completed quickly. These independent variables were examined carefully to create an overview or metadata of mean, minimum, and maximum values, and to see if a variable was categorical or continuous, among other things (see Appendix 5.1 for the list of variables). Dummies were used during the model-building process which increased the number of variables to more than 60.

To examine and narrow down the number of variables, tests were conducted in three stages. First, a bivariate data analysis was done in which each independent variable was evaluated based on the strength of its individual relationship with the log of PCE. Variables with a significant relationship with the dependent variable were retained. The analysis used an F-test for means for categorical variables (see Table 5.2 for an example) and a correlation coefficient test for continuous variables (see Table 5.3 for an example).[5] Both tests selected variables that generated probability values less than the assigned significant level. Selected variables that were highly correlated with the dependent variable were retained in the model.

Table 5.2 **Example of F-Test for Means Using the Categorical Variables**

Obs	Categorical Variable	Sample Size	DF	SS1	F-stat	Prob
1	motorbike	11,297	1	264575.8	2421.92	0.0000000
2	colortv (color tv)	11,297	1	251205.9	2274.88	0.0000000
3	ricecooker (rice cooker)	11,297	1	245796.6	2216.29	0.0000000
4	gascooker (gas cooker)	11,297	1	243019.5	2186.40	0.0000000
5	telephone	11,297	1	197464.4	1714.35	0.0000000
6	toilet	11,292	6	298012.4	467.12	0.0000000
7	num_u15 (household member under 15 years old)	11,290	8	248647.7	280.71	0.0000000
8	num_dep (number of dependent)	11,289	9	227154.0	224.08	0.0000000
9	refee (rental fee)	11,297	1	176345.6	1506.55	0.0000000
...	...	...	...	...	...	...

Obs = observation; DF = Degrees of freedom; SS = Sum of squares; F-stat = Statistics; Prob = Probability of acceptance
Source: Authors' calculation based on 2002 VLSS.

Table 5.3 **Example of Correlation Coefficient Test for Continuous Variables**

Pearson Correlation Coefficients, N = 11299					
Prob > |r| under H0: Rho=0					
Dv	prop_u15	prop_o15	livingarea	prop_dep	prop_labor
Corr. Coef.	-0.35539	0.35539	0.23516	-0.20947	0.20947
Prob	<.0001	<.0001	<.0001	<.0001	<.0001
Dv	prop_illi	hage	prop_o60	prop_o70	prop_studmem
Corr. Coef.	-0.17242	0.13166	0.09637	0.05286	-0.00678
Prob	<.0001	<.0001	<.0001	<.0001	0.4713

Note: prop_u15 = Proportion of household members under 15 years; leavingarea = Leaving area; prop_dep = proportion of dependents; prop_labor = proportion of persons in the labor force (15–16 years); prop_illi = proportion of illiterate people; hage = age of household head; prop_o60 = proportion of member where age = 60; prop_o70 = proportion of member where age = 70; prop_studmem = proportion of studying people
Source: Authors' calculation based on 2002 VLSS.

The second stage in selecting variables involved a multivariate analysis on multicollinearity between predictors. Some of the independent variables

5 A continuous variable has numeric values such as 1, 2, 3, 4, 5, etc. The relative magnitude of the values is significant. For example, a value of 2 indicates twice the magnitude of 1. On the other hand, a categorical variable, also known as a nominal variable, has values that function as labels rather than as numbers. For example, a categorical variable for gender might use the value *1* for male and *2* for female; marital status might be coded as *1* for single, *2* for married, *3* for divorced, and *4* for widowed. Some software applications allow the use of nonnumeric (character-string) values for categorical variables. Hence, a data set could have the strings *Male* and *Female* or *M* and *F* for a categorical gender variable. Because categorical values are stored and compared as string values, a categorical value of *001* is different from the value of *1*. In contrast, values of *001* and *1* would be equal for continuous variables (see http://www.dtreg.com/vartype.htm).

could have been highly correlated with each other and, therefore, would have been redundant. This redundancy could have caused problems in the modeling process. In the multivariate analysis, a correlation test was run for pairs of independent variables. If the correlation coefficient of two independent variables was equivalent to 80 percent and above, then it was assumed that multicollinearity existed between these two variables. However, even if there was multicollinearity, variables that had a high degree of relationship with the dependent variables were kept (see Appendixes 5.2, 5.3, and 5.6 for the list of candidate variables).

The final stage in selecting the variables involved transforming continuous independent variables. For this purpose, the variables chosen from the previous stage were plotted against the log of PCE. In Figure 5.1, the shapes of the plot suggest independent variables should be transformed. Possible transformations were also tested in conjunction with the dependent variable (see Table 5.4 for an example). The transformed variables that generated high correlation were retained. Table 5.5 lists the variables that were transformed in this study.

Table 5.4 **Transformation of Nonlinear Independent Variables to Minimize Error**

Variables	Transformation
Urban file	
• proportion of dependent people (prop_dep)	Truncated at 90th percentile
• proportion of people studying (prop_studmen)	Square root
• proportion of people 15 years old or older (prop_o15)	Square root
Rural file	
• proportion of dependent people (prop_dep)	Square root
• proportion of illiterate people (prop_illi)	Square root
• age of household head (hage)	Natural logarithm
• agricultural land area (agriland)	Natural logarithm

Source: Author's summary based on the modeling development results.

A test for multicollinearity was again done to track down possible multicollinearity among transformed and untransformed variables. From this test, the list of the best candidate variables was finalized for use in the model-building process.

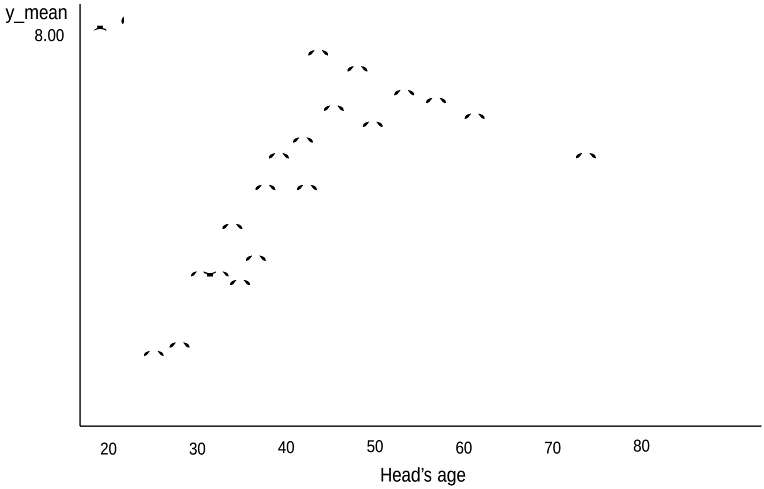
Table 5.5 **Transformation of Nonlinear Independent Variables**

Pearson Correlation Coefficients, N = 4822
Prob > |r| under H0: Rho=0

	Transformation Type				
	Natural Logarithm	*Square Root*	*Truncated at 95th percentile*	*Truncated at 99th percentile*	*No transformation*
Correlation coefficient	0.03712	0.03198	0.03031	0.02745	0.02643
Probability	0.0099	0.0264	0.0353	0.0567	0.0665

Independent Variable: Head's age
Source: Author's calculation based on 2002 VLSS.

Figure 5.1 **Example of Variable Plot that Needs Transformation**



Note: The scatter plot suggest a curvilinear or non-linear that has to be transformed to satisfy linearity criteria for the model.
Source: Author's calculation.

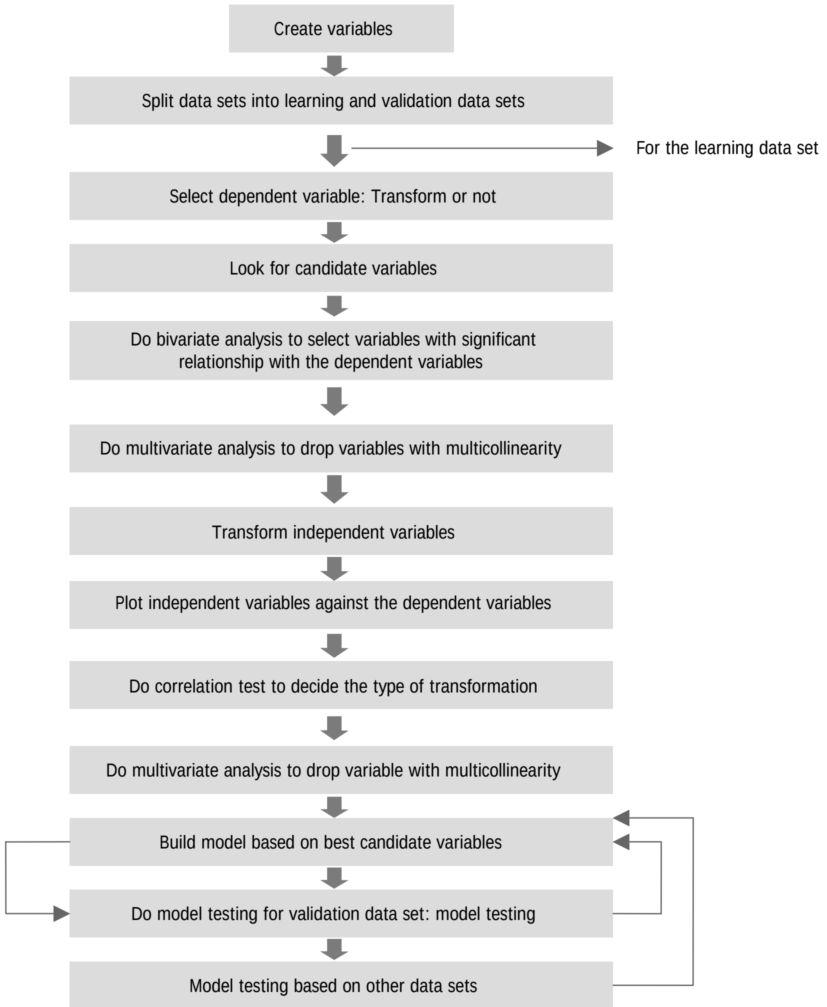
Model Building. The model was built using the learning data set for rural and urban areas, and weighted using the sample weight of the survey. Model-adequacy checks were performed by examining the R-squared values, residual plot, and plot of actual versus predicted values of log PCE for constancy of variance test and matched tabulation to see if top and bottom quintiles were balanced.

As mentioned in a previous section, subsamples for rural and urban areas were each split into learning and validation data sets to test the stability of the model across the subsamples. The model created using the learning data set would be applied to the validation data set. The following were the criteria considered for developing the model:

- The same set of predictors were significant in the validation model.
- The correlation direction of these predictors was the same as the dependent variable.
- Model statistics for the two data sets were similar or negligibly different.

Figure 5.2 is a summary of the steps in the methodology.

Figure 5.2 **Flow Chart for Building a Poverty Predictor Model**



Source: Author's framework.

Method for Phase 2

To further ensure that the final model was the best model possible, significant predictors were tested and validated using the 1997/98 VLSS.[6] The test was

6 The 1992/93 VLSS, the General Statistical Office's earliest living standards survey, was not considered in the study because data were too old to be used for testing the model.

to examine the stability of the model across time. All the model statistics and selection criteria were also reviewed for this model to see how much the chosen predictors fit in the 1997/98 VLSS. The 1997/98 VLSS collected information on 6,000 households. It does not include income data but, like the 2002 VHLSS, it gathered more detailed information on household expenditure, household characteristics, and commune data.

Method for Phase 3

To further test the methodology or disprove that poverty predictors may be different when estimating for a more disaggregated level than the national level, another regression modeling procedure was implemented for two provinces in the North Central Coast subregion, namely, Thanh Hoa and Nghe An, using the 2002 VHLSS. The selected subregion accounted for the biggest share of rural poor households in the country based on the 2002 VHLSS. While constructing the poverty predictor model for Thanh Hoa and Nghe An, two variables were added to the list of candidate variables, that is, *maize* (households harvesting maize = 1) and *sugarcane* (households harvesting sugarcane = 1) since these agricultural products are popular and indigenous crops in these provinces. Data sets were also equally split into learning and validation subsamples to test the stability of the whole data set, each with only 705 observations.

Method for Phase 4

After the identification of the variables necessary for the poverty predictor model, a pilot survey was implemented. The main objective was to assess the effectiveness of the poverty predictor model in estimating the poverty rate of the subregion taking into consideration the perceptions of respondents themselves (self-assessment), enumerators, and hamlet chiefs on household poverty classification. The survey used a questionnaire that contains not only variables identified in the poverty predictor model, but also questions on the interventions that the government or international organizations provided and could provide, as well as emerging issues on trade liberalization.

The sampling method used in this pilot survey was the two-stage cluster random sampling. The survey was conducted in Thanh Hoa and Nghe An with a sample size of 500 households. The results of the 2004 VHLSS were used as a benchmark in assessing the effectiveness of the survey, specifically, in classifying poor households. The results of the 2004 VHLSS were also used as a sampling frame for the pilot survey.

Results in Phases 1 and 2

Rural Areas

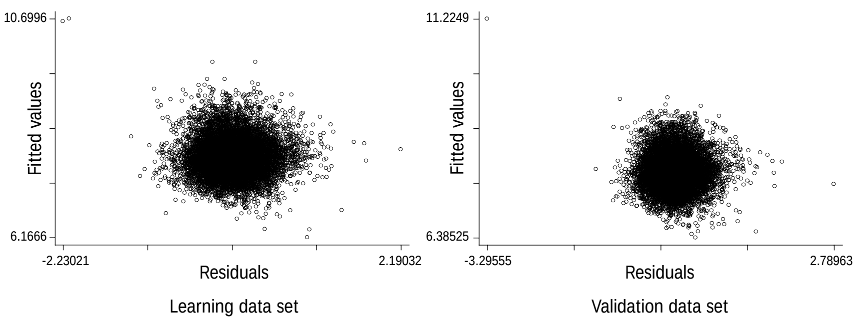
In general, the results for the rural areas were acceptable as shown in Table 5.6. The model from the learning data set generated an R-squared of 0.5801; for the validation data set, the R-squared was 0.5762. In other words, about 58 percent of the changes in the log of PCE was due to changes in the retained predictors. All predictors retained their significance and the same correlation sign was observed in both data sets (see Appendix 5.3 and 5.4 for details).

Table 5.6 **Summary of Goodness of R^2 of the Regression Model for the Learning and Validation Data Sets in Urban and Rural Areas**

Data Set	Urban	Rural
Learning	0.7417	0.5801
Validation	0.7517	0.5762

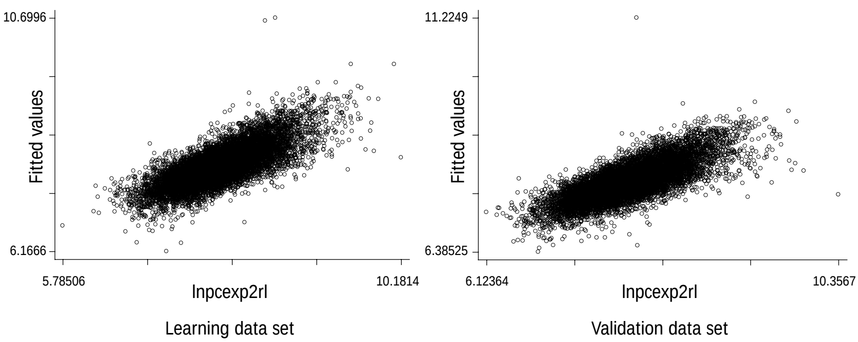
Source: Author's summary based on SUSENAS for the modeling development results.

Figure 5.3 **Residual Plot for the Rural Subsamples**



Note: This is to test homogeneity criteria of the residuals.
Source: Author's calculation based on 2002 VLSS.

Figure 5.4 **Actual Versus Predicted Values of Log Per Capita Expenditure for the Rural Subsamples**



lnpcexp2rl = natural logarithm of real per capita expenditure
Note: This is to test homogeneity criteria of the residuals.
Source: Author's calculation based on 2002 VLSS.

Diagnosing the models through a residual check, as shown in Figure 5.3, revealed that error variance is constant across observations for both rural subsamples, hence, the error term is homoscedastic. This is verified in Figure 5.4, which also proves linearity of the error.

The matched tabulation in Table 5.7 shows a good percentage match in the top and bottom quintiles, almost 60.0 percent for both. For the middle quintiles, the match is not very high, probably due to the small difference among adjacent households in terms of per capita expenditure. However, quintile 1 of the predicted log of PCE for the learning data set catches about 85.0 percent of total people in quintiles 1 and 2 of the actual values, that is, 59.6 percent and 25.4 percent, respectively. This is similar to the result in the validation data set. Therefore, if the purpose is to detect poor people and provide support, including people in quintile 1 of the predicted values can be relevant.

Table 5.7 **Matched Tabulation for the Rural Subsamples**

Learning Data Set		**Predicted Quintiles**					
		1	**2**	**3**	**4**	**5**	**Total**
Actual quintile	**1**	59.6	27.2	10.0	3.0	0.2	20.0
	2	25.4	32.8	25.6	13.7	2.5	20.0
	3	11.3	24.0	30.7	24.8	9.2	20.0
	4	3.1	12.6	24.4	34.3	25.4	20.0
	5	0.5	3.4	9.2	24.2	62.6	20.0
	Total	100.0	100.0	100.0	100.0	100.0	100.0

Validation Data Set		**Predicted Quintiles**					
		1	**2**	**3**	**4**	**5**	**Total**
Actual quintile	**1**	59.8	26.7	10.8	2.5	0.3	20.0
	2	25.0	33.1	26.5	12.9	2.4	20.0
	3	10.5	23.6	30.1	27.3	8.5	20.0
	4	4.1	12.7	23.8	34.2	25.2	20.0
	5	0.6	3.9	8.7	23.1	63.7	20.0
	Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculation based on 2002 VLSS.

To further validate the models, mean values of the predicted log of PCE calculated from the two data sets were also compared. As shown in Table 5.8, the values of the two data sets are quite similar and show the stability of the model across the whole data set for rural areas.

Table 5.8 **Comparison of Mean Values of the Per Capita Expenditure for the Rural Subsample**

	Learning Data Set		***Validation Data Set***	
Quintile	*Actual Mean*	*Predicted Mean*	*Actual Mean*	*Predicted Mean*
1	1,321	1,557	1,326	1,552
2	1,926	2,066	1,925	2,067
3	2,441	2,447	2,422	2,446
4	3,138	2,941	3,142	2,941
5	5,091	4,342	5,090	4,310

Note: Total number of observations = 11,299
Source: Authors' calculation based on 1997/98 VLSS.

In Phase 2 for the rural areas, the model is applied to the 1997/98 VLSS, the results of which are presented in Tables 5.9 and 5.10 and Figures 5.5 and 5.6. As shown, almost all variables were still significant at 5 percent. Again, figures reveal that there was no heteroscedasticity in the error terms. This was an encouraging result given that the 1997/98 VLSS was conducted 4 years prior to the 2002 VHLSS.

At this point, the model now had 19 variables, including dummies, found to be very significant at the 5-percent level in the rural areas. There

Table 5.9 **Summary of Goodness of Fit of 1997/98 VLSS and Thanh Hao and Nghe An for Model Validation**

	Data Set	R-Squared
Subsample of VLSS 2002 and VLSS 1997/1998	Urban	0.6693
	Rural	0.5328
Survey in Thanh Hao and Nghe An	Learning	0.6039
	Validation	0.6100

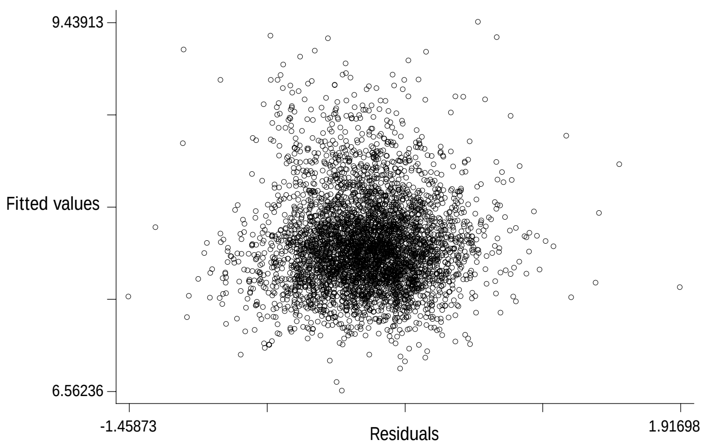
Source: Author's summary based on national and validation surveys.

Table 5.10 **Matched Tabulation for the Rural Subsamples Tested on the 1997/98 VLSS Rural Data Set**

		Predicted Quintile					
		1	2	3	4	5	Total
Actual Quintile	1	59.8	26.7	10.8	2.5	0.3	20.0
	2	25.0	33.1	26.5	12.9	2.4	20.0
	3	10.5	23.6	30.1	27.3	8.5	20.0
	4	4.1	12.7	23.8	34.2	25.2	20.0
	5	0.6	3.9	8.7	23.1	63.7	20.0
	Total	100.0	100.0	100.0	100.0	100.0	100.0

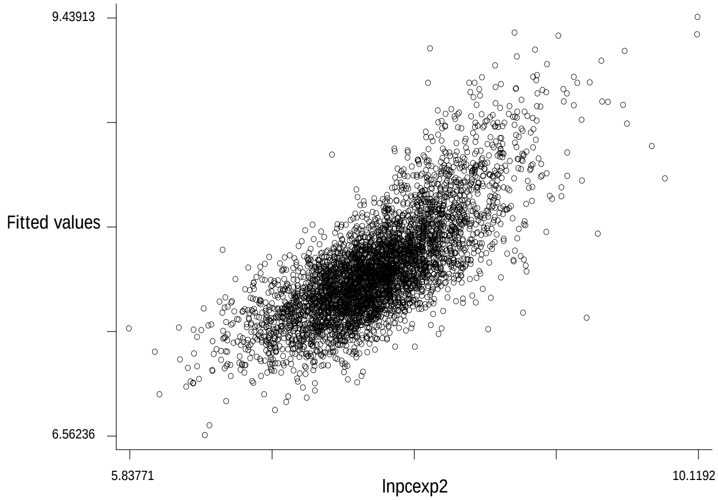
Source: Authors' calculations based on 1997/98 VLSS.

Figure 5.5 **Residual Plot for Rural Subsamples Tested on 1997/98 VLSS Rural Data Sets**



Note: This is to test homogeneity criteria of the residuals.
Source: Author's calculation based on 1997/98 VLSS.

Figure 5.6 **Actual Versus Predicted Values of Log Per Capita Expenditure for the Rural Subsamples Tested on 1997/98 VLSS Rural Data Sets**



lnpcexp2rl = natural logarithm of real per capita expenditure
Note: This is to test homogeneity criteria of the residuals.
Source: Author's calculation based on 1997/98 VLSS.

were 14 variables that belonged to five groups of household characteristics and 5 agricultural variables:

- Demographic: head's ethnicity, head's age, household size, marital status of the head, proportion of dependent people (aged <15 or >60 years)
- Assets: motorbike
- Housing: living area, electricity, toilet type, and house type
- Geographic: region
- Education: head's highest diploma, highest diploma of head's spouse, head's illiteracy
- Agricultural variables: agricultural land area, agricultural household, garden, rented-out land, proportion of members with main job in agriculture

This model was designed particularly for rural areas, therefore, variables relating to agricultural activities were of special concern. In this model, five agricultural variables are found to be significant in predicting household living standards. Households involved in agricultural activities in general have lower living standards than others, especially when there are more members involved in agriculture. However, if households were renting out agricultural land and maintained a garden at home, their living standards could improve significantly. Renting out agricultural land usually occurs when they have rights over a large piece of land or they have other higher income-earning activities.

The asset predictor (motorbike) has a positive relationship with the log of PCE.

Education, like in other studies, has a very strong effect on the living standards of households. The more education household heads have, the higher the household's living standards; and the less illiterate the heads are, the better the living conditions of the households.

The regional factor has strong impact. People living in the North Central Coast have lower living standards than people in other regions. This seems to be very reliable because these areas are always the hardest places to live in Viet Nam. The households in the South East area, including Ho Chi Minh City and the Mekong River Delta (the Rice Granary of Viet Nam), are better-off than in any other region, as shown by the very significant impact of the dummy variable for these regions.

The age of the household head has a positive impact on the household's living standards. The older the head, the better the living conditions. In addition, better household characteristics–that is, having a better toilet type, a larger living area, and access to electricity–means better living standards.

It is quite interesting that ethnic Kinh-Vietnamese and Chinese households have worse living standards than others. According to Dominique van de Walle and Dileni Gunewardena, this can be attributed to what they call as *quality gaps*, such as ethnic minorities receiving poor-quality education (Rama and Kim 2005).

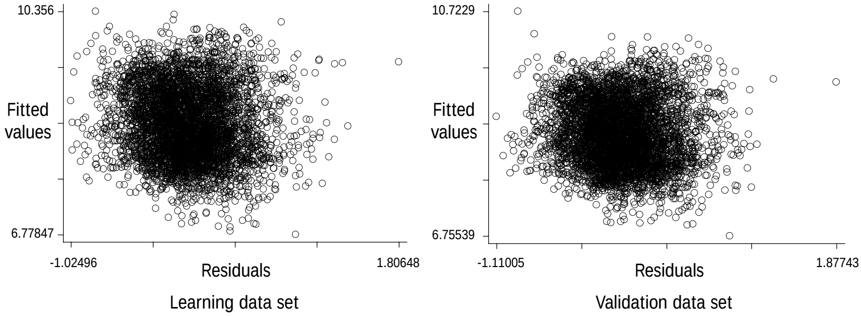
Households with more dependents and, especially, with more household members (larger household size) have lower living standards. Families living in semipermanent housing such as apartments and all temporary house-types also have lower living standards.

Urban Areas

The modeling process used for the rural data set was also applied to the urban data set and the model result was even better. As presented in Table 5.6, with only 3,455 observations for the learning data set and 3,454 in validation data set, the R-squared at 0.7417 and 0.7517, respectively, is higher for the urban data set than for the rural data set (see Appendix 5.7 and 5.8 for details). The assumption of homoscedasticity in the error term is also validated (Figures 5.7 and 5.8).

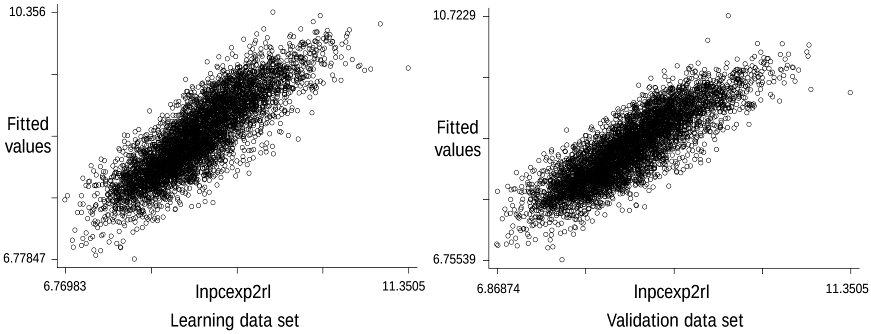
The matched tabulation in Table 5.11 also shows a good percentage match in the top and bottom quintiles, also almost 60 percent for both the learning and validation data sets. As it was for the rural areas, the match is not good for the middle quintiles.

Figure 5.7 **Residual Plot for the Urban Subsamples**



lnpcexp2rl = natural logarithm of real per capita expenditure
Note: This is to test homogeneity criteria of the residuals.
Source: Author's calculation based on 2002 VLSS.

Figure 5.8 **Log Per Capita Expenditure for Urban Subsamples—Actual Versus Predicted Values**



lnpcexp2rl = natural logarithm of real per capita expenditure
Note: This is to test homogeneity criteria of the residuals.
Source: Author's calculation based on 2002 VLSS.

As was done for the rural area subsamples, mean values of the predicted log of PCE calculated from the two data sets for the urban areas were compared to further validate the models. As exhibited in Table 5.12, the values of the two data sets are almost the same and reveal the stability of the model across the entire data set for urban areas.

With reference to Table 5.13 and Figures 5.9 and 5.10, testing results in Phase 2 for urban areas were also acceptable. As shown, almost all variables are still significant at 5 percent. Again, figures reveal that there is no heteroscedasticity in the error terms and the matched tabulation shows top and bottom quintiles are good matches.

Table 5.11 **Matched Tabulation for the Urban Subsamples on the 1997/98 VLSS Urban Data Set**

Learning Data Set		*Predicted Quintiles*					
		1	2	3	4	5	Total
Actual Quintiles	1	66.6	26.6	6.7	0.1	0.0	20.0
	2	24.6	44.1	25.9	5.4	0.0	20.0
	3	7.5	20.8	39.6	27.4	4.6	20.0
	4	1.2	7.4	23.6	42.0	25.9	20.0
	5	0.1	1.0	4.2	25.2	69.5	20.0
	Total	100.0	100.0	100.0	100.0	100.0	100.0

Validation Data Set		*Predicted Quintiles*					
		1	2	3	4	5	Total
Actual Quintiles	1	67.0	27.1	5.2	0.7	0.0	20.0
	2	24.8	41.2	28.6	5.1	0.3	20.0
	3	6.4	24.0	39.6	25.3	4.6	20.0
	4	1.9	6.8	22.1	43.4	25.8	20.0
	5	0.0	0.9	4.3	25.5	69.3	20.0
	Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculation based on 2002 VLSS.

Table 5.12 **Comparison of Mean Values of Per Capita Expenditure for the Urban Subsamples**

	Learning Data Set		*Validation Data Set*	
Quintile	*Actual Mean*	*Predicted Mean*	*Actual Mean*	*Predicted Mean*
1	2,214	2,441	2,204	2,378
2	3,559	3,643	3,590	3,606
3	4,972	5,030	4,977	5,019
4	7,046	7,207	7,127	7,296
5	13,319	11,950	13,090	11,955

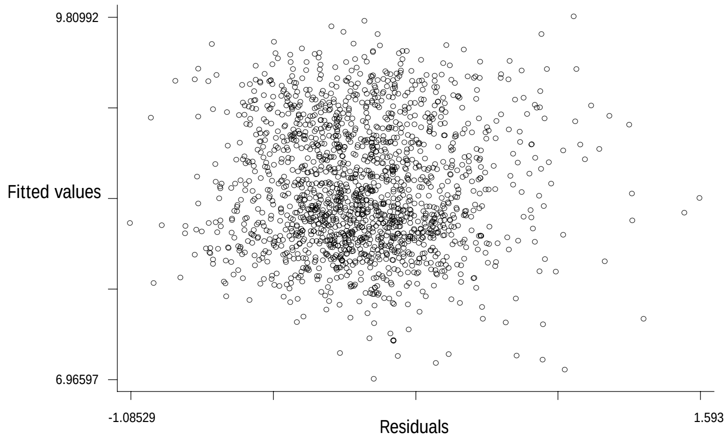
Note: Total number of observations = 3,454
Source: Authors' calculation based on 2002 VLSS.

Table 5.13 **Matched Tabulation for Urban Subsamples Tested on the 1997/98 VLSS Urban Data Set**

		Predicted Quintile					
		1	2	3	4	5	Total
Actual Quintile	1	65.0	26.3	8.7	0.0	0.0	20.0
	2	26.6	37.3	28.9	6.6	0.6	20.0
	3	6.4	27.8	35.0	25.4	5.5	20.0
	4	1.7	8.1	21.1	41.9	27.2	20.0
	5	0.3	0.6	6.4	26.0	66.8	20.0
	Total	100.0	100.0	100.0	100.0	100.0	100.0

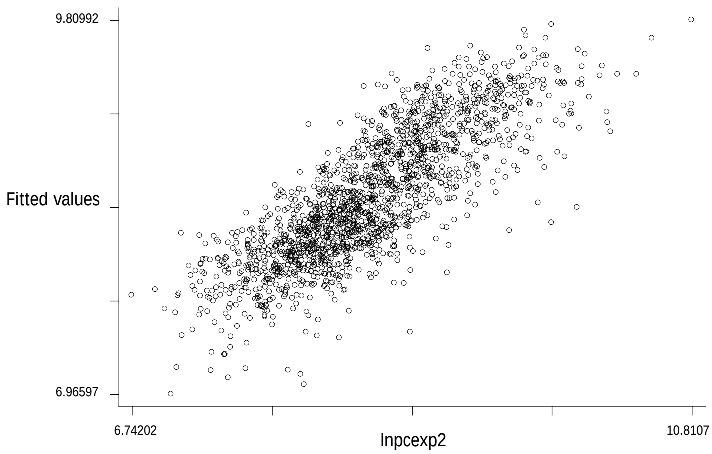
Source: Authors' calculation based on 1997/98 VLSS.

Figure 5.9 **Residual Plot of Urban Area Subsamples Tested on 1997/98 VLSS Urban Data Sets**



Note: This is to test homogeneity criteria of the residuals.
Source: Author's calculation based on 1997/98 VLSS.

Figure 5.10 **Log Per Capita Expenditure for the Urban Subsamples Tested on 1997/98 VLSS Urban Data Sets—Actual Versus Predicted Values**



Note: This is to test homogeneity criteria of the residuals.
Source: Author's calculation based on 1997/98 VLSS.

Some variables in the model for urban area subsamples tested in 1997/98 VLSS have the same signs of impact as in the rural areas. Households who have assets such as a gas cooker, motorbike, music mixer, refrigerator or freezer, rice cooker, or telephone are better-off. In addition, households are in better condition if the household head has had more education. If their house is relatively spacious and has a good toilet facility, then the family has good living conditions. Finally, those living in the South East have better living conditions than in other urban areas.

In contrast, households are poorer if household size is bigger and if there are more members of the family aged 15 years and below.

Results in Phase 3

From the modeling results of data sets for the provinces of Thanh Hoa and Nghe An (Table 5.9), R-squared values are found to be quite acceptable at 0.60 for the learning data set and 0.61 for the validation data set. For both data sets, at a 10-percent level of significance, all but one predictor (the proportion of members working in agriculture) are significant. The signs of correlations for models of both data sets are the same. Variables found significant were:

- Assets: colored TV, electric fan, motorbike, rice cooker, and water pump
- Demography: household size, proportion of household members less than 15 years old
- Education: head with college diploma or higher, spouse's educational attainment
- Employment: head's main occupation is white collar
- Housing: type of house and living area
- Health: number of household members hospitalized in the last 12 months

Ownership of a colored TV, electric fan, rice cooker, motorbike, or water pump dictates positive living standards in the two provinces. The same relationship is traced to the household head's educational attainment and main sectoral occupation (if a white collar job). In the subregion, a significant number of household heads in nonpoor households have white collar jobs. This may not be true for other areas, which may be why it was not significant in the model generated for the whole country.

Households with better house types–semipermanent or permanent–and larger houses also have better living conditions. Finally, the number of household members hospitalized in the past 12 months has a positive impact on living standards. It's possible that this means that members of poor households are seldom hospitalized because they don't have enough resources to pay for the hospitalization, and not because they seldom get sick.

As also discussed in previous results, household size and proportion of household members below 15 years old have negative relationships with living standards. In addition, the household experiences worse living conditions if the spouse of the household head has secondary educational attainment or below, or none at all. This may be attributed to less job opportunities in the subregion for people with these educational credentials (see Appendix 5.9–5.11 for details).

Results in Phase 4

An examination of the correlation between the different methods used for identifying poor households, shows that the correlation of poverty classifications based on self-assessment and enumerator's and hamlet chief's opinion is quite high (Table 5.14). In contrast, the correlation coefficients between these methods and PPM is quite low, ranging from 0.38 to 0.44. The coefficients are all significant at the 5-percent level.

Table 5.14 **Correlation between Different Methods Used for Identifying Poor Households**

Methods Used for Identifying Poor Households	*Self-Assessment*	*Enumerator*	*Hamlet Chief*	*Poverty Predictor Model*
Self-Assessment	1			
Enumerator	0.80	1		
Hamlet Chief	0.73	0.87	1	
Poverty Predictor Model	0.41	0.44	0.38	1

Source: Authors' calculation based on PPM questionnaire.

Table 5.15 shows that through self-assessment, 140 of the total 500 households surveyed are classified as poor, while this figure for PPM is only 110 of the total 500 households surveyed, resulting in a higher poverty rate based on self-assessment. This is not surprising since self-assessed poverty is usually high as households tend to be pessimistic when comparing their economic status with neighbors that are well-off. In terms of mismatch, 19 percent of PPM nonpoor are classified by self-assessment as poor and a rather large 34 percent of PPM poor are classified by self-assessment as nonpoor. The relatively large difference between the estimates based on PPM and self-assessment is broadly consistent with findings of similar works, such as the *Viet Nam Development Report* 2004 (World Bank 2004), on different poverty classifications.

Table 5.16 compares the classification based on the PPM and those based on the enumerator's assessment. It can be shown that almost 12 percent of PPM nonpoor were classified as poor by the enumerator, while 40 percent of the PPM poor were classified nonpoor by the enumerator. The enumerator's assessment is closer to the PPM classification with only 95 mismatched

Table 5.15 **Matched Tabulation Between PPM Result sand SA-Based Poverty Classification**

			SA Poverty Classification		
			Nonpoor	*Poor*	*Total*
PPM Classification	*Nonpoor*	*Mean*	81.24	18.76	100.00
		Standard Error (%)	(2.51)	(2.51)	
		Number of Observations	319	71	390
	Poor	*Mean*	34.07	65.93	100.00
		Standard Error (%)	(6.13)	(6.13)	
		Number of Observations	41	69	110
	Total	*Mean*	72.26	27.74	100.00
		Standard Error (%)	(2.57)	(2.57)	
		Number of Observations	360	140	500

PPM = poverty predictor model; SA = self-assessment
Source: Authors' calculation based on PPM questionnaire.

households, compared with 112 mismatched households between self-assessed and PPM classifications. In addition, PPM-based poverty classification is only higher by three poor households compared with those classified as poor by the enumerator.

Table 5.16 **Matched Tabulation Between PPM Results and EA-Based Poverty Classification**

			EA-Based Poverty Classification		
			Nonpoor	*Poor*	*Total*
PPM Classification	*Nonpoor*	*Mean*	88.21	11.79	100
		Standard Error (%)	(2.07)	(2.07)	
		Number of Observations	344	46	390
	Poor	*Mean*	40.51	59.49	100
		Standard Error (%)	(6.36)	(6.36)	
		Number of Observations	49	61	110
	Total	*Mean*	79.13	20.87	100
		Standard Error (%)	(2.33)	(2.33)	
		Number of Observations	393	107	500

EA = enumerators assessment; PPM = poverty predictor model
Source: Authors' calculation based on PPM questionnaire.

Comparing the classifications based on PPM and the hamlet chief's assessments, it can be observed from Table 5.17 that more households were classified as poor by the PPM. Based on the PPM, 110 poor households were classified as poor compared with 86 assessed as poor households by the hamlet chiefs. There were 98 mismatched households between these two classifications.

Among the four methods of classification, self-assessment classified the most number of poor with a total of 140 households. As mentioned earlier, self-assessed poverty status usually results in higher estimates because of the tendency of households to be pessimistic, sometimes hoping that they will

Table 5.17 **Matched Tabulation Between PPM Results and HCA-Based Poverty Classification**

PPM Classification			HCA-Based Poverty Classification		
			Nonpoor	*Poor*	*Total*
	Nonpoor	*Mean*	89.76	10.24	100
		Standard Error (%)	(1.95)	(1.95)	
		Number of Observations	353	37	390
	Poor	*Mean*	52.71	47.29	100
		Standard Error (%)	(6.49)	(6.49)	
		Number of Observations	61	49	110
	Total	*Mean*	82.71	17.29	100
		Standard Error (%)	(2.18)	(2.18)	
		Number of Observations	414	86	500

PPM = Poverty Predictor Model; HCA = Hamlet's Chief's Assesment
Source: Authors' calculation based on PPM questionnaire.

benefit from interventions if they declare themselves poor. The relatively close intervals of results among the PPM-based, enumerator's assessment, and hamlet chief's assessment methods could probably be accounted for by the fact that the PPM classification was actually based on easy-to-collect and observable variables, which could also be the same variables used by the enumerators and hamlet chiefs in assessing the poverty status of a household.

Aside from these assessments, the effectiveness of PPM can also be gauged by comparing the classification of households in the 2002 and 2004 VHLSSs using the consumption-based classification, since this model was developed through the VHLSS. Table 5.18 presents the comparison generated from using the 2002 VHLSS with 609 households classified as poor in this subregion based on household consumption and only 484 households classified as poor in the PPM.

Table 5.18 **Matched Tabulation Between PPM Results and Consumption-Based Poverty Classification**

PPM Poverty Classification			HCA Consumption-Based Classification		
			Nonpoor	*Poor*	*Total*
	Nonpoor	*Mean*	79.2	20.8	70.2
		Standard Error (%)	0.019	0.019	
		Number of Observations	903	243	1,146
	Poor	*Mean*	25.1	74.9	29.8
		Standard Error (%)	0.031	0.031	
		Number of Observations	118	366	484
	Total	*Mean*	63.1	36.9	100
		Standard Error (%)	0.02	0.02	
		Number of Observations	1,021	609	1,630

PPM = Poverty Predictor Model; HCA = Hamlet's Chief's Assessment
Source: Authors' calculation based on PPM questionnaire and 2002 VLSS.

Given these results, there is probably a need to refine the PPM to understand the relatively large discrepancy between the number of households classified as poor based on the PPM and those based on consumption data, considering that the VHLSS was used in developing the PPM.

Conclusion

Given the well-known problems in collecting household income or consumption expenditure data, poverty predictor models have been developed in recent years based on household demographic and asset characteristics which are easy to collect but significantly correlated to poverty. These models could be used to identify the poor households for intervention programs. This paper develops poverty predictor models for rural and urban areas in Viet Nam using the 2002 VHLSS survey data. The models are then tested for consistency and stability with 1997/98 VLSS data. The method is also verified using data from two relatively poor provinces and also from a pilot survey that takes into account local perceptions, among other information.

Overall, the poverty predictor models perform in a robust manner across alternative data sets. The variables in the model cover a wide range of easily verifiable information that include assets, such as TVs and motorbikes, and demographic characteristics, such as dependents and number of earning members, education, and housing conditions. Cross tabulations of actual and predicted values reveal that the models capture about 60 percent of the bottom-quintile households classified in terms of per capita expenditure distribution. Performance with respect to poor households also turns out to be similar.

Appendix

Appendix 5.1 **List of Primary Variables Identified from 2002 Viet Nam Living Standard Survey**

Variable Name	Description	Variable Name	Description
Tinh	Province	hunemp	Head is unemployed?
Huyen	District	num_unemp	Number of unemployed people
Xa	Commune/Ward	Hilliter	Head is illiterate?
Diaban	EAs	Pilliter	Husband/Wife is illiterate?
Hoso	Household Identification	Hdip	Head's highest diploma
Livingarea	Living area	Pdip	Husband/Wife's highest diploma
Housetype	Type of house	Hethnic	Head's ethnicity
Ownership	Do you own this house?	num_dep	Number of dependent people (age < 15 and > 60)
Payrent	Do you have to pay for rent?	num_u15	Number of age under-15 people
Rentpayee	Pay rent to whom?	num_o15	Number of age over-15 people
Otherhouse	Do you have other houses?	num_o60	Number of age over-60 people
Mfrout	Do you get any money from renting out any houses?	num_o70	Number of age over-70 people
Newbhouse	Did you have any newly built house in the last 12 months?	num_labor	Number of people in labor age (15 < age < 60)
Wsource	Main drinking water sources	num_child	Number of head's children
Toilet	Type of toilet	Hhsize	Household size
Electric	Electricity	prop_dep	Dependent proportion
Qui	Quarter of 2002	prop_u15	Proportion of < 15 people
Motorbike	If household has a motorbike?	prop_o15	Proportion of ≥ 15 people
Waterpump	If household has a water pump?	prop_o60	Proportion of > 60 people
Telephone	If household has a telephone?	prop_o70	Proportion of > 70 people
Video	If household has a video?	prop_labor	Proportion of people in labor age (15–60)
Colortv	If household has a colored TV?	Hsex	Head's sex
Bwtivi	If household has a black and white TV?	Hage	Head's age
Musicmixer	If household has a music mixer?	hmarital	Head's marital status
Refee	If household has a refrigerator?	reg8	8 regions
Elecfan	If household has an electric fan?	urban02	Urban: 1, Rural: 2
Gascooker	If household has a gas cooker?	wt30	Household weight
Ricecooker	If household has a rice cooker?	Hhszwt30	Individual weight
Nonfarm	Household with nonfarm activities	hhexp2rl	2002 real total household expenditure
num_inpatient	Number of times an inpatient	pcexp2rl	2002 real per capita expenditure
Inpatient	Any inpatient time?	prop_illi	Proportion of age ≥ 15 people illiterate
Hjbowner	Head's job owner	prop_studmem	Proportion of people studying in the last 12 months
hocc02	Head's sectoral occupation	prop_unemp	Proportion of unemployed people in the total age ≥ 15 people
prop_agri	Proportion of age ≥ 15 economically active people working in agriculture	Agrihh	Agricultural household
num_agri	Number of people involved in agricultural activities	Agland_area	Total agricultural land
rentedout	Household with land rented out	rentedin	Household with land rented in
agriser	If household does agricultural services	Garden	If household has a garden
Cow	If household has a cow	Brdfacs	If household has breeding facilities
Grinder	If household has a grinder	Mill	If household has a rice milling machine
Workshop	If household has a workshop	rplucker	If household has a rice plucker
Pullinmach	If household has a pulling machine	Store	If household has a store
Trailer	If household has a trailer	Plough	If household has a plough

Source: Authors' summary based on 2002 VLSS.

Appendix 5.2 **List of Candidate Variables for Rural Subsamples**

Variable Name	Description	Variable Name	Description
Colortv	If household has a colored TV?	pdip_3	Husband/Wife with upper secondary diploma
Elecfan	If household has an electric fan?	pdip_4	Husband/Wife with technical worker diploma
electric_t	Electricity	pilliter_t	Husband/Wife is illiterate?
gascooker	If household has a gas cooker?	Prop_dep_t	Dependent proportion
hage_t	Head's age	Prop_illi_t	Proportion of age ≥ 15 people illiterate
hdip_0	Head with primary diploma	Refee	If household has a refrigerator?
hdip_1	Head with lower secondary diploma	reg8_1	Red River Delta
hdip_2	Head with upper secondary diploma	reg8_2	North East
hdip_3	Head with technical worker diploma	reg8_3	North West
hdip_4	Head with professional secondary school diploma	reg8_4	North Central Coast
hdip_5	Head with junior college diploma and higher	reg8_5	South Central Coast
hdip_6	Head with primary diploma	reg8_6	Central Highlands
hethnic	Head's ethnicity	reg8_7	South East
hhsize	Household size	reg8_8	Mekong River Delta
hilliter	Head is illiterate?	ricecooker	If household has a rice cooker?
hjbowner_t	Head's job owner	Telephone	If household has a telephone?
hocc02_1	Head's sectoral occupation: agriculture, forestry, fishery	toilet_1	Flush toilet with septic tank/sewage pipes
hocc02_2	Head's sectoral occupation: manufacturing	toilet_2	Suilabh toilet
hocc02_3	Head's sectoral occupation: sales services	toilet_3	Double vault compost latrine
hocc02_4	Head's sectoral occupation: white collar	toilet_4	Toilet directly over the water
hocc02_5	Head's sectoral occupation: others	toilet_5	Others
hocc02_6	Head's sectoral occupation: others not working	toilet_6	No toilet
housetype_1	House type is villa or permanent house/ apartment with private bath/kitchen/toilet	Video	If household has a video?
housetype_2	House type is permanent house/ apartment without private bath/kitchen/toilet	waterpump	If household has a water pump?
housetype_3	House type is semipermanent house/ apartment	Wsource_1	Individual tap
housetype_4	Temporary house and others	Wsource_2	Public tap
Livingarea	Living area	Wsource_3	Deep drill well with pump
Motorbike	If household has a motorbike?	Wsource_4	Hand dug well, constructed well
Nonfarm	Household with nonfarm activities	Wsource_5	Deep well
pdip_0	Husband/Wife with no diploma	Wsource_6	Rain water
pdip_1	Husband/Wife with primary diploma	Wsource_7	River, lake, pond
pdip_2	Husband/Wife with lower secondary diploma	wsource_8	Bought water (in tank, bottled or in a jar), filtered spring water, and others
prop_agri	Proportion of age ≥ 15 economically active people working in agriculture	Agrihh	Agricultural household
num_agri	Number of people involved in agricultural activities	lnagland_area	Natural logarithm of total agricultural land
rentedout	Household with land rented out	rentedin	Household with land rented in
agriser	If household does agricultural services	Garden	If household has garden
Cow	If household has a cow	Brdfacs	If household has a breeding facilities
Grinder	If household has a grinder	Mill	If household has a rice milling machine
Workshop	If household has a workshop	rplucker	If household has a rice plucker
Pullinmach	If household has a pulling machine	Store	If household has a store
Trailer	If household has a trailer	plough	If household has a plough

Source: Authors' summary based on 2002 VLSS.

Appendix 5.3 **Regression Model for Learning Data Set of Rural Subsamples**

Variable	Variable Description	Estimate	Sign	Pr>|t|
Dependent Variable				
ln(pcexp2rl)	Natural logarithm of real per capita expenditure per year (best for 2002)			
Independent Variables				
Agrihh (Control variable)	Household with agricultural activities? Yes=1, No=0	-0.078	-	0.000
Garden	Household has a garden? Yes=1, No=0	0.049	+	0.006
Mill	Household has a mill? Yes=1, No=0	0.087	+	0.014
Agriser	Household does any agricultural services? Yes=1, No=0	0.045	+	0.054
rentedout	Household rented out its land? Yes=1, No=0	0.042	+	0.000
prop_agri	Proportion of members with main job in agriculture	-0.132	-	0.000
livingarea	Living area (m^2)	0.001	+	0.000
motorbike	Household has motorbike? Yes=1, No=0	0.237	+	0.000
Hethnic	Ethnicity Vietnamese and Chinese: 1, others: 2	0.068	+	0.000
electric_t	Household has access to electricity?	0.088	+	0.000
Hilliter	Is the head illiterate?	-0.071	-	0.000
hdip_0	Head's highest diploma: no diploma	-0.140	-	0.000
hdip_1	Head's highest diploma: primary school	-0.107	-	0.000
hdip_2	Head's highest diploma: lower secondary school	-0.094	-	0.003
hdip_3	Head's highest diploma: upper secondary school	-0.069	-	0.000
housetype_2	House type is permanent house/apartment without private bath/kitchen/toilet	-0.182	-	0.000
housetype_3	House type is semi-permanent house/apartment	-0.258	-	0.000
housetype_4	Temporary house and others	-0.385	-	0.000
No partner (control variable)	No husband/wife (widow, single, divorced)	-0.143	-	0.000
pdip_0	Head's husband/wife highest diploma: no diploma	-0.127	-	0.000
pdip_1	Head's husband/wife highest diploma: primary school	-0.135	-	0.000
pdip_2	Head's husband/wife highest diploma: lower secondary school	-0.125	-	0.018
pdip_3	Head's husband/wife highest diploma: upper secondary school	-0.088	-	0.000
reg8_4	North Central Coast	-0.072	-	0.000
reg8_7	South East	0.250	+	0.000
reg8_8	Mekong River Delta	0.291	+	0.000
toilet_1	Flush toilet with septic tank/sewage pipes	0.282	+	0.000
toilet_2	Suilabh toilet	0.177	+	0.000
toilet_3	Double vault compost latrine	0.091	+	0.001
Wsource_1	Individual tap	0.112	+	0.000
prop_dep_t	Dependent proportion	-0.236	-	0.000
Hhsize	Household size	-0.092	-	0.000
hage_t	Head's age	0.181	+	0.000
lnagriland	Natural logarithm of agricultural land area	0.009		0.000
Intercept		7.894	+	0.000

Model Statistics

pweight: wt30; Strata: Tinh; PSU: Diaban; Number of obs = 11299; Number of strata = 61; Number of PSUs = 880; Population size = 6523233; F(27,364) = 170.410; Prob>F = 0.000; R-squared = 0.5801

Source: Authors' calculation.

Appendix 5.4 **Regression Model for Validation Data Set of Rural Subsamples**

Variable	Variable Description	Estimate	Sign	Pr>|t|
Dependent Variable				
ln(pcexp2rl)	Natural logarithm of real per capita expenditure per year (best for 2002)			
Independent Variables				
agrihh	Household with agricultural activities? Yes=1, No=0	-0.093	-	0.000
garden	Household has a garden? Yes=1, No=0	0.031	+	0.017
mill	Household has a mill? Yes=1, No=0	0.099	+	0.001
agriser	Household does any agricultural services? Yes=1, No=0	0.043	+	0.017
rentedout	Household rented out its land? Yes=1, No=0	0.041	+	0.048
prop_agri	Proportion of members with main job in agriculture	-0.107	-	0.000
livingarea	Living area (m^2)	0.001	+	0.022
motorbike	Household has motorbike? Yes=1, No=0	0.241	+	0.000
hethnic	Ethnicity Vietnamese and Chinese: 1, others: 2	0.104	+	0.000
electric_t	Household has access to electricity?	0.070	+	0.000
hilliter	Is the head illiterate?	-0.071	-	0.000
hdip_0	Head's highest diploma: no diploma	-0.145	-	0.000
hdip_1	Head's highest diploma: primary school	-0.098	-	0.000
hdip_2	Head's highest diploma: lower secondary school	-0.089	-	0.000
hdip_3	Head's highest diploma: upper secondary school	-0.050	-	0.037
housetype_2	House type is permanent house/apartment without private bath/kitchen/toilet	-0.135	-	0.000
housetype_3	House type is semi-permanent house/apartment	-0.208	-	0.000
housetype_4	Temporary house and others	-0.356	-	0.000
nopartner	No husband/wife (widow, single, divorced)	-0.183	-	0.000
pdip_0	Head's husband/wife highest diploma: no diploma	-0.153	-	0.000
pdip_1	Head's husband/wife highest diploma: primary school	-0.144	-	0.000
pdip_2	Head's husband/wife highest diploma: lower secondary school	-0.155	-	0.000
pdip_3	Head's husband/wife highest diploma: upper secondary school	-0.122	-	0.000
reg8_4	North Central Coast	-0.077	-	0.000
reg8_7	South East	0.218	+	0.000
reg8_8	Mekong River Delta	0.291	+	0.000
toilet_1	Flush toilet with septic tank/sewage pipes	0.285	+	0.000
toilet_2	Suilabh toilet	0.211	+	0.000
toilet_3	Double vault compost latrine	0.078	+	0.000
wsource_1	Individual tap	0.122	+	0.001
prop_dep_t	Dependent proportion	-0.232	-	0.000
hhsize	Household size	-0.088	-	0.000
hage_t	Head's age	0.170	+	0.000
lnagriland	Natural logarithm of agricultural land area	0.011		0.000
Intercept		7.888	+	0.000

Model Statistics

pweight: wt30; Strata: tinh; PSU: diaban; Number of obs = 11301; Number of strata = 61; Number of PSUs = 882; Population size = 6566241; F(27,364) = 200.620; Prob>F = 0.000; R-squared = 0.5762

Source: Authors' calculation.

Appendix 5.5 **Regression Model of 2002 VLSS for Rural Areas Tested on 1997/98 VLSS Rural Subsamples**

Variable	Variable Description	Estimate	Sign	Pr>|t|
Dependent Variable				
ln(pcexp2rl)	Natural logarithm of real per capita expenditure per year (best for 2002)			
Independent Variables				
Agrihh (control variable)	Household with agricultural activities? Yes=1, No=0	-0.068	-	0.000
Garden	Household has a garden? Yes=1, No=0	0.051	+	0.006
Mill	Household has a mill? Yes=1, No=0	0.087	+	0.231
Agriser	Household does any agricultural services? Yes=1, No=0	0.062	+	0.154
rentedout	Household rented out its land? Yes=1, No=0	0.072	+	0.000
prop_agri	Proportion of members with main job in agriculture	-0.102	-	0.000
livingarea	Living area (m^2)	0.060	+	0.000
motorbike	Household has motorbike? Yes=1, No=0	0.312	+	0.000
Hethnic	Ethnicity Vietnamese and Chinese: 1, others: 2	0.059	+	0.000
electric_t	Household has access to electricity?	0.092	+	0.001
Hilliter	Is the head illiterate?	-0.097	-	0.032
hdip_0	Head's highest diploma: no diploma	-0.140	-	0.000
hdip_1	Head's highest diploma: primary school	-0.107	-	0.000
hdip_2	Head's highest diploma: lower secondary school	-0.094	-	0.003
hdip_3	Head's highest diploma: upper secondary school	0.018	-	0.169
housetype_2	House type is permanent house/apartment without private bath/kitchen/toilet	0.125	-	0.462
housetype_3	House type is semi-permanent house/apartment	-0.158	-	0.014
housetype_4	Temporary house and others	-0.226	-	0.000
Nopartner (control variable)	No husband/wife (widow, single, divorced)	-0.285	-	0.000
pdip_0	Head's husband/wife highest diploma: no diploma	-0.038	-	0.004
pdip_1	Head's husband/wife highest diploma: primary school	-0.124	-	0.001
pdip_2	Head's husband/wife highest diploma: lower secondary school	-0.221	-	0.118
pdip_3	Head's husband/wife highest diploma: upper secondary school	0.088	-	0.609
reg8_4	North Central Coast	-0.002	-	0.876
reg8_7	South East	0.224	+	0.000
reg8_8	Mekong River Delta	0.279	+	0.000
toilet_1	Flush toilet with septic tank/sewage pipes	0.389	+	0.032
toilet_2	Suilabh toilet	0.107	+	0.000
toilet_3	Double vault compost latrine	0.001	+	0.001
Wsource_1	Individual tap	-0.041	+	0.652
prop_dep_t	Dependent proportion	-0.195	-	0.000
Hhsize	Household size	-0.153	-	0.000
hage_t	Head's age	0.151	+	0.000
lnagriland	Natural logarithm of agricultural land area	0.007		0.001
Intercept		7.785	+	0.000

Model Statistics

pweight: wt; Strata: Reg10; PSU: commune; Number of obs = 4265; Number of strata = 7; Number of PSUs = 136; Population size = 6566241; F(27,364) = 84.000; Prob>F = 0.000; R-squared = 0.5328

Source: Authors' calculation.

Appendix 5.6 **List of Candidate Variables for Urban Subsamples**

Variable Name	Description	Variable Name	Description
Bwtivi	If household has a black-and-white TV?	pdip_2	Husband/Wife with lower secondary diploma
Colortv	If household has a colored TV?	pdip_3	Husband/Wife with upper secondary diploma
Elecfan	If household has an electric fan?	pdip_4	Husband/Wife with technical worker diploma
Gascooker	If household has a gas cooker?	pdip_5	Husband/Wife with professional secondary school diploma
hdip_0	Head with no diploma	pdip_6	Husband/Wife with junior college diploma and higher
hdip_1	Head with primary diploma	prop_dep_t	Dependent proportion
hdip_2	Head with lower secondary diploma	prop_illi	Proportion of age ≥ 15 people illiterate
hdip_3	Head with upper secondary diploma	prop_labor	Proportion of people in labor age (15–60)
hdip_4	Head with technical worker diploma	prop_o15_t	Proportion of age ≥ 15 people
hdip_5	Head with professional secondary school diploma	prop_studmem_t	Proportion of people studying in the last 12 months
hdip_6	Head with junior college diploma and higher	prop_u15	Proportion of age < 15 people
Hethnic	Head's ethnicity	refee	If household has a refrigerator?
Hhsize	Household size	reg8_1	Red River Delta
Hilliter	Head is illiterate?	reg8_2	North East
Hjbowner_t	Head's job owner	reg8_3	North West
hmarital_t	Head's marital status	reg8_4	North Central Coast
hocc02_1	Head's sectoral occupation: agriculture, forestry, fishery	reg8_5	South Central Coast
hocc02_2	Head's sectoral occupation: manufacturing	reg8_6	Central Highlands
hocc02_3	Head's sectoral occupation: sales services	reg8_7	South East
hocc02_4	Head's sectoral occupation: white collar	reg8_8	Mekong River Delta
hocc02_5	Head's sectoral occupation: others	ricecooker	If household has a rice cooker?
hocc02_6	Head's sectoral occupation: others not working	telephone	If household has a telephone?
housetype_1	House type is villa or permanent house/apartment with private bath/kitchen/toilet	toilet_1	Flush toilet with septic tank/sewage pipes
housetype_2	House type is permanent house/apartment without private bath/kitchen/toilet	toilet_2	Suilabh toilet
housetype_3	House type is semipermanent house/apartment	toilet_3	Double vault compost latrine
housetype_4	Temporary house and others	toilet_4	Toilet directly over the water
hsex_t	Head's sex	toilet_5	Others
Livingarea	Living area	toilet_6	No toilet
mfrout_t	Do you get any money from renting out any houses?	video	If household has a video?
Motorbike	If household has a motorbike?	waterpump	If household has a water pump?
musicmixer	If household has a music mixer?	wsource_1	Individual tap
num_child	Number of head's children	wsource_2	Public tap
num_dep	Number of dependent people (age < 15 and > 60)	wsource_3	Deep-drill well with pump
num_labor	Number of people in labor age (15 < age < 60)	wsource_4	Hand dug well, constructed well
num_o15	Number of age over-15 people	wsource_5	Deep well
num_u15	Number of age under-15 people	wsource_6	Rain water
otherhouse_t	Do you have other houses?	wsource_7	River, lake, pond
pdip_0	Husband/Wife with no diploma	wsource_8	Bought water (in tank, bottled or in a jar), filtered spring water, and others
pdip_1	Husband/Wife with primary diploma		

Source: Authors' summary based on 1998 and 2002 VLSS.

Appendix 5.7 **Regression Results for Learning Data Set of Urban Subsamples**

Variable	Variable Description	Estimate	Sign	Pr>|t|
Dependent Variable				
ln(pcexp2rl)	Natural logarithm of real per capita expenditure (best for 2002)			
Independent Variables				
gascooker	Household has a gas cooker? Yes=1, No=0	0.048	+	0.062
hdip_6	Household head's highest diploma is junior college or higher.	0.135	+	0.000
hhsize	Household size	-0.103	-	0.000
hmarital_t	Household head is not married yet	0.143	+	0.007
housetype_1	House type is villa or permanent house/ apartment with private bath/kitchen/toilet	0.259	+	0.000
housetype_4	No house, temporary, or other house types	-0.152	-	0.000
livingarea	Living area	0.002	+	0.000
motorbike	Household has a motorbike? Yes=1, No=0	0.180	+	0.000
musicmixer	Household has a music-mixer? Yes=1, No=0	0.091	+	0.000
num_u15	Number of age under-15 people in the household	-0.069	-	0.000
refee	Household has a refrigerator/freezer? Yes=1, No=0	0.181	+	0.000
reg8_4	North Central Coast	-0.205	-	0.000
reg8_6	Central Highland	-0.108	-	0.011
reg8_7	South East	0.296	+	0.000
ricecooker	Household has a rice cooker? Yes=1, No=0	0.100	+	0.000
telephone	Household has a telephone? Yes=1, No=0	0.146	+	0.000
toilet_1	Flush toilet with septic tank/sewage pipes	0.151	+	0.000
toilet_5	Other types of toilet	-0.087	-	0.012
wsource_1	Private tap	0.152	+	0.000
wsource_4	Constructed well	-0.064	-	0.021
wsource_5	Simple soiled well	-0.158	-	0.001
Intercept		8.432	+	0.000

Model Statistics

pweight: wt30; Strata: tinh; PSU: diaban; Number of obs = 3,455; Number of strata = 61; Number of PSUs = 443; Population size = 2,055,589; F(27,364) = 143.27; Prob>F = 0.0000; R-squared = 0.7417

Source: Authors' calculation based on 2002 VLSS.

Appendix 5.8 **Regression Results for Validation Data Set of Urban Subsamples**

Variable	Variable Description	Estimate	Sign	Pr>|t|
Dependent Variable				
ln(pcexp2rl)	Natural logarithm of real per capita expenditure (best for 2002)			
Independent Variables				
gascooker	Household has a gas cooker? Yes=1, No=0	0.113	+	0.000
hdip_6	Household head's highest diploma is junior college or higher	0.152	+	0.000
hhsize	Household size	-0.092	-	0.000
hmarital_t	Household head is not married yet	0.198	+	0.000
housetype_1	House type is villa or permanent house/ apartment with private bath/kitchen/toilet	0.223	+	0.000
housetype_4	No house, temporary, or other house types	-0.185	-	0.000
livingarea_t	Living area	0.002	+	0.000
motorbike	Household has a motorbike? Yes=1, No=0	0.152	+	0.000
musicmixer	Household has a music mixer? Yes=1, No=0	0.159	+	0.000
num_u15	Number of age under-15 people in the household	-0.072	-	0.000
refee	Household has a refrigerator/freezer? Yes=1, No=0	0.141	+	0.000
reg8_4	North Central Coast	-0.132	-	0.000
reg8_6	Central Highland	-0.111	-	0.007
reg8_7	South East	0.312	+	0.000
ricecooker	Household has a rice cooker? Yes=1, No=0	0.093	+	0.000
telephone	Household has a telephone? Yes=1, No=0	0.156	+	0.000
toilet_1	Flush toilet with septic tank/sewage pipes	0.163	+	0.000
toilet_5	Other types of toilet	-0.097	-	0.003
wsource_1	Private tap	0.121	+	0.000
wsource_4	Constructed well	-0.103	-	0.001
wsource_5	Simple soiled well	-0.164	-	0.001
Intercept		8.395	+	0.000

Model Statistics

pweight: wt30; Strata: tinh; PSU: diaban; Number of obs = 3,454; Number of strata = 61; Number of PSUs = 445; Population size = 2,126,854; F(27,364) = 156.52; Prob>F = 0.0000; R-squared = 0.7517

Source: Authors' calculation based on 2002 VLSS.

Appendix 5.9 **Regression Results of 2002 VLSS for Urban Areas Tested on 1997/98 VLSS Urban Subsamples**

Variable	Variable Description	Estimate	Sign	Pr>|t|
Dependent Variable				
ln(pcexp2rl)	Natural logarithm of real per capita expenditure (best for 2002)			
Independent Variables				
gascooker	Household has a gas cooker? Yes=1, No=0	0.103	+	0.001
hdip_6	Household head's highest diploma is junior college or higher	0.077	+	0.006
hhsize	Household size	-0.096	-	0.000
hmarital_t	Household head is not married yet.	0.082	+	0.136
housetype_1	House type is villa or permanent house/ apartment with private bath/kitchen/toilet	0.009	+	0.799
housetype_4	No house, temporary or other house types	-0.060	-	0.082
livingarea_t	Living area	0.001	+	0.004
motorbike	Household has a motorbike? Yes=1, No=0	0.321	+	0.000
musicmixer	Household has a music mixer? Yes=1, No=0	0.177	+	0.000
num_u15	Number of age under-15 people in the household	-0.031	-	0.004
refee	Household has a refrigerator/freezer? Yes=1, No=0	0.178	+	0.000
reg8_4	North Central Coast	-0.046	-	0.277
reg8_6	Central Highland	0.183603	dropped	0.000
reg8_7	South East	0.143	+	0.000
ricecooker	Household has a rice cooker? Yes=1, No=0	0.167	+	0.000
telephone	Household has a telephone? Yes=1, No=0	0.110	+	0.000
toilet_1	Flush toilet with septic tank/sewage pipes	0.224	+	0.000
toilet_5	Other types of toilet	0.085	+	0.014
wsource_1	Private tap	-0.049	-	0.223
wsource_4	Constructed well	-0.099	-	0.118
wsource_5	Simple soiled well	-0.111	-	0.080
Intercept		8.341	+	0.000

Model Statistics

pweight: wt; Strata: reg10; PSU: commune; Number of obs = 1,730; Number of strata = 3; Number of PSUs = 58; Population size = 3,878,496; F(27,364) = 110.72; Prob>F = 0.0000; R-squared = 0.6693

Source: Authors' calculation based on 1997/98 and 2002 VLSS.

Appendix 5.10 **Regression Results for Learning Data Set for Thanh Hao and Nghe An**

Variable	Variable Description	Estimate	Sign	Pr>|t|
Dependent Variable				
ln(pcexp2rl)	Natural logarithm of real per capita expenditure (best for 2002)			
Independent Variables				
colortv	Household has a colored TV? Yes=1, No=0	0.104	+	0.002
elecfan	Household has an electric fan? Yes=1, No=0	0.084	+	0.006
hdip6	Head with college diploma and up	0.144	+	0.074
hhsize	Household size	-0.086	-	0.000
hocc024	Head's main sectoral occupation: white collar	0.159	+	0.016
housetype_1	Villa or permanent house/apartment with private bath/kitchen/toilet	0.489	+	0.000
housetype_2	Permanent house/apartment without private bath/kitchen/toilet	0.158	+	0.001
housetype_3	Semipermanent house/apartment	0.129	+	0.001
livingarea	Living area (m^2)	0.002	+	0.000
motorbike	Household has a motorbike? Yes=1, No=0	0.244	+	0.000
num_inpatient	Number of household members who were in-hospital patients over the last 12 months	0.078	+	0.005
pdip1	Head's husband/wife with no diploma	-0.149	-	0.004
pdip2	Head's husband/wife with primary diploma	-0.151	-	0.005
pdip3	Head's husband/wife with lower secondary diploma	-0.098	-	0.014
prop_agri	Proportion of members working in agriculture	-0.043	-	0.439
prop_u15	Proportion of household members under 15 years	-0.256	-	0.000
ricecooker	Household has a rice cooker? Yes=1, No=0	0.123	+	0.000
waterpump	Household has a water pump? Yes=1, No=0	0.072	+	0.068
Intercept		7.820	+	0.000

Model Statistics

pweight: wt30; Strata: Tinh; PSU: Diaban; Number of obs = 705; Number of strata = 2; Number of PSUs = 39; Population size = 631,215.9; F(27,364) = 89.76; Prob>F = 0.0000; R-squared = 0.6039

Source: Derived from poverty predictor model validation questionnaire.

Appendix 5.11 Regression Results for Validation Data Set for Thanh Hao and Nghe An

Variable	Variable Description	Estimate	Sign	Pr>|t|
Dependent Variable				
ln(pcexp2rl)	Natural logarithm of real per capita expenditure (best for 2002)			
Independent Variables				
colortv	Household has a colored TV? Yes=1, No=0	0.085	+	0.001
elecfan	Household has an electric fan? Yes=1, No=0	0.111	+	0.006
hdip6	Head with college diploma and up	0.120	+	0.016
hhsize	Household size	-0.089	-	0.000
hocc024	Head's main sectoral occupation: white collar	0.160	+	0.046
housetype_1	Villa or permanent house/apartment with private bath/kitchen/toilet	0.383	+	0.000
housetype_2	Permanent house/apartment without private bath/kitchen/toilet	0.264	+	0.000
housetype_3	Semipermanent house/apartment	0.199	+	0.000
livingarea	Living area (m^2)	0.001	+	0.002
motorbike	Household has a motorbike? Yes=1, No=0	0.276	+	0.000
num_inpatient	Number of household members who were in-hospital patients over the last 12 months	0.093	+	0.000
pdip1	Head's husband/wife with no diploma	-0.100	-	0.032
pdip2	Head's husband/wife with primary diploma	-0.118	-	0.014
pdip3	Head's husband/wife with lower secondary diploma	-0.097	-	0.014
prop_agri	Proportion of members working in agriculture	-0.049	-	0.304
prop_u15	Proportion of household members under 15 years	-0.345	-	0.000
ricecooker	Household has a rice cooker? Yes=1, No=0	0.077	+	0.000
waterpump	Household has a water pump? Yes=1, No=0	0.067	+	0.036
Intercept		7.825	+	0.000

Model Statistics

pweight: wt30; Strata: Tinh; PSU: Diaban; Number of obs = 705; Number of strata = 2; Number of PSUs = 39; Population size = 641,897.7; F(27,364) = 113.25; Prob>F = 0.0000; R-squared = 0.61

Source: Derived from poverty predictor model validation questionnaire.

CHAPTER 6

Poverty Mapping and GIS Application in Indonesia: How Low Can We Go?

Uzair Suhaimi , Guntur Sugiyarto, Eric B. Suan, and Mary Ann Magtulis

Introduction

The overarching goal of the Asian Development Bank (ADB) is to reduce poverty, which is in line with Millennium Development Goal (MDG) No. 1 of halving poverty incidence by 2015. In this context, a systematic technique for identifying poor regions is very important in improving poverty reduction programs.

Most poverty indicators developed with national household survey data, however, are reliable only at very aggregated levels such as province or state, with a possibility of further disaggregation into urban and rural. Poverty indicators in Indonesia derived from the National Socioeconomic Survey (SUSENAS), for instance, are reliable only up to the provincial level by urban and rural areas. This level of aggregation may not be appropriate for various poverty reduction projects or programs. Therefore, the availability of poverty indicators at a more disaggregated geographical area is very essential, especially in the context of poverty targeting and other poverty reduction programs.

One way to develop poverty indicators for smaller areas is to use poverty mapping, which has been implemented in Indonesia since 1990 (Suryahadi and Sumarto 2003b). The main goal of poverty mapping is to generate reliable estimates of poverty indicators at disaggregated levels to better understand local specificities. It would otherwise not be possible to obtain such disaggregated indicators given the existing household survey data.

Poverty mapping results have been increasingly used to geographically target scarce resources (Baschieri and Falkingham 2005). Mapping results may also include other welfare indicators such as the health and nutritional status of the population. Box 6.1 highlights the benefits that poverty mapping can substantiate in policies, while, to present a balance view, Box 6.2 cites different concerns underlying the efficiency of the estimates from poverty mapping.

Box 6.1 **The Benefits of Mapping Poverty Indicators**

Poverty mapping is a method to estimate poverty indicators for more disaggregated geographic units that the household survey can not produce. With poverty mapping, poverty impact assessments can be conducted at more disaggregated levels. Results of poverty mapping can help define poverty, describe the situation and problem, identify and select interventions, and guide resource allocation. Geographically disaggregated data from these assessments can then be displayed in a map. Henniger (1998) pointed out that linking poverty assessments to maps provides new benefits such as:

- Poverty maps make it easier to integrate data from various sources and from different disciplines to help define and describe poverty.
- A spatial framework allows switching to new units of analysis, such as from administrative to ecological boundaries, and access new variables not collected in the original survey like community characteristics.
- Identifying spatial patterns with poverty maps can provide new insights into the causes of poverty. An example is how much of the physical isolation and poor agroecological endowments impediments are needed to escape poverty that affects the type of interventions to consider.
- The allocation of resources can be improved. Poverty maps can assist in deciding where and how to target antipoverty programs. Geographic targeting, as opposed to across-the-board subsidies, has been shown to be effective at maximizing the coverage of the poor while minimizing leakage to the nonpoor (Baker and Grosh 1994).
- With appropriate scale and robust poverty indicators, poverty maps can assist in the implementation of poverty reduction programs such as providing subsidies in poor communities and cost recovery in less poor areas.
- Poverty maps with high resolution can support efforts to decentralize and localize decision making.

Maps are powerful tools for visualizing spatial relationships and can be used very effectively to reach policy makers. They provide an additional return on investments in survey data, which often remain unused and unanalyzed after the initial report or study is completed.

Source: Author's summary.

The term *poverty mapping* has been used interchangeably to refer to an econometric modeling technique, or to generating a map of existing poverty indicators, or a combination of the two–estimating the poverty indicators and then generating their maps. Poverty mapping in this study refers to the last point meaning, i.e., poverty mapping modeling and developing a geographic information system (GIS) map application of the poverty mapping modeling results.

Box 6.2 **Some Recent Concerns on Poverty Mapping**

Poverty estimates from household income or expenditure surveys are normally available at the national or provincial level. To fill an obvious data gap in dealing with poverty issues in small areas like districts, subdistricts, and villages; Elbers, Lanjouw, and Lanjouw (2003a), introduced a poverty mapping technique which has been applied in several countries. This technique estimates correlates of poverty for a set of variables which are common to household surveys and censuses and then predicts poverty for smaller areas using census data.

In 2006, an independent committee evaluating the World Bank's research (http://www.worldbank.org/poverty/) raised some concerns about the precision of smaller-area poverty estimates of poverty mapping. In particular, the committee was concerned that the prediction errors in census blocks across space within a local area, say wards within a city or districts within a province, would not be independent, giving rise to spatial correlation in error terms. In the absence of reliable estimates, the committee thinks poverty maps would be of "limited usefulness." In view of this problem, poverty maps may be viewed as indicative rather than firm measures of the extent of poverty in small areas and should be used with other available indicators of poverty for decision-making processes.

Source: Author's summary.

Poverty mapping modeling based on data sets from household survey and census data reveals relationships between poverty and some variables common to both types of data sources. The modeling relationship is then applied to population census data to get estimates of poverty indicators of wider geographical areas. Finally, poverty maps are developed to achieve the following purposes:

- Develop more accurate and cost-effective targeting and monitoring of poverty reduction projects and programs.
- Improve ex-ante impact assessment of proposed projects and policies.
- Improve poverty analysis and statistical capacity.
- Foster good governance by increasing the transparency of government resource allocation and disseminating information about the geographic distribution of poverty to stakeholders.

Applications of Poverty Mapping Across Countries

Elbers, Lanjouw, and Lanjouw (2002, 2003a, 2003b, 2004) developed the technique of poverty mapping to use detailed information about living standards available in household surveys and wider coverage of censuses to estimate poverty indicators at relatively small areas. By combining the strengths of each source and the technique, the estimators can be used at a remarkably disaggregated level to create effective poverty maps for clusters of subregional levels.

Poverty mapping has been implemented successfully in a number of countries to generate disaggregated poverty indicators, as summarized in Table 6.1. A similar procedure was also applied by Arellano and Meghir (1992) in a labor supply model using the United Kingdom's Family Expenditure Survey to estimate models of wages and other income conditioning on variables common across two samples.

Table 6.1 **Applications of Poverty Mapping in Some Selected Countries**

Country/ Reference	*Focus of Estimation*	*Lowest Disaggregation Level*
Cambodia Fujii, T. (2005)	Child Malnutrition Indicators	Commune
Ecuador Hentschel et al. (2000)	Basic needs and welfare indicators	Parish (lowest administrative area)
Indonesia SMERU (2005)	Poverty incidence	Village
Madagascar Mistiaen et al. (2001)	Welfare indicators	Commune (lowest administrative area)
Mozambique Simler and Nhate (2003)	Welfare, poverty (incidence and gap) and inequality measures	Village
Philippines World Bank (2005)	Poverty incidence, gap and severity	Municipality (urban and rural)
South Africa Alderman et al. (2002)	Poverty incidence	Magisterial district and transitional local council
Tajikistan Baschieri and Falkingham (2005)	Poverty incidence based on estimated consumption expenditure and food consumption expenditure	Rayon (district) and Jamoat (lowest administrative area)
Viet Nam Minot (1998)	Household characteristics as poverty indicators	District

Source: Authors' compilation.

Demombynes et al. (2001) constructed estimates of local welfare for many countries, while Henstchel et al. (2000) demonstrated how sample survey data can be combined with census data to yield predicted poverty rates for the population covered by the census. The use of geographic poverty maps was explored by Mistiaen et al. (2002) in Madagascar by combining detailed information from the household survey with the population census, replicating the method used by Elbers, Lanjouw, and Lanjouw (ELL Method). Cluster estimation was also used by Fujii (2005) to conduct small-area estimations of child nutrition status using the Cambodia Demographic and Health Survey. In his study, he extended the ELL model by identifying two layers of specific structure of error terms unique to nutrition indicators.

Poverty mapping studies for generating disaggregated welfare indicators have some similarities. The methodology is an extension of small-area estimation (Ghosh and Rao 1994, Rao 1999), i.e., applying the developed estimators based on small surveys to population census characteristics. Box 6.3 summarizes poverty mapping conducted for Pakistan, where the number of poor is estimated at the district level through poverty predictor modeling.

Box 6.3 **Poverty Mapping for Pakistan**

There are different ways to implement poverty mapping. One method is to produce maps of available poverty indicators and some relevant household characteristics (e.g., education, health, and other demographic information) directly from existing administrative or household survey data. Another method is to first estimate the number of poor households at the lowest possible disaggregated level, i.e., at district, subdistrict or village, through poverty modeling and then map out the result. This second method is done by using household characteristics available from survey and census data sets. Finally, a third method is to combine the first two methods by mapping poverty indicators from administrative or survey data as overlays on the map of poverty measures estimated through the model.

In poverty mapping done for Pakistan, the second approach was employed with an additional poverty incidence map using survey data with limited coverage. Two sets of thematic maps were also generated showing household characteristics by districts based on the 2001 Pakistan Socioeconomic Survey and the 1998 Population Census.

Three steps were involved in identifying poverty predictors and estimating poverty incidence at the district level. The first step was to use a multivariate regression model, where the dependent variable was per capita expenditure per month and the independent variables were various household characteristics. The next step was to use a probit model, where the dependent variable was poverty status, that is, a value of *1* is assigned if estimated per capita expenditure is below the poverty line, *0* if otherwise. This time the model estimation was done for every district. Based on both models, the poverty predictor variables found were household size, high dependency ratio, and low education. The final step was to implement multivariate poverty modeling using the estimated poverty incidence for every district as dependent variable and the significant predictors that resulted from the previous steps, but the data used were from the census. The result revealed estimated poverty incidence for 108 districts with the three most important predictors being family size, high dependency ratio, and education (Siddiqui 2005).

Figures 6.1 displays geographically referenced information on poverty incidence by district based on household survey data for only 71 districts in Pakistan. Figure 6.2 shows estimated poverty incidence based on poverty predictor modeling results for 108 districts in Pakistan. Figures 6.1 shows that incidence varies significantly across districts. The incidence of poverty is highest in Muzaffargarh (76.6 percent) and lowest in Panjgur (15.4 percent). Figure 6.2 reflects that poverty is not only concentrated in the southern part of Punjab but also in the central part of Balochistan and the upper part of the North Western Frontier Province.

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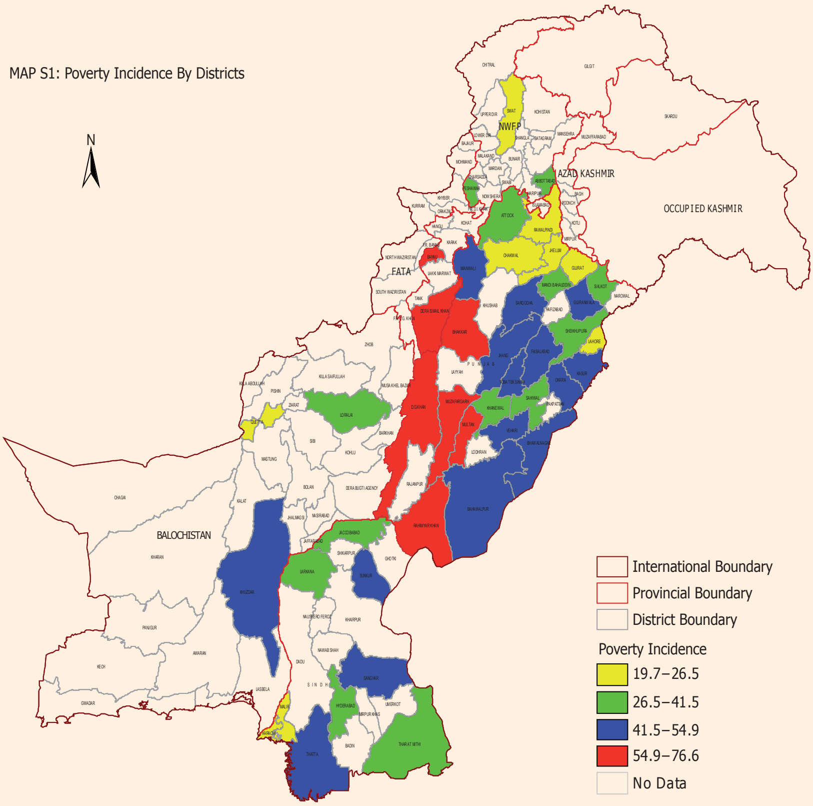
Source: Nabeela 2005, ADB 2005b.

Box 6.3 continued

Figure 6.1 **A Poverty Map of Pakistan Showing Survey-Based Poverty Incidences**



Source: Based from the 2001 Pakistan Socio-Economic Survey.

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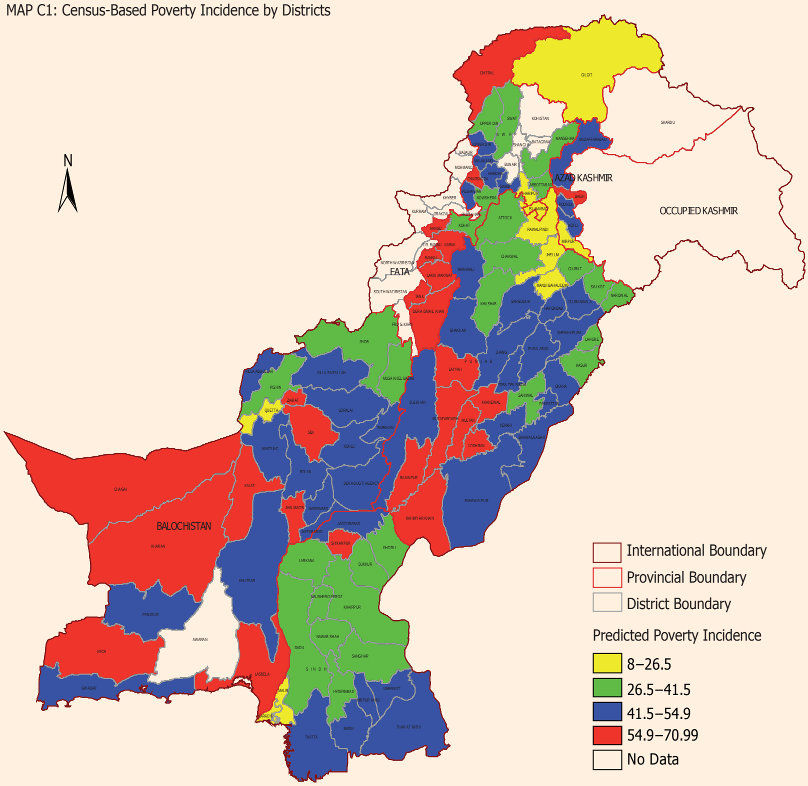
The construction of poverty maps for small administrative areas was also conducted in Indonesia as early as 1990. For allocating the poverty reduction fund as part of the Presidential Instruction on Disadvantaged Villages (IDT), entitled poor villages were identified based on a scoring system developed from a composite index of variables from the village census (Village Potential Statistics or *Potensi Desa*–Podes) data, complemented with the personal evaluation and perception of the subdistrict leader (*Camat*).

Box 6.3 continued

Figure 6.2 **A Poverty Map of Pakistan Showing Model-Based Poverty Incidences**

MAP C1: Census-Based Poverty Incidence by Districts



Source: Based from the 1998 Population Census of Pakistan.

The poverty mapping results identify possible causes of poverty, that suggest that geographically targeted policy measures may be used to alleviate poverty. The results can also be used for assessing the impact and effectiveness of poverty reduction programs.

Source: Nabeela 2005, ADB 2005b.

In another instance, the government's Family Welfare Development Program used a different classification system in defining the welfare status of families, i.e., according to some specific criteria such as religious practice, frequency of eating, pieces of clothing owned, types of house floor, and type of health services used. For a family to be classified as one with the highest welfare status, it has to satisfy a total of 24 indicators. Box 6.4 summarizes this welfare classification system.

Box 6.4 Welfare Classification System of the Family Welfare Development Progam of Indonesia

The Indonesian National Family Planning Movement has evolved from a fledgling program in the early 1970s into what it is now—a community and social development movement. From a purely clinical family planning approach, it has now become a comprehensive family development movement. The basis of its field operations is the annual family registration, undertaken January–March each year and based on 24 indicators. The hierarchical family welfare classification, or what is called the *family prosperity status*, is summarized below with the variables classified by stage of prosperity. It is important to emphasize that this registration is mainly for operational purposes, i.e., these variables serve as intervention points to elevate the prosperity status of each family.

This welfare classification system had also been used in the National Family Planning Coordinating Board's (BKKBN's) Family Prosperous Programme to improve family welfare (including family planning) autonomously after gaining a "prosperous family" status.

Source: Summarized from Weidemann (1998).

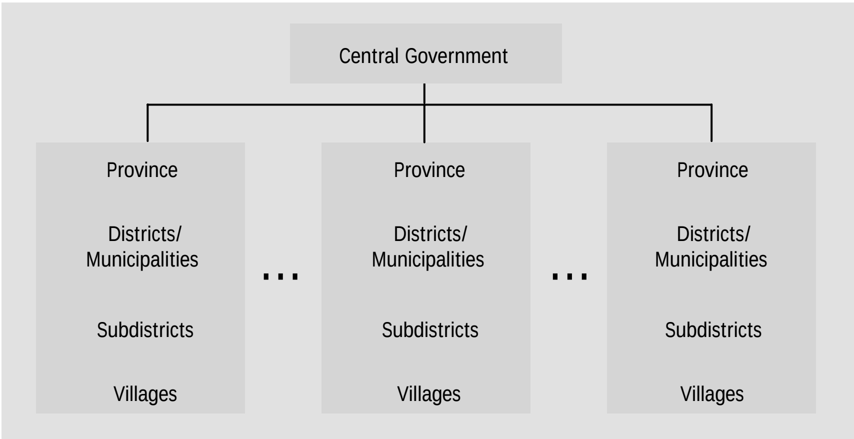
Moreover, an independent Indonesian institution for research and public policy studies, the Social Monitoring and Early Response Unit (SMERU), developed a tool for better targeting the poor by implementing poverty mapping. Using the ELL method, poverty indicators for small areas were estimated and GIS maps of the results were developed. The poverty mapping developed in this paper further refines the SMERU work by introducing some new features such as a dynamic "traffic-light" classification system that uses red, yellow, and green to represent high, moderate, and low poverty incidence; options for changing default cutoff points; and the option to overlay the poverty maps with graphs of variables taken from the Podes (which collects information on infrastructure and social facilities).

Study Background

Indonesia is the fourth most populous country and is the biggest archipelago (having the most number of islands) in the world. The first level of administration below the central government administration is the province. Each province is then further divided into districts (*Kabupaten*) or municipalities (*Kotamadya*), subdistricts (*Kecamatan*), and villages (*Desa/Kelurahan*) as the lowest administrative level (Figure 6.3).

Indonesia has relatively high poverty incidence compared with its neighbors like Malaysia and Thailand. In 2004, for instance, about 36 million people in Indonesia lived below the poverty line and the corresponding poverty incidences in total, rural, and urban areas were 16.7 percent, 20.3 percent, and

Figure 6.3 **Administrative Structures in Indonesia**



Source: Authors' summary.

13.5 percent, respectively. On the other hand, poverty incidence in Malaysia in 1999 was 7.5 percent and in Thailand in 2002 it was 9.9 percent.[1]

Poverty lines and poverty indicators in Indonesia were calculated using data from the SUSENAS, which collects among others, data on household income expenditures on different kinds of goods and services that can be used for calculating poverty indicators. The official poverty indicators were first published by Badan Pusat Statistik (BPS) Indonesia in 1984 for the period 1976–1984. Since then, poverty indicators have been estimated annually as part of the government program to reduce poverty. This program was intensified in 1994 with the implementation of the IDT program. Unfortunately, the economic crisis in 1997 resulted in an increase in the number of poor in Indonesia.

Table 6.2 shows poverty indicators in Indonesia from 1976 to 2003. Economic development was able to reduce poverty significantly in the early years. In 1976, 54 million people or 40 percent of the population were poor and the number was reduced to below 35 million or 22 percent in 1984, a remarkable reduction of almost 19 percentage points in a period of 8 years. The reduction slowed down in subsequent years as oil revenues declined. By 1993, 14 percent of the population was poor and in 1996 the headcount ratio was only 11.3 percent–the lowest in the history of the country. This trend was reversed drastically by the economic crisis in 1997, so much so that in 1998 the poverty incidence increased to 24 percent. From 1999, it has remained fairly constant at around 17 to 19 percent.

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1 ADB Poverty and Development Indicators Database Online Query (http://lxapp1.asiandevbank.org:8030/sdbs/jsp/).

Table 6.2 **Poverty in Indonesia, 1976–2003**

Year	Poverty Line (Rp/capita/ month)		Headcount Ratio (%)			Poverty Incidence (million)		
	Urban	Rural	Urban	Rural	Total	Urban	Rural	Total
1976	4,522	2,849	38.8	40.4	40.1	10	44.2	54.2
1978	4,969	2,981	30.8	33.4	33.3	8.3	38.9	47.2
1980	6,381	4,449	29.0	28.4	28.6	9.5	32.8	42.3
1981	9,777	5,877	28.1	26.5	36.8	9.3	31.3	40.6
1984	13,731	7,746	23.1	21.2	21.6	9.3	25.7	35
1987	17,381	10,294	20.1	16.1	17.4	9.7	20.3	30
1990	20,614	13,295	16.8	14.3	15.1	9.4	17.8	27.2
1993	27,905	18,244	13.5	13.8	13.7	8.7	17.2	25.9
1996	38,426	27,413	9.7	12.3	11.3	7.2	15.3	22.5
1999	89,845	69,420	15.1	20.2	18.2	12.4	25.1	37.5
2000	91,632	73648	14.6	22.4	19.1	12.3	26.4	38.7
2001	100,011	80,382	9.8	24.8	18.4	8.6	29.3	37.9
2002	130,499	96,512	14.5	21.1	18.2	13.3	25.1	38.4
2003	138,803	105,888	13.6	20.2	17.4	12.2	25.1	37.3

Rp = rupiah
Source: Sugiyarto, Oey-Gardiner, and Triaswati (2006).

The calculation of poverty indicators in Indonesia is based on the official poverty line, which is estimated at the provincial level with different poverty lines for urban and rural areas. The poverty lines have been estimated as the cost of consuming a food commodity basket of 2,100 calories per capita per day and some essential nonfood items for a given reference population.

Poverty incidence in Indonesia is widely dispersed across regions and provinces. For instance, poverty incidence varied from 3.4 percent in the province of Jakarta to 41.8 percent in Papua. Therefore, information on where the poor people are located is important, but such information is severely constrained by the design of the SUSENAS. Although the survey is conducted every year, its limited sample size and distribution only allow for the calculation of poverty indicators down to the provincial urban and rural levels.

To estimate poverty indicators at lower administrative levels, such as for district to village levels, poverty mapping was implemented using the 1999 SUSENAS, 2000 Population Census, and 2000 Podes. The results show that reliable poverty indicators can be generated at the subdistrict level with the standard errors of estimates at less than 10 percent. At the village level, however, the standard errors of the estimates increased at nearly 14 percent, making them less reliable. Detailed results of this poverty mapping are available from BPS Indonesia.

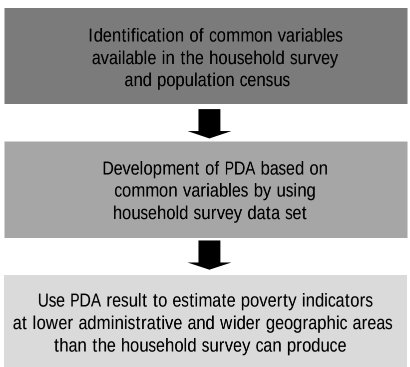
Modeling Developments

The methodology applied to this study, the ELL, is described in detail in Elbers, Lanjouw, and Lanjouw (2002, 2003a, and 2003b). The first major step in the application of the cluster method was running the regression models, based on the household per capita measure of consumption expenditure, on some exogenous variables found in both the household survey and population census. The household survey variables used in this poverty determinant analysis had to be strictly comparable to the variables in the population census.

The second major step was to estimate per capita consumption using the coefficients and residual terms randomly drawn from the estimated distribution as provided in the first step. The imputed consumption was, in turn, used to estimate poverty and inequality measures at the lowest administrative level, that is, the village level.[2] Simulation was done to arrive at robust point estimates with minimum standard error.[3]

Figure 6.4 shows the steps in implementing poverty mapping modeling. The common variables are identified according to some diagnostic tests in terms of relationships and distributional characteristics distinct to both the household survey and population census. Constrained to the underlying properties of the disturbance errors (idiosyncratic error), a cluster model is developed within the scope of poverty determinant analysis to identify

Figure 6.4 **Poverty Mapping Modeling**



PDA = poverty determinant analysis
Source: Authors' summary.

2 The process uses a computer program developed by Qinghua Zhao of the World Bank's Development Research Group (Qinghua 2002).

3 See Elbers, Lanjouw, and Lanjouw (2002, 2003a, and 2003b) for a more detailed description of the methodology.

significant parameters that would fit the census data. Finally, the parameter is subjected to a larger coverage area as depicted by the census data but bound by acceptable standard errors (model error and computational error).

Data Sources

Among the various surveys conducted by BPS Statistics Indonesia, the SUSENAS is the most appropriate data source for estimating poverty incidence due to the inclusion of consumption data. Besides the consumption data, the survey also covers numerous data items on population characteristics, such as demographic, education, health, employment, and housing characteristics which are also found in the population census. This study used the complete population census of 2000 for the purpose of providing the basic characteristics down to the lowest administrative levels, i.e., national, district, subdistrict, and village. In addition, accompanying every census is a Podes that collects information at the village levels. This information is intended to examine village potential in economic, social, and other aspects. Accordingly, other poverty-related indicators derived from the Podes can be overlaid with the poverty mapping results for spatial analysis.

Using the cluster-estimation method, poverty indices at the level of smaller administrative areas are estimated by combining the SUSENAS, Podes, and the complete 2000 Population Census data. Even though the SUSENAS is not designed to provide poverty estimation at levels lower than the province, it does supply consumption data that are required for estimating poverty measures. The census, on the other hand, does not cover consumption data but provides basic characteristics of individual households that make poverty estimation at the lowest level of administration possible.

In summary, poverty rate estimation as part of the poverty mapping is implemented using data sets from the following sources:

- SUSENAS Consumption Module (1999), which provides data on food and nonfood consumption. Total sample size of the survey is about 65,000 households throughout the country and is allocated proportionately in all provinces except Maluku, Maluku Utara, and Papua.
- SUSENAS Core (1999), which provides data on other individual and household characteristics and is used in implementing the cluster models. Total sample size is about 200,000 households and is allocated proportionately in all provinces except Maluku, Maluku Utara, and Papua.
- Population Census (2000), which provides data on individual and household characteristics. Data are used for simulation of various models for optimal estimation of poverty and inequality measures.

In addition, data generated are aggregated for the village level to produce community variables.

- Podes Census (2000), which provides community (i.e., village) data of approximately 69,000 villages. This is used to identify the so-called spatial distributional effects of poverty. The Podes covers all villages throughout the country and is used as the main data source to derive some geographic and background variables of poverty. The resulting characteristics are recommended for use as layers in poverty maps. In addition, the 2000 Master File of Villages (MFD) is used to link the four data sets. MFD is also employed to detect changes in villages during the period 1999–2000 to ensure the accuracy of village data.

Table 6.3 presents the determinants of poverty from each of the data sources. Using the common variables found in the census and survey data sets, and the variables that come from the Podes, consumption regression models were run to estimate the distribution of coefficients and residual terms. To provide more explanatory power for log per capita expenditure, the distribution and the summary statistics of each candidate variable were checked using Student t-statistics to compare data from the census and the survey. The variables with different distribution as shown in the summary statistics were excluded from the model. Checking for distribution and summary statistics is done at every stratum (province, urban and rural). Some variables used in determining the urban score for a village were composite indices. Table 6.4 lists the variables and their corresponding attributes and scores used in the construction of the urban score.

Table 6.3 **List of Variables Used in the Cluster Model Building in Indonesia**

Source	*Variable*
SUSENAS	Log expenditures per capita per month
SUSENAS/Podes/Census	Demographic Characteristics Education Occupation Health Infrastructure

SUSENAS = National Socioeconomic Survey: Podes = Village Potential Survey
Source: Authors' summary.

Table 6.4 **Variables Used in Constructing Urban Score**

Variable/Classification
1. Population density per km^2
2. Percentage of agricultural households
3. Percentage of households with electricity
4. Percentage of households with TVs
5. Accessibility to urban facilities
A. Kindergarten
B. Junior High School
C. Senior High School
D. Market with semi permanent or permanent building
E. Movie, theater/cinema
F. Shopping areas
G. Hospital
H. Hotel, billiards, amusement center
6. Village Total Score (5.A – 5.H)
7. Urban supporting facilities (only for urban)
A. Public lighting
B. Public bank
C. Public telephone/telecommunications shop
D. Supermarket/Department store
8. Total Score of Supporting Facility (7.A – 7.D)
9. Grand Total of Village Score (6 + 8)
10. Percentage of land area for other buildings other than housing

Source: Authors' summary.

In addition to common variables that satisfy the t-test, the interaction and higher-order variables (until the third order) derived from two or more well-tested single variables were also included. The cluster-estimation model is basically a prediction model and, hence, endogeneity problems are ignored.

In the prediction model, the dependent variable was the logarithm transformed per capita consumption as provided by the 1999 SUSENAS Consumption Module. The regression models were run for all provinces and, separately, for urban and rural areas.

Definitions and Properties of Estimators

The assimilation of individual characteristics from the SUSENAS and the 2000 Population Census was very similar to synthetic estimation used in small-area geographic modeling. The observed per capita household consumption in the SUSENAS was used as a function of a vector of variables characterized in both survey and census[4]:

$$\ell n\, y_{ch} = \mathrm{E}[\ell n\, y_{ch} \mid x_{ch}] + \mu_{ch} \tag{1}$$

where

y_{ch} : per capita consumption for household h and cluster c
x_{ch} : socio-economic characteristic of household h in cluster c
μ_{ch}- vector of disturbances

Using a linear approximation of the conditional expectation (Equation 1), the observed log per capita consumption expenditure can be expressed as follows:

$$\ell n(y_{ch}) = x_{ch}\,\beta + \mu_{ch} \quad (\textit{Beta}\ \text{model}) \tag{2}$$

where β is a vector of c parameters and μ_{ch} is disturbance terms satisfying $E[\mu_h \mid \chi_h] = 0$.

By design, the SUSENAS does not provide spatial information. Therefore, the disturbance terms, as shown in Equation 2, include spatial effects and heteroskedasticity[5] to improve the model. The following formula is used for spatial effects:

---

4 Characteristics must have the same accuracy in the manner that definitions of each source are the same.

5 In the case of poverty mapping of Tajikistan (Baschieri and Falkingham 2005), heteroskedasticity appeared to be significant in some strata. In order to capture this, the alpha model was implemented only to result in a low R-squared. Hence, the heteroskedasticity component was not estimated; instead, a location component was estimated where possible.

$$\mu_{ch} = \eta_c + \varepsilon_{ch} \tag{3}$$

Here, η_c is a *cluster* component and ε_{ch} is a household component. On the average at village level, distribution terms can be expressed as follows:

$$\mu_{c.} = \eta_c + \varepsilon_{c.} \tag{4}$$

and then,

$$\mathrm{E}[\mu_c{}^2] = \sigma_\eta{}^2 + \mathrm{var}(\varepsilon_{c.})$$

$$= \sigma_\eta{}^2 + \tau_c{}^2$$

In the above equation, η_c and ε_{ch} are assumed to be normally distributed and independent from each other. Following Elbers, Lanjouw, and Lanjouw (2002), the estimated variance of spatial effects can be expressed as follows:

$$\mathrm{var}(\hat{\sigma}_\eta{}^2) = \sum_c [a_c{}^2 \,\mathrm{var}(\mu_{c.}{}^2) + b_c{}^2 \,\mathrm{var}(\hat{\tau}_c{}^2)] \tag{5}$$

In the absence of spatial effect, η_c, equation 3 becomes simpler, $\mu_{ch} = +\varepsilon_{ch}$.

However, this is normally an unrealistic assumption. Following Elbers, Lanjouw, and Lanjouw (2002), the residual can be explained by a logistic model that regresses the transformed ε_{ch} with household characteristics:

$$\ell n\left[\frac{\varepsilon^2{}_{ch}}{A - \varepsilon^2{}_{ch}}\right] = Z_{ch}^T \hat{\alpha} + r_{ch} \quad (\textit{Alpha} \text{ model}) \tag{6}$$

Here, A is set as $A = 1.05 * \max\{\varepsilon_{ch}^2\}$, and r is a residual.

Estimated variance of ε_{ch} can be calculated using the following equation:

$$\hat{\sigma}^2{}_{\varepsilon,ch} = \left[\frac{AB}{1+B}\right] + \frac{1}{2}\hat{V}ar(r)\left[\frac{AB(1-B)}{(1+B)^3}\right] \tag{7}$$

Here $B = \exp\{Z_{ch}^T \hat{\alpha}\}$

Equation 7 suggests the generalized least squares model is employed in Equation 2 instead of the ordinary least squares model.

In Equation 2, per capita logarithmic consumption $\ell n(y_{ch})$ as provided by the 1999 SUSENAS Consumption Module serves as the dependent variable. For explanatory variables x_{ch} all common variables found in both the 1999 SUSENAS Core and 2000 population data sets (both L1 and L2 schedules) can serve as candidate variables to be included in the model.

Properties considered:

- Presence of disturbance error at households' consumption expenditure from their expected value (μ_{ch}). This is proportional to the size of the population of households.
- Variance in the first-stage estimate of the parameters of the cluster model.
- Inexact method to compute the predicted value of consumption expenditure in census data.

Implementation and Diagnostics Tests

The procedure in running the cluster model is carried out through the following steps:

1. developing the beta model (Equation 2);
2. calculating location effects (Equation 3);
3. calculating variance of estimators (Equation 4);
4. preparing the term residual to run the alpha model (Equation 6);
5. developing the generalized least squares estimate model;
6. using decomposition value singular to decompose the variance-covariance matrix as provided by the previous step to establish vectors that are randomly and normally distributed;
7. reading data census, eliminating missing values, and providing variables required by the beta and alpha models; and
8. storing all data sets required for simulation.

One of the major expected outputs of the cluster model is the headcount index (P_o), the proportion of population below a specified poverty line with reasonable reliability. Table 6.5 exhibits the summary estimation of poverty incidence for Java and non-Java provinces. As shown here, the estimation of poverty measure at provincial and district levels are reasonably reliable.

The results in Table 6.6 show that reliable poverty indicators can still be generated at the subdistrict level with standard errors of estimates less than 10 percent. At the village level, however, standard errors of estimates increased to nearly 14 percent, making them less reliable. This successful implementation was enhanced by the availability of the village census data. Complete results of the poverty mapping exercise are available from BPS Statistics Indonesia.

Finally, acceptability of the results depends on how they could be used by policy makers. However, from a technical perspective, what is desirable is a simultaneous lowering of both the level of standard errors and the level of aggregation. There is, however, a trade-off between these two goals.

Table 6.5 **Poverty Incidence (P_0) in Java and Non-Java Provinces**

Province	P_0 (%)	Interval P_0 (%), α=10%		Difference (3–4)	Standard Error
		Upper Bound	Lower Bound		
(1)	(2)	(3)	(4)	(5)	(6)
Java Provinces					
Jakarta	4.3	3.5	5.0	1.5	0.01353
West Java	19.0	18.2	19.8	1.6	0.01268
Central Java	28.4	27.8	29.1	1.4	0.01627
East Java	29.1	28.5	29.7	1.2	0.01474
Yogyakarta	26.5	25.2	27.8	2.6	0.04599
Non-Java Provinces					
Nanggroe Aceh Darussalam	13.1	11.8	14.3	2.4	0.05267
North Sumatera	17.6	16.5	18.8	2.3	0.02388
West Sumatera	11.7	10.8	12.6	1.9	0.03183
Riau	15.1	13.9	16.4	2.4	0.03325
Jambi	24.1	22.7	25.4	2.7	0.05546
South Sumatera	26.5	25.2	27.8	2.6	0.03620
Bengkulu	19.5	18.1	20.8	2.7	0.06613
Lampung	26.6	25.4	27.9	2.5	0.03475
Bangka Belitung	19.4	17.3	21.5	4.2	0.08549
Banten	12.2	11.4	12.9	1.4	0.02311
Bali	8.6	8.0	9.2	1.2	0.03142
West Nusa Tenggara	32.9	31.7	34.1	2.4	0.04728
East Nusa Tenggara	47.7	46.6	48.8	2.2	0.05610
West Kalimantan	25.4	24.4	26.4	2.0	0.04731
Central Kalimantan	16.3	15.0	17.6	2.6	0.05392
South Kalimantan	14.3	13.2	15.4	2.2	0.03955
East Kalimantan	17.7	15.7	19.7	4.0	0.04918
North Sulawesi	15.8	14.5	17.2	2.8	0.04966
Central Sulawesi	31.5	30.1	32.9	2.8	0.06812
South Sulawesi	20.3	19.4	21.1	1.7	0.03030
South East Sulawesi	32.9	31.8	34.0	2.2	0.07424
Gorontalo	23.1	20.9	25.2	4.3	0.09104

α = level of significance
Source: Authors' calculation based on poverty mapping results.

Table 6.6 **Standard Error of Poverty Incidence by Estimation Level**

	Mean Standard Error				
	Province	District/Municipality	Subdistrict	Village	Total
Java	0.00435	0.02196	0.07446	0.15967	0.14987
Non-Java	0.01019	0.02449	0.04837	0.12017	0.11380
Total	0.00900	0.02365	0.06173	0.13677	0.12921

Source: Authors' calculation based on poverty mapping results.

To test the validity of the model, Tables 6.7 and 6.8 compare P_0 as provided by the cluster estimate method and the SUSENAS, by province, in both urban and rural areas. The differences in the estimates from those provided by direct estimation which were officially published (SUSENAS) and those by census (i.e., provided by the cluster model) are almost negligible. Figure 6.5 demonstrates that the poverty estimates in rural areas produced from census data were very similar in the indices between the two approaches.

Table 6.7 **Comparison of Headcount Ratio (P_0) and Standard Error ($\hat{\delta}_{ch}$) Between Cluster Estimates and SUSENAS Results for Urban Area**

Province	*Cluster-Estimate*		*SUSENAS*		*Difference*
	P_0	$\hat{\delta}_{ch}$	P_0	$\hat{\delta}_{ch}$	(2)-(4)
(1)	(2)	(3)	(4)	(5)	(6)
Nanggroe Aceh Darussalam	10.2	0.7	10.2	3.0	0.0
Bali	7.1	0.3	9.4	2.7	(2.3)
Bangka Belitung	22.8	1.7	—	—	—
Banten	10.6	0.4	11.5	2.0	(0.9)
Bengkulu	20.5	1.2	22.0	4.5	(1.5)
Yogyakarta	21.3	0.7	23.8	3.4	(2.5)
Jakarta	4.3	0.4	4.0	0.8	0.3
Gorontalo	18.7	1.5	—	—	—
Jambi	20.0	0.9	22.4	4.3	(2.3)
West Java	19.6	0.6	18.9	2.0	0.7
Central Java	29.7	0.5	27.8	2.0	1.9
East Java	24.9	0.4	24.7	1.9	0.2
West Kalimantan	12.8	0.9	10.8	3.3	2.0
South Kalimantan	11.4	0.9	10.4	2.6	0.9
Central Kalimantan	6.8	1.3	5.6	2.5	1.1
East Kalimantan	12.8	1.4	10.0	3.9	2.9
Lampung	24.2	0.9	24.0	3.4	0.1
West Nusa Tenggara	30.4	0.9	31.9	4.2	(1.6)
East Nusa Tenggara	30.3	1.2	29.2	4.7	1.1
Riau	9.0	0.7	9.1	2.8	(0.0)
South Sulawesi	15.4	0.4	18.3	3.3	(2.9)
Central Sulawesi	21.2	0.8	23.1	6.0	(1.9)
South East Sulawesi	15.0	0.5	15.7	5.6	(0.7)
North Sulawesi	11.2	1.2	—	—	—
West Sumatera	17.4	0.8	18.2	3.9	(0.8)
South Sumatera	24.2	1.2	—	—	—
North Sumatera	18.0	0.9	18.3	2.5	(0.3)

SUSENAS = National Socioeconomic Survey
Source: Authors' calculation based on Poverty mapping results.

To ensure the validity and reliability of the models, a diagnostic test was done as illustrated in Table 6.9. The table shows the results for Nanggroe Aceh Darussalam–Urban, on which there are two major points worth mentioning. First, the model is able to explain some 50 percent variation of headcount index, that is, 0.50. Second, the multiplication of the mean and model parameter (i.e., the regression coefficient) for each variable is very similar between the two sources, for both unweighted and weighted versions. For an inspection, it is useful to focus on the sums of the products between the two sources. The sum for the weighted version, for example, is 11.94[6] and for poverty mapping (according to the population census or Sensus Penduduk–SP 2000) it is 11.95 (equivalent to Rp154,817[7]).

For further inspection, a visual presentation of the distributions of the consumption models derived from the SUSENAS and the census is provided

6 This is about Rp153,277; equal to the average value of logarithmic per capita expenditure, according to the SUSENAS.

7 Rp stands for rupiah.

Table 6.8 **Comparison of Headcount Ratio (P_0) and Standard Error ($\hat{\delta}_{ch}$) Between Cluster Estimates and SUSENAS Results for Rural Area**

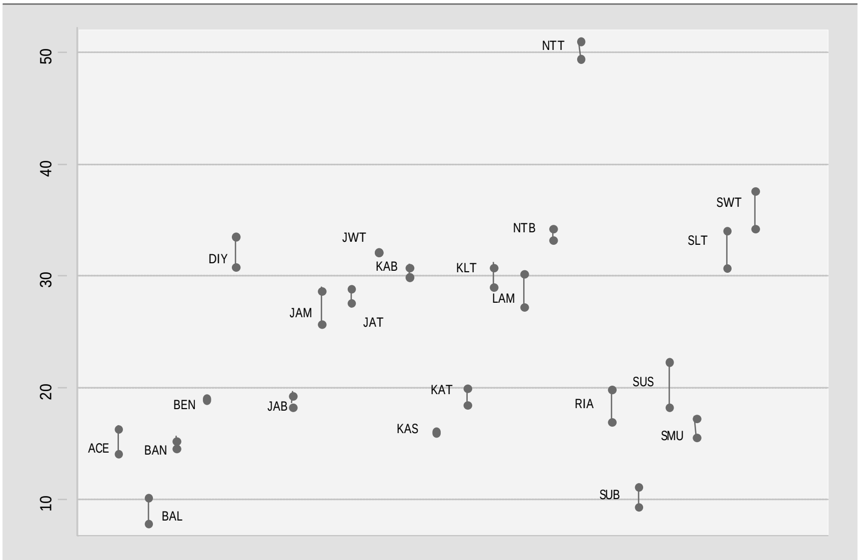
Province	*Cluster-Estimate*		*SUSENAS*		*Difference*
	P_0	$\hat{\delta}_{ch}$	P_0	$\hat{\delta}_{ch}$	(2–4)
(1)	(2)	(3)	(4)	(5)	(6)
Nanggroe Aceh Darussalam	14.2	0.8	16.3	2.8	(2.1)
Bali	10.2	0.4	7.9	1.8	2.3
Bangka Belitung	16.9	1.0	...	...	...
Banten	14.6	0.6	15.4	1.4	(0.8)
Bengkulu	19.0	0.7	18.9	4.8	0.2
Yogyakarta	33.6	0.9	30.8	3.3	2.8
Jakarta	...	...	...	...	...
Gorontalo	24.6	1.2	...	...	...
Jambi	25.7	0.7	28.6	5.4	(2.9)
West Java	18.4	0.4	19.3	1.4	(0.9)
Central Java	27.6	0.4	28.8	1.6	(1.2)
East Java	32.0	0.3	32.1	1.6	(0.1)
West Kalimantan	29.9	0.6	30.7	3.3	(0.8)
South Kalimantan	16.0	0.6	16.2	2.7	(0.2)
Central Kalimantan	20.0	0.6	18.5	4.2	1.4
East Kalimantan	29.0	1.2	30.7	4.9	(1.7)
Lampung	27.3	0.7	30.2	3.3	(3.0)
West Nusa Tenggara	34.2	0.7	33.2	3.0	1.0
East Nusa Tenggara	50.9	0.6	49.4	3.7	1.5
Riau	19.8	0.8	17.0	3.4	2.9
South Sulawesi	22.3	0.6	18.4	2.5	4.0
Central Sulawesi	34.0	0.9	30.7	4.6	3.4
South East Sulawesi	37.6	0.6	34.2	5.6	3.4
North Sulawesi	18.5	0.6	...	...	...
West Sumatera	9.4	0.5	11.2	2.0	(1.9)
South Sumatera	27.7	0.6	...	...	...
North Sumatera	17.3	0.5	15.5	2.2	1.8

SUSENAS = National Socioeconomic Survey
Source: Authors' calculation based on Poverty mapping results.

(Figures 6.6 and 6.7). These figures provide a visual presentation of the results by comparing the distributions of estimates from SP 2000 with SUSENAS 1999. Results for the province Nanggroe Aceh Darussalam, urban and rural areas, are used as examples.

The comparisons show that expenditure from the SUSENAS is slightly lower than expenditure from SP 2000 in both urban and rural areas. For urban areas, the distributions fit each other within the interval of 6–50 cumulative percent, but then SP 2000 produced higher results within the interval of 50–90 percent. Beyond that, SUSENAS produced higher percentage results. For rural areas, the distributions are the same within the interval of 6–40 cumulative percentages and higher for SP 2000 for the rest of the percentages. Overall, the distributions of the two results for all provinces under study fit each other relatively well. As far as the headcount index is concerned, the most important is the distribution of the results for the lowest 30 percent of the income distribution as the headcount ratio is within this range.

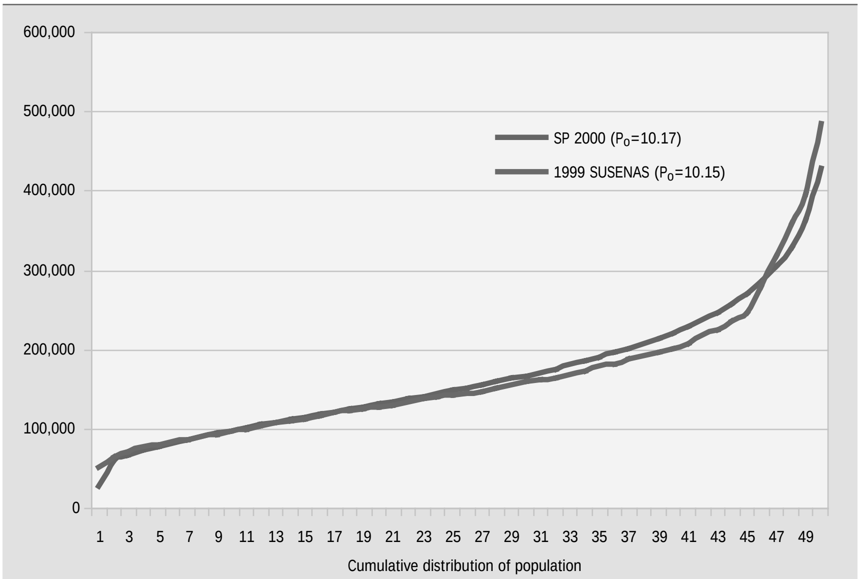
Figure 6.5 **Comparisons of Poverty Estimates Between the Cluster-Method and the SUSENAS in Rural Areas, 2000**



ACE = Nanggroe Aceh Darussalam; BAL = Bali; BAN = Banten; BEN = Bengkulu; DIY = D. I. Yogyakarta; JAB = Jawa Barat; KAS = Kalimantan Selatan; KLT = Kalimantan Timur; KAT = Kalimantan Tengah; LAM = Lampung; NTB = Nusa Tenggara Barat; NTT = Nusa Tenggara Timur; RIA = Riau; SUB = Sumatera Barat; SMU = Sumatera Utara; SUS = Sulawesi Selatan; SLT = Sulawesi Tengah; SWT = Sulawesi Tenggara

Source: Authors' calculation based on Poverty Mapping Results.

Figure 6.6 **Percentage Distribution of Expenditure in Nanggroe Aceh Darussalam—Urban Area**



SP = Population census.

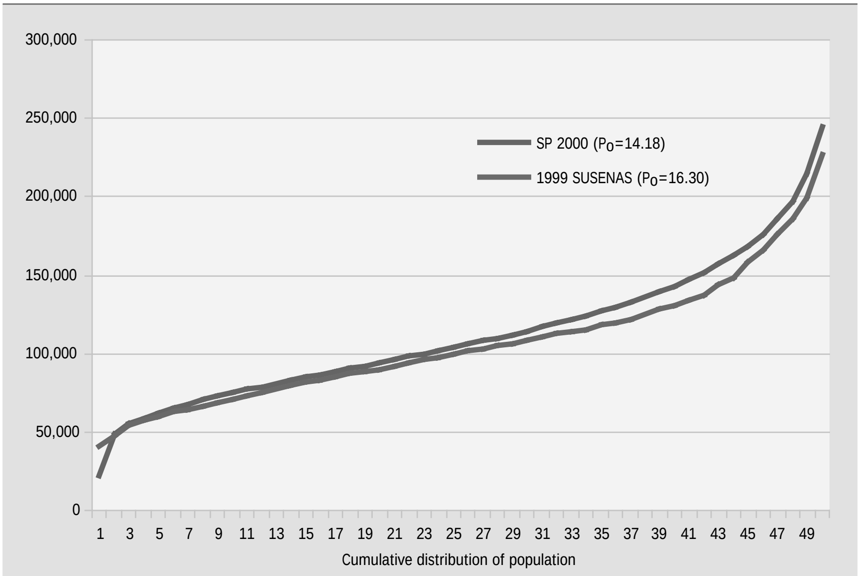
Source: Authors' calculation based on poverty mapping and SUSENAS results.

Table 6.9 **Diagnostic Tests of Nanggroe Aceh Darussalam—Urban Area**

Nanggroe Aceh Darussalam–Urban										
	Unweighted Mean		*Weighted Mean*		*Parameter*	*Unweighted Mean x (b)*		*Weighted Mean x (b)*	
Variable Name	*SUSENAS 1999*	*SP 2000*	*SUSENAS 1999*	*SP 2000*	*(b)*	*SUSENAS 1999 (2)x(6)*	*SP 2000 (3)x(6)*	*SUSENAS 1999 (4)x(6)*	*SP 2000 (5)x(6)*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
thhsize	4.46	4.12	5.59	5.04	-0.23233	-1.04	-0.96	-1.30	-1.17
vsecth3	0.32	0.36	0.34	0.36	1.12880	0.37	0.41	0.38	0.41
vwork	0.81	0.85	0.85	0.85	0.49844	0.41	0.42	0.42	0.42
hhs_prad	1.47	1.42	1.78	1.60	0.10169	0.15	0.14	0.18	0.16
vcba	2.75	2.93	2.89	2.99	-0.23723	-0.65	-0.70	-0.69	-0.71
veduch4	0.14	0.12	0.13	0.12	1.55913	0.22	0.19	0.21	0.19
sex	0.81	0.86	0.87	0.89	0.12695	0.10	0.11	0.11	0.11
thhsize2	24.89	20.75	35.69	29.31	0.01142	0.28	0.24	0.41	0.33
constant					12.20751	12.20751	12.20751	12.20751	12.20751
					R-squared=50.0%	12.05	12.06	11.94	11.95
Nanggroe Aceh Darussalam–Rural									
	Unweighted Mean		*Weighted Mean*		*Parameter*	*Unweighted Mean x (b)*		*Weighted Mean x b()*	
Variable Name	*SUSENAS 1999*	*SP 2000*	*SUSENAS 1999*	*SP 2000*	*(b)*	*SUSENAS 1999 (2)x(6)*	*SP 2000 (3)x(6)*	*SUSENAS 1999 (4)x(6)*	*SP 2000 (5)x(6)*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
rasio	0.87	0.84	0.91	0.90	-0.12957	-0.11	-0.11	-0.12	-0.12
hhsize	4.54	4.25	5.45	5.10	-0.07833	-0.36	-0.33	-0.43	-0.40
married	0.81	0.86	0.87	0.91	0.08726	0.07	0.08	0.08	0.08
ussch	0.06	0.08	0.06	0.08	-0.17671	-0.01	-0.01	-0.01	-0.01
health	0.28	0.35	0.28	0.35	0.71542	0.20	0.25	0.20	0.25
dist_ls	0.53	0.46	0.52	0.46	0.06087	0.03	0.03	0.03	0.03
elsch	0.63	0.73	0.64	0.73	-0.15090	-0.10	-0.11	-0.10	-0.11
comm	0.15	0.18	0.15	0.19	-0.55923	-0.08	-0.10	-0.08	-0.11
age_rasio	39.45	35.96	41.01	38.60	0.00196	0.08	0.07	0.08	0.08
vsex	0.87	0.88	0.87	0.88	-4.76834	-4.15	-4.21	-4.15	-4.21
vage	43.53	42.33	43.68	42.39	-0.01692	-0.74	-0.72	-0.74	-0.72
vhhsize	4.16	4.25	4.18	4.32	0.91611	3.81	3.90	3.83	3.96
vmarried	0.85	0.86	0.85	0.86	3.02091	2.57	2.60	2.57	2.60
veduch1	0.68	0.65	0.68	0.65	-11.57397	-7.86	-7.52	-7.90	-7.54
veduch2	0.16	0.17	0.16	0.17	-12.49233	-2.00	-2.09	-2.01	-2.08
veduch3	0.13	0.16	0.13	0.16	-9.92067	-1.30	-1.57	-1.27	-1.56
tssch	0.09	0.01	0.09	0.01	0.72027	0.06	0.01	0.06	0.01
vsecth2	0.09	0.09	0.09	0.09	-0.94309	-0.08	-0.08	-0.08	-0.08
vsecth3	0.11	0.10	0.11	0.10	-2.38987	-0.26	-0.23	-0.26	-0.23
vwkstath1	0.42	0.48	0.43	0.48	1.47497	0.63	0.71	0.64	0.71
vwkstath2	0.31	0.28	0.31	0.28	1.60297	0.50	0.44	0.49	0.45
vwkstath3	0.17	0.15	0.17	0.15	1.91081	0.33	0.29	0.32	0.29
vcba	3.20	3.25	3.22	3.31	-0.09352	-0.30	-0.30	-0.30	-0.31
pr_telp	0.01	0.01	0.01	0.01	-18.94475	-0.19	-0.13	-0.20	-0.13
vrasio	0.85	0.84	0.85	0.85	-2.24346	-1.90	-1.89	-1.90	-1.90
vprsckid	0.19	0.20	0.19	0.20	-4.77307	-0.90	-0.96	-0.90	-0.97
vprunde5	0.09	0.10	0.09	0.10	-3.84777	-0.36	-0.40	-0.36	-0.40
vownhou	0.61	0.62	0.62	0.62	0.21653	0.13	0.13	0.13	0.13
vrenthou	0.03	0.02	0.03	0.02	0.64336	0.02	0.01	0.02	0.02
distkec	7.00	11.02	6.96	10.91	-0.01951	-0.14	-0.21	-0.14	-0.21
density	1.97	2.35	1.97	2.34	0.09461	0.19	0.22	0.19	0.22
skor	5.08	4.60	5.09	4.61	0.03337	0.17	0.15	0.17	0.15
vilsect1	0.98	0.99	0.98	0.98	-2.05431	-2.01	-2.02	-2.00	-2.02
constant					25.65781	25.65781	25.65781	25.65781	25.65781
					R-squared=61.0%	11.60	11.55	11.53	11.52

SUSENAS = National Socioeconomic Survey; SP = Census of population
Source: Authors' calculation based on the poverty mapping results.

Figure 6.7 **Percentage Distribution of Expenditure in Nanggroe Aceh Darussalam—Rural Area**



SP = Population census.
Source: Authors' calculation based on poverty mapping and SUSENAS results.

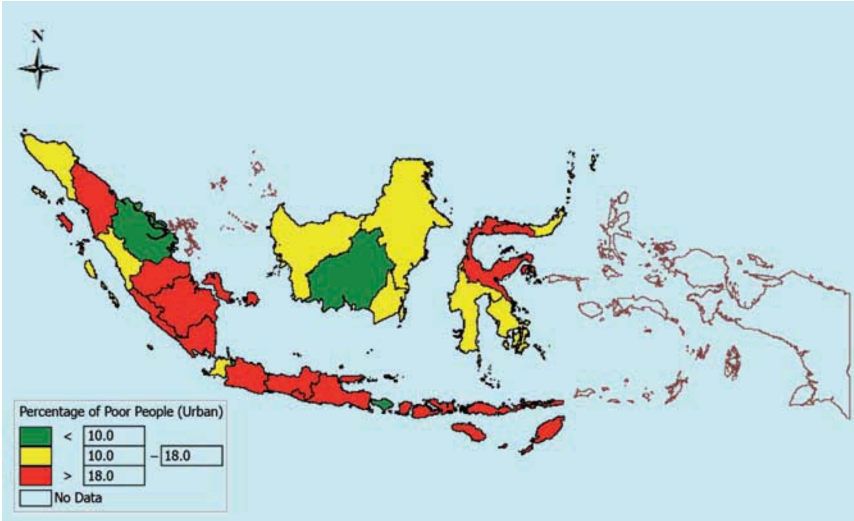
Developing a GIS Application of the Results

Recent studies on cluster estimation overlaid by thematic maps offer a promising avenue for analyzing the potential poverty impact of a variety of policy proposals. One could look into, for example, the potential impact of geographically targeted transfer schemes (Yin et al. 2004). All cluster-model results discussed in this chapter have been presented in thematic maps such as the map in Figure 6.8. They are generated through a dynamic, flexible, and user-friendly type of GIS application named PRISMA, or Poverty Reduction Information System for Monitoring and Analysis. A complete description of PRISMA, including examples of its application, is presented in the appendix of this chapter.[8]

PRISMA interactively combines district poverty indicators at household and population levels with other poverty-related indicators such as population density, share of agriculture by household, communication facilities, access to TV, access to school (secondary and high school), access to hospital, access to electricity, access to a safe-water facility, average urban score, welfare status, and average distance to the center of the subdistrict.

8 A CD-ROM version of PRISMA can be obtained from ADB's Economics and Research Department.

Figure 6.8 **Percentage of Poor Population in Urban Areas by Province**



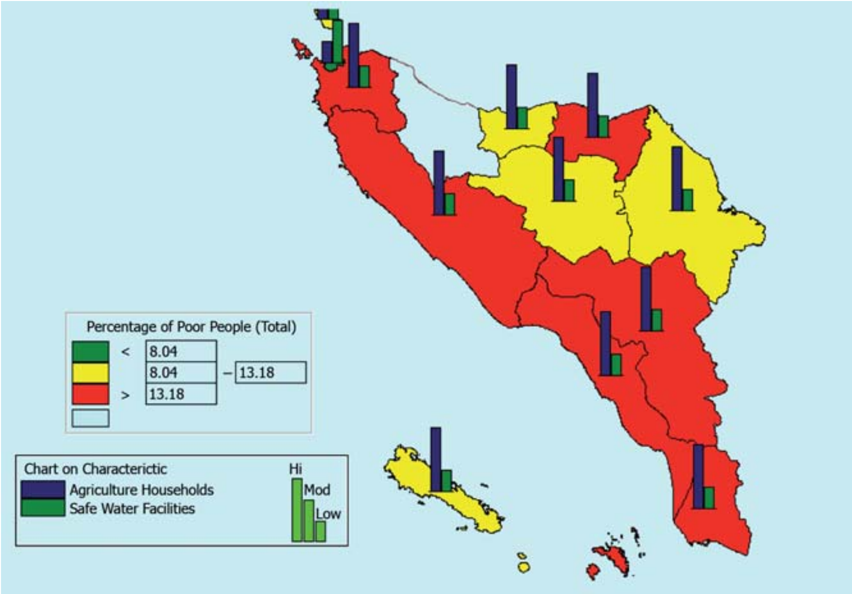
Note: The map that presents the geographical distribution of poor and nonpoor based on the poverty mapping results.
Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

In the system, the poverty indicators maps are presented using the traffic-light classification system (see Figure 4.8) mentioned earlier, in which red represents high, yellow average to moderate, and green low poverty incidence. The absence of color in an area on the map indicates that data is not available for that particular area. Geographic targeting can thus be visually illustrated according to the information available. This figure shows, for example, that the lower part of Indonesia (from North Sumatera to East Nusa Tenggara) is comparatively poorer based on the poverty headcount criterion of above 18 percent.

In addition to the default cutoff points that represent actual results from poverty mapping, users can also change the cutoff points and do spatial analysis using other levels of poverty incidence. Other features include the overlaying of bar charts of poverty characteristics, altering the traffic-light classification, presenting detailed information about a province or district, exporting maps for use in other software applications, and printing output.

Figure 4.9 is an example of how some socioeconomic variables can be overlaid on the poverty map. In addition to indicating poverty incidence in Nanggroe Aceh Darussalam using the traffic-light classification system, data from the Podes on the proportion of agricultural households and access to safe-water facilities is overlaid on the poverty map to show that a high proportion of households in the province are agricultural while access to safe-water facilities is moderate in all districts except in Banda Aceh and Sabang districts.

Figure 6.9 **Percentage of Poor People in Nanggroe Aceh Darussalam Province with Some Overlaying Variables by District**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

Overlying Variables

This section discusses variables used to overlay poverty incidence based on the headcount index in the GIS application. These "layering" variables of the poverty mapping result are correlates of poverty identified in the 2000 Podes survey. The unit of observation is the village, which is aggregated into district and municipality levels to be consistent with the district level measured for the headcount ratio.

To emphasize the user-friendly characteristics of the system, the cutoff points of the variable can be changed by the users according to their interests or concerns. For example, the default criteria for good access to hospital facilities is: 75 percent or more of the villages in a district must have their own hospital or are located not farther than 2.5 kilometers from the hospital. The system allows users to change this threshold, i.e., from 75 percent to 50 percent, for instance.

The thresholds used to categorize variables are set up differently across provinces, such as the distance from the village to the subdistrict capital. The reason for this is that population density and distribution vary considerably across provinces. Five kilometers to the subdistrict capital is considered relatively far in Java but not so in other provinces outside Java. Table 6.10 lists the variables with their different thresholds. For example, in the case of North Sumatera, less than three kilometers from the subdistrict capital city is considered close, while more than seven kilometers is considered far. The rationale for this is that 25 percent of villages in North Sumatera are located less than three kilometers from the capital city of their respective subdistricts, while 50 percent of them are located between three and seven kilometers, and 25 percent are more than seven kilometers. The capital city of a subdistrict is used as a reference because some basic public facilities like the public health center (*Puskesmas*) and junior and senior high schools are usually located in the capital city of a subdistrict.

Table 6.10 **Thresholds Used for Classifying Distances from Village to Subdistrict Capital by Province** (in kilometer)

Province	*Close* [a]	*Far* [b]
Nanggroe Aceh Darussalam	2.0	4.0
North Sumatera	3.0	7.0
West Sumatera	2.0	3.8
Riau	3.5	10.0
Jambi	3.0	9.0
South Sumatera	4.0	10.0
Bengkulu	3.0	6.0
Lampung	3.0	6.0
Bangka Belitung	2.9	9.0
Jakarta	1.2	2.0
West Java	2.0	4.0
Central Java	2.0	4.0
Yogyakarta	1.5	3.0
East Java	2.0	4.0
Banten	2.4	5.0
Bali	2.5	5.0
West Nusa Tenggara	1.5	4.0
East Nusa Tenggara	4.2	10.0
West Kalimantan	5.0	13.0
Central Kalimantan	7.0	20.0
South Kalimantan	2.5	5.0
East Kalimantan	4.1	14.5
North Sulawesi	1.9	5.0
Central Sulawesi	4.0	12.0
South Sulawesi	2.5	6.0
South East Sulawesi	3.0	8.0
Gorontalo	2.0	4.0

a = The lowest quintile (the closest 25%)
b = The highest quintile (the farthest 25%)
Source: Authors' calculation.

The sensitivity of the proposed layer variables is examined by observing variation in the headcount index between categories. For example, the percentage of agricultural households (Agric) is correlated with the headcount ratio, the overlying index is found to vary with the Agric variable by 14 percent in the lowest category, 21 percent in the medium category, and 26 percent in the highest category. In other words, the proportion of agricultural households, to some extent, explains variation in the headcount index–the higher the proportion, the higher the index. Tables 6.11 and 6.12 highlight the test results of the sensitivity of the variables concerned.

Conclusion

Poverty indicators derived from household surveys on income or consumption, or both, have a limited regional disaggregation. In this study, poverty mapping modeling is implemented by using household surveys and population census to estimate poverty indicators down to the smallest administrative units, i.e., for district to village levels. The methods have been

Table 6.11 **Categorization of Layer Variables in the GIS Application of Poverty Mapping Results**

Variable Name	*Label*	*Indicator*	*Category*	*Number of Districts*	*Average P_0 (%)*	*Std. Dev. of P_0*
Urban	Urban score	Composite index of urban	Low Urban	87	0.276	0.116
			Urban	89	0.219	0.089
			High urban	142	0.199	0.099
Density	Population density	Population per square kilometer	Low	98	0.252	0.108
			Medium	114	0.237	0.100
			High	106	0.189	0.101
Agric	Agriculture households	Percentage of agriculture households	Low	50	0.135	0.075
			Medium	94	0.208	0.082
			High	174	0.261	0.108
TelCom	Communication facilities	Percentage of villages with communication facilities	Low	85	0.273	0.114
			Medium	124	0.234	0.094
			High	109	0.180	0.093
TV	TV	Percentage households having TVs	Low	83	0.304	0.117
			Medium	207	0.210	0.081
			High	28	0.110	0.073
ScSch	Access to secondary school	Percentage of villages having secondary school or located 2.5 km or less	Low	3	0.306	0.148
			Medium	224	0.249	0.102
			High	91	0.166	0.091
HgSch	Access to high school	Percentage of villages having high schools or located 2.5 km or less	Low	102	0.272	0.114
			Medium	158	0.226	0.091
			High	58	0.145	0.076
Hospital	Access to hospital	Percentage of villages having hospitals or located 2.5 km or less	Low	251	0.249	0.102
			Medium	57	0.143	0.072
			High	10	0.127	0.071
Poor	Poor family	Percentage households considered as under welfare	High	45	0.119	0.058
			Medium	261	0.234	0.092
			Low	12	0.441	0.114
Electr	Electricity	Percentage of households using electricity	Low	13	0.420	0.114
			Medium	196	0.247	0.093
			High	109	0.164	0.083
Water	Safe water facilities	Percentage households using pipe or pump-water facilities	Low	222	0.254	0.100
			Medium	69	0.175	0.093
			High	27	0.124	0.071
Distance	Distance to center of subdistrict	Percentage of villages by distance to center of subdistrict office	Low	60	0.154	0.0687
			Medium	42	0.201	0.1152
			High	216	0.251	0.1028

Std. Dev. = Standard Deviation
Notes: The first and the highest quintiles are used for the categorization except otherwise stated and P_0 as head count index in percent.
Source: Authors' calculation based on the poverty mapping results.

Table 6.12 **Pearson Correlations among Layered Variables and between Layered Variables and Headcount Ratio (P_0)**

	DENSITY	*AGRIC*	*TELCOM*	*TV*	*SCSCH*	*HGSCH*	*HOSPIT*	*URBAN*	*POOR*	*ELECTR*	*WATER*	*DISTANC*
P0	-0.36	0.49	-0.37	-0.62	-0.36	-0.44	-0.42	-0.45	0.73	-0.58	-0.45	0.37
DENSITY		-0.82	0.61	0.61	0.65	0.76	0.81	0.87	-0.37	0.55	0.72	-0.56
AGRIC			-0.79	-0.81	-0.81	-0.91	-0.90	-0.97	0.50	-0.73	-0.76	0.71
TELCOM				0.78	0.86	0.83	0.68	0.84	-0.44	0.81	0.65	-0.51
TV					0.75	0.78	0.72	0.82	-0.64	0.87	0.67	-0.55
SCSCH						0.93	0.76	0.87	-0.41	0.75	0.63	-0.60
HGSCH							0.89	0.94	-0.47	0.74	0.73	-0.71
HOSPIT								0.91	-0.43	0.64	0.76	-0.73
URBAN									-0.48	0.77	0.78	-0.69
POOR										-0.59	-0.43	0.35
ELECTR											0.64	-0.49
WATER												-0.57

Note: All bivariate correlations are significant at one per cent level (2-tailed).
Source: Authors' calculation based on the poverty mapping results.

implemented successfully in a number of countries. The technique can also be used to generate other welfare indicators such as the welfare index, nutrition status, basic needs index, school drop-out rate, and inequality measures.

The application of poverty mapping in Indonesia incorporates information from the Podes to strengthen the modeling results. The overall results show that the poverty mapping technique can generate reliable poverty indicators at district and subdistrict levels with standard errors estimates of less than 10 percent. In some cases, the estimation can actually go down to the village level, but the estimates at the village level are generally less reliable as their standard errors reach about 14 percent. The successful implementation of poverty mapping brings with it a reminder to make more use of the census data, which seems still underutilized in most developing countries. Poverty mapping results of this study were also used as a basis for a GIS application by combining with other poverty-related information in a dynamic interactive PRISMA.

Appendix 6.1

Poverty Reduction Information System for Monitoring and Analysis: A GIS Application of Poverty Mapping Results

Guntur Sugiyarto, Dudy Sulaeman, Eric B. Suan, and Mary Ann Magtulis.

Introduction

Estimation of poverty indicators at a more disaggregated geographical area is implemented in Indonesia by using a poverty mapping technique. The estimation is conducted by using data sets from three sources, namely, the household expenditure survey (SUSENAS), village census (Podes), and population census (Sensus Penduduk–SP) data. The technique maximizes the rich information of surveys and the wider coverage area of censuses. The results basically show that the poverty indicator estimates are reliable even at the village level in Java; while for outside Java, the estimates are only reliable up to the subdistrict level.

However, statistical tables may not be as revealing and intelligible to most people as they should be–not even to regular data users. Thus, a geographic information system (GIS) application was developed by incorporating poverty indicator estimates for small areas such as districts with other poverty-related information. The geographically disaggregated poverty indicators are used to provide information on the spatial distribution of poverty. This information can be used as a decision-support system for specific evidence-based interventions, programs, and plans for targeting the poor (Albert et al. 2003).

This report summarizes the development of a GIS tool that could display geographically referenced information (i.e., spatial data) of poverty characteristics and create visuals of meaningful relationships and significant patterns in data. The tool is called the Poverty Reduction Information System for Monitoring and Analysis (PRISMA).

PRISMA allows users to simulate changes in poverty incidences to reflect different level of targets that are regularly faced by developing countries like Indonesia. It can therefore provide meaningful information for monitoring and analysis. The system adopts a “traffic-light” classification system of red, yellow, and green to represent, respectively, high, average, and low poverty incidences.

The construction of interactive poverty-referenced maps helps in visualizing disparities of living standards across regions. This visual information is useful in identifying areas that need additional resources for poverty reduction. A causal relationship between the welfare status of households and geographic or other factors may be displayed. As a result, improved poverty targeting may be better planned. The provinces, districts, subdistricts, and even villages where the poor households are located, for instance, may be selected for some programs such as to improve infrastructure and education and health facilities. These areas may also be targeted for direct transfer programs such as food-for-work, improved access to credit, or direct government subsidies to enhance the availability of social services to those who need them most.

Poverty Reduction Information System for Monitoring and Analysis

PRISMA was developed by using two computer software programs– MapObject 2.1 and Visual Basic 6.0. The system runs on Windows XP Professional. It has a comprehensive database of spatial information based on the poverty mapping results and other sources. For the Indonesian data set, however, spatial information provided by PRISMA is available for only 27 out of 30 provinces of Indonesia. This is because SUSENAS 1999, one of the sources of data sets used in the small-area estimation of Indonesia's poverty indicators, covered only these 27 provinces. Excluded provinces are Maluku, Maluku Utara, and Irian Jaya, which is now known as Papua.

The system is user-friendly and very intuitive as it is very easy to run and understand. It has standard geographic data and other spatial information to ensure universal compatibility and replicability for other countries. The tool was pilot-tested by using poverty mapping modeling results conducted in Indonesia that can be scaled for other countries.

Users can view thematic maps showing spatial distribution of one or more specific data themes for a particular geographic area. Data themes that can be generated using PRISMA menus are: spatial disaggregation, and population, household, and poverty characteristics related to Indonesia. Other PRISMA features include the overlay of bar charts of poverty characteristics, flexible alteration of the traffic-light classification of thematic maps, presentation of detailed information about a province or district, export of maps for use in other software application, and output printing.

How to use PRISMA

Figure 1 shows PRISMA's opening screen: the provincial map of Indonesia with an embedded overview map. The top of the screen has a drop-down menu for map disaggregation with submenus on *population*, *household,* and *characteristics*. Other features include GIS functions that allow users to view more detailed information about the selected area, zoom in and out, move the map around to review its perimeter (when zoomed in), revert to the original map size, and print.

Appendix Figure 6.1 **Introductory Screen of PRISMA**

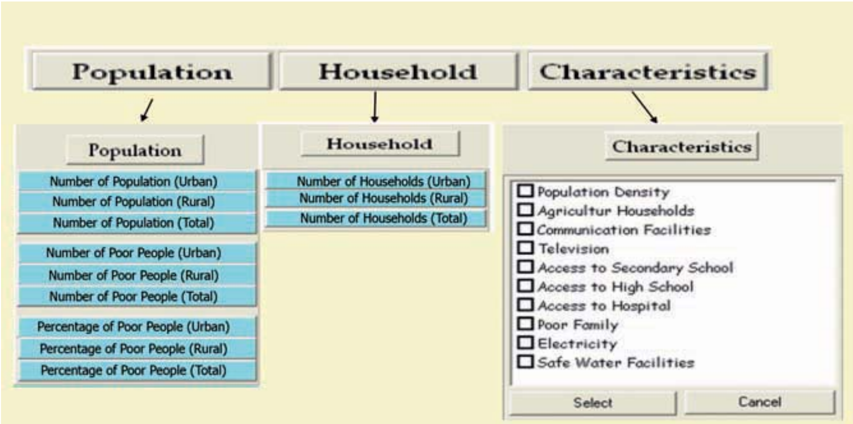
Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

Viewing Poverty Maps

To view spatial information in a map, users choose the level of administrative aggregation—national to district levels—from the drop-down menu. Specifically, users can choose a map of Indonesia with provincial or district data, and a map of a selected province with disaggregated information on districts.

To view poverty indicators of a province or district, choices are listed on the population and household menus, which can then be combined with indicators available on the characteristics menu. Appendix Figure 6.2 shows the detailed indicators available in each menu.

Appendix Figure 6.2 **Menu Bars for Population, Households, and Characteristics**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

The population menu contains spatial information on the sizes of populations and the number and percentage of poor people in rural and urban areas, and in total. The household menu shows the number of households in urban and rural areas, and in total. The characteristics menu provides information on the following indicators:

- Population density: number of people per square kilometer
- Agriculture households: percentage of households whose head's primary occupation is in agriculture
- Communication facilities: percentage of villages with communication facilities such as telephone and fax lines
- TVs: percentage of households with TV sets
- Access to secondary schools: percentage of villages with a secondary school located within its vicinity or at a radius of not more than 2.5 kilometers (km)
- Access to high schools: percentage of villages with a high school located within its vicinity or at a radius of not more than 2.5 km
- Access to hospitals: percentage of villages with a hospital located within its vicinity or at a radius of not more than 2.5 km
- Urban score: total score of the composite urban index for the village–the higher the value, the more urban the area
- Under-welfare family: percentage of households considered under-welfare based on the welfare classification developed by the National Coordinating Board for Family Planning
- Electricity: percentage of households with access to electricity

- Safe-water facilities: percentage of households with access to a water pipe or pump
- Distance to the center of the subdistrict: percentage of villages by distance to the center of the subdistrict office (subdistrict capital)

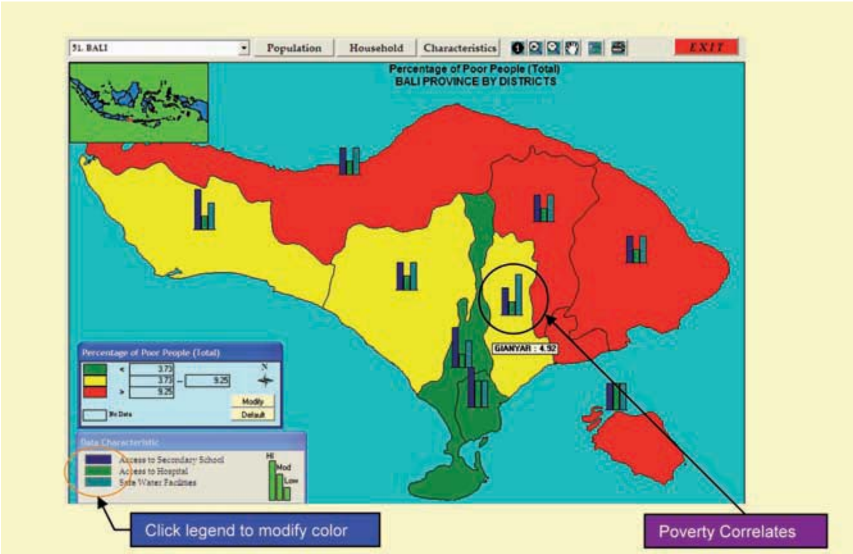
The characteristics menu cannot be activated, however, if the map chosen at the drop-down menu is *Indonesia by Provinces* or *Indonesia by Districts.* The indicators are not visible at these levels and cannot be visually presented in those maps. The combination of poverty indicators at the household or per capita level with other indicators available in the characteristics menu (described below) can only work on maps of individual provinces disaggregated by districts.

The population or household menu contains a poverty indicator theme presented in a three-colored map–using the traffic-light classification system of poverty indicators. Green areas connote the lowest magnitude or below-average poverty regions, yellow portrays regions with moderate or average poverty, and red represents the highest magnitude or above-average poverty regions. Regions with no color on the map indicate that there is no data available for that particular area.

The poverty indicator theme map can then be combined or overlaid with one or more other indicators available in the characteristics menu. This overlying system can be used to examine the association of poverty indicators with other indicators. These indicators will overlay the poverty indicator map theme with bar charts which indicate high, moderate, and low scales–as defined in a legend–of the selected indicators. Users can change the color, move, and even resize the legends to improve the presentation.

These features thus allow geographic targeting to be visually illustrated according to the information provided by the poverty mapping results, which can be enhanced by overlaying other indicators from other sources such as the Podes. Appendix Figure 6.3, for example, shows the percentage of poor people in urban and rural districts of Bali province using the traffic-light classification scheme of the poverty indicators as the spatial theme. Bar charts of access to secondary schools, hospitals, and safe-water facilities are overlaid on the district map. The result shows that poverty incidence seems to be concentrated in the northern part of the island. Access to safe-water facilities is relatively good and in one district, i.e., Gianyar, the access rate to safe-water facilities is even better than access to education.

Appendix Figure 6.3 **Poverty Indicators Based on the Traffic Light Classification System Overlaid with Bar Charts of Other Important Variables**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

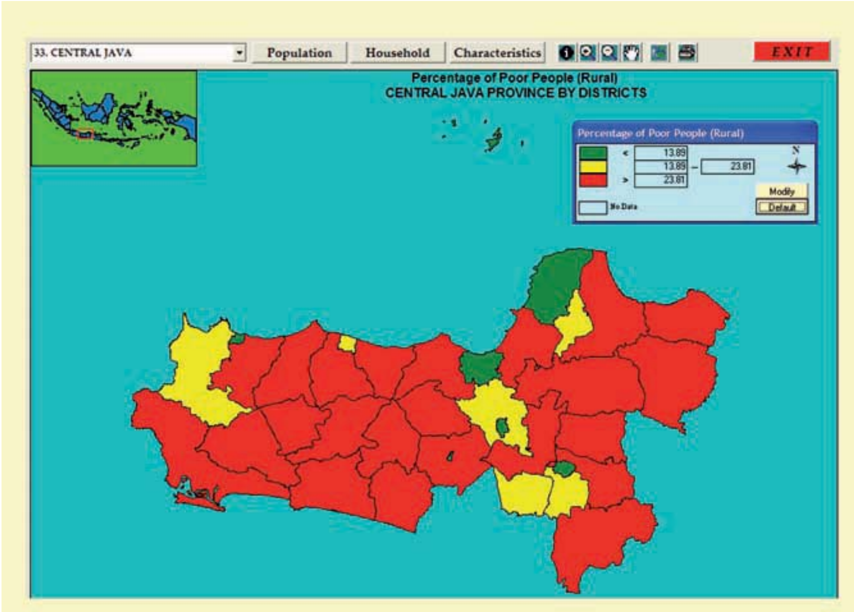
Modifying the Classification

The "default" settings for each specific subject in PRISMA are arbitrary, making PRISMA flexible and user-friendly. Aside from viewing the map, the user can also modify the default classification of the poverty condition by changing the legend of the traffic-light classification system. The user can alter the value in the interval of classification and click on *modify* to activate the change. The new cutoff points display a different level of grouping and automatically change the color distribution of the map. Clicking on *default* reverts the image to one showing the default upper or lower limit of the interval. Appendix Figure 6.4 and 6.5, for example, show the percentage of poor people in rural areas in Central Java. Appendix Figure 6.4 follows the default traffic-light color distribution, while Appendix Figure 6.5 displays a different color distribution after the yellow interval's upper limit was changed from 23.81 to 25 percent. This change increased the number of districts in yellow and diminished those in red.

Using the Information Icon

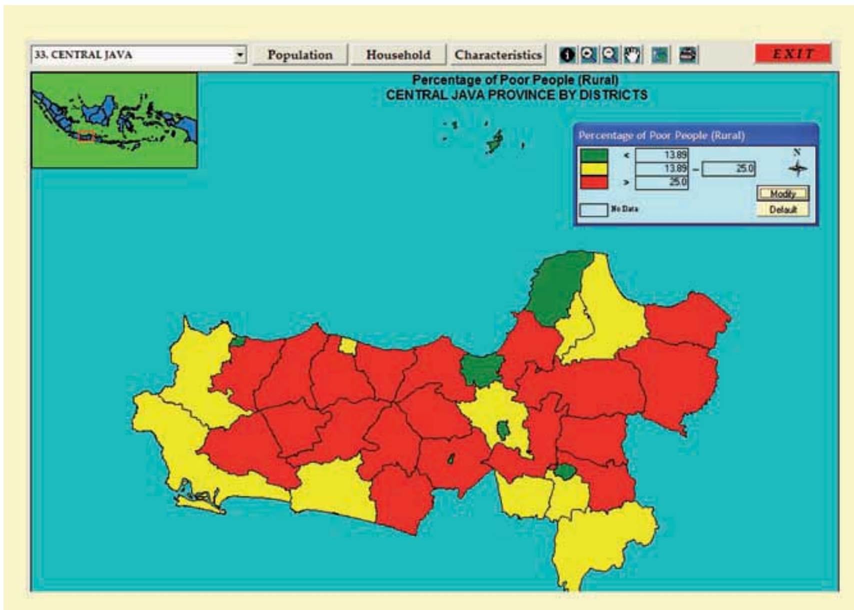
The information icon, , provides poverty details of an area. By pointing the cursor to the interactive map and clicking on an area of interest, a new window is displayed showing a statistical table and charts. The table presents

Appendix Figure 6.4 **Default Classification of the Poverty Incidence**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

Appendix Figure 6.5 **Modified Classifications of the Poverty Incidence**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

values of variables chosen from the population, household, and characteristics menus. These are the same variables on the menus of the introductory screen (the characteristics menu is not activated for the provincial level). The bar chart below the table shows the graphical distribution of the districts. Its theme depends on the variable chosen from the table above it, and the theme is implemented by clicking on the variable name.

The user can also create a graph of the variable of interest by clicking on the checkbox left of the variable name. The resulting graph appears on the table's right. The user can click on more than one variable to compare poverty statistics of the district or province under review.

There is also an option to either print the window in view or to go back to the main menu. The print option copies the table or graphs to a digital "clipboard" for pasting in other software applications as a picture object. In this way they can be printed on paper. (See Printing the Map below.)

As shown in Appendix Figure 6.6, by clicking on the Musi Banyu Asin district (where 27.22 percent of the total population is poor) in the map of South Sumatera (or Sumatera Selatan) province, a new window appears. The statistical table in the upper left of the new window shows the poverty characteristics of the district. The bar chart on the table's right shows that a low percentage of villages in Musi Banyu Asin have communication facilities but that a moderate percentage of households have TV sets. The chart in the lower portion shows that the Musi Banyu Asin district is only second among districts in Sumatera Selatan when it comes to under-welfare families, the highest is found in Ogar Komering Ilir, and the lowest is in Muara Enim.

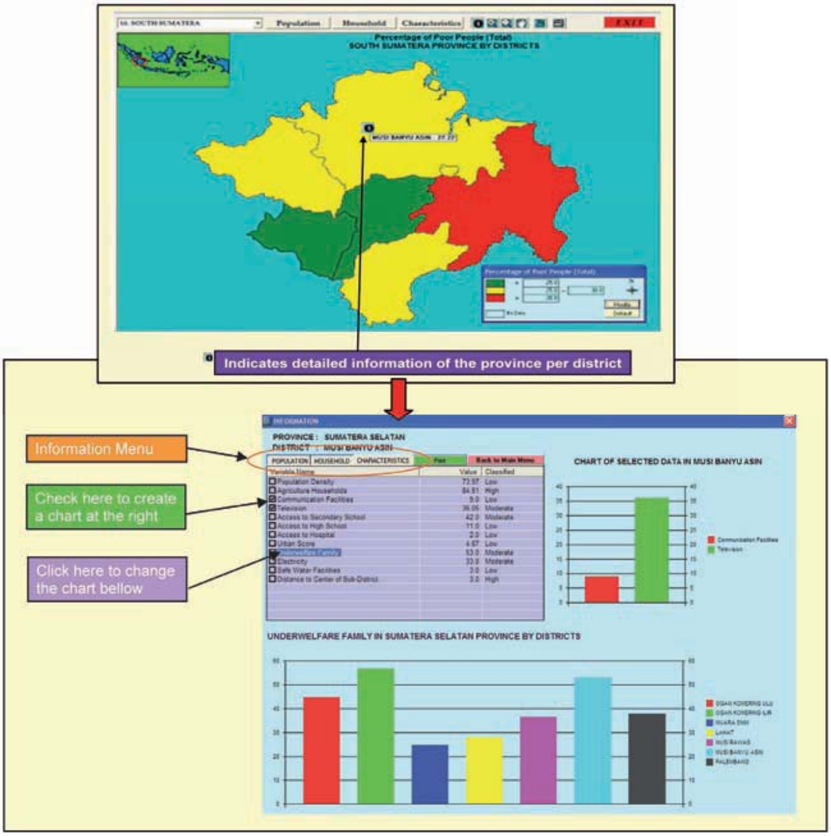
Other GIS Icons

Zooming In, *Zooming Out*, *Full Extent,* and *Pan Map* tools are used to change the magnification of the map. When the mouse is dragged to any side of the window, magnification increases (zooming in). Clicking any space on the map triggers zooming out. The Full Extent tool reverts the map to its original size. The Pan or Hand Map tool is used to move the map around to view its perimeter and is used only if the map is already zoomed in. Appendix Figure 6.7 shows, for example, by zooming in on a map of Southeast Sulawesi, the number of poor people in the rural areas of the province's Kendari and Muna districts is displayed.

Printing the Map

The print bar allows the user to change the layout of the map and use it in other computer applications. Appendix Figure 6.8 displays the map of Jakarta

Appendix Figure 6.6 **Displaying the Related Statistical Tables and Graphs Using the Information Window**



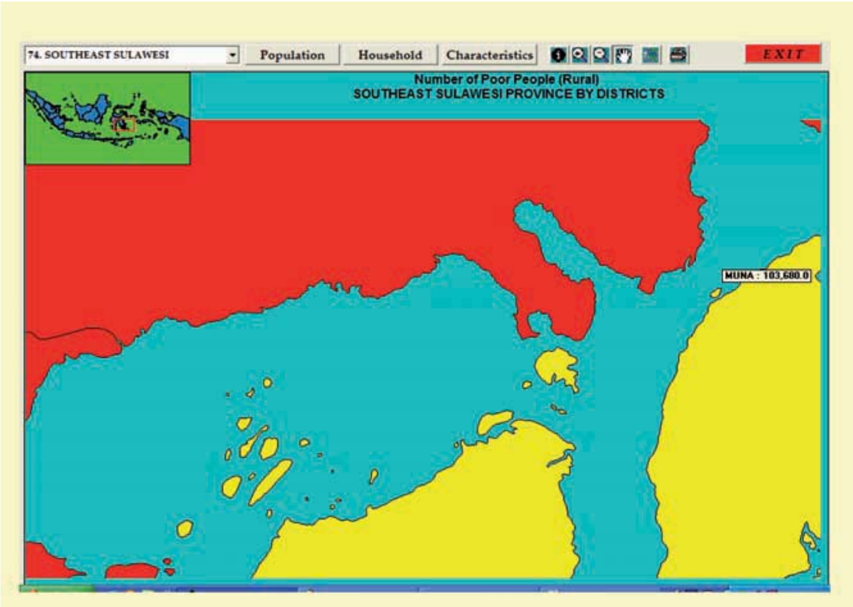
Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

province by districts in the print menu environment, indicating the number of households in urban areas. Here, the user can alter the default layout by changing the background color of the map, presence of the north-orientation graphic, traffic-light classification, and legend of chart or data characteristics. The user can also move the position of the map title and other parts of the map. When the layout is final, the user can view the output by clicking the *Preview* button.

The *Hint* button reveals guidelines or tips on how to correctly print the map. The following are statements found on this dialog box:

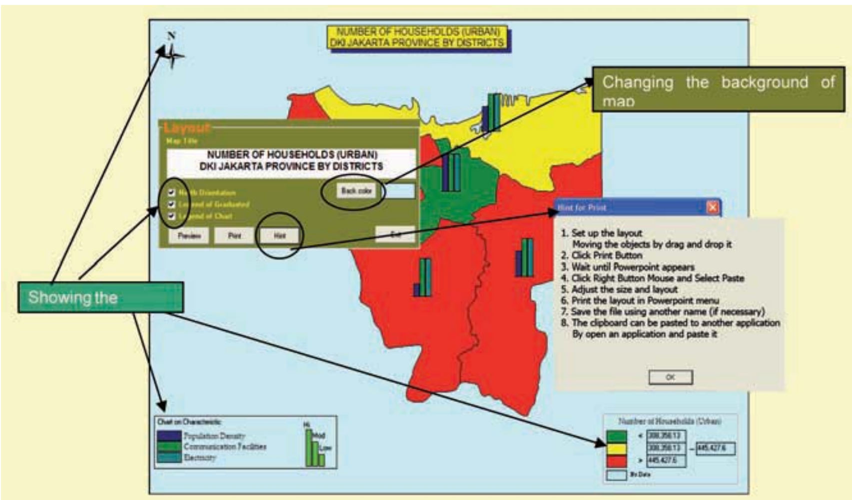
- Set up the layout. Move objects by dragging and dropping them–this changes the general appearance of the map.
- Click print button. This does not print out the map, rather, the map is copied onto the clipboard.

Appendix Figure 6.7 **Example of Zooming in a Map of Southeast Sulawesi to Enlarge a Picture**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

Appendix Figure 6.8 **Guidelines and Options to Make a Print Out**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

- Wait until PowerPoint appears. This opens an Microsoft (MS) PowerPoint application and retrieves a working file or loads a blank slide where the map can be affixed.
- Click right button of mouse and select Paste. This copies and pastes the map onto a PowerPoint slide.
- Adjust the size and layout. This corrects the size or crops the picture if needed.
- Print the layout from the PowerPoint menu. This prints the map.
- Save the file using another name (if necessary). This saves the file as a PowerPoint or graphic file.
- The clipboard can be pasted to another application by opening an application and pasting it. This allows the user to paste the picture on to the clipboard for use with other applications like MS Word.

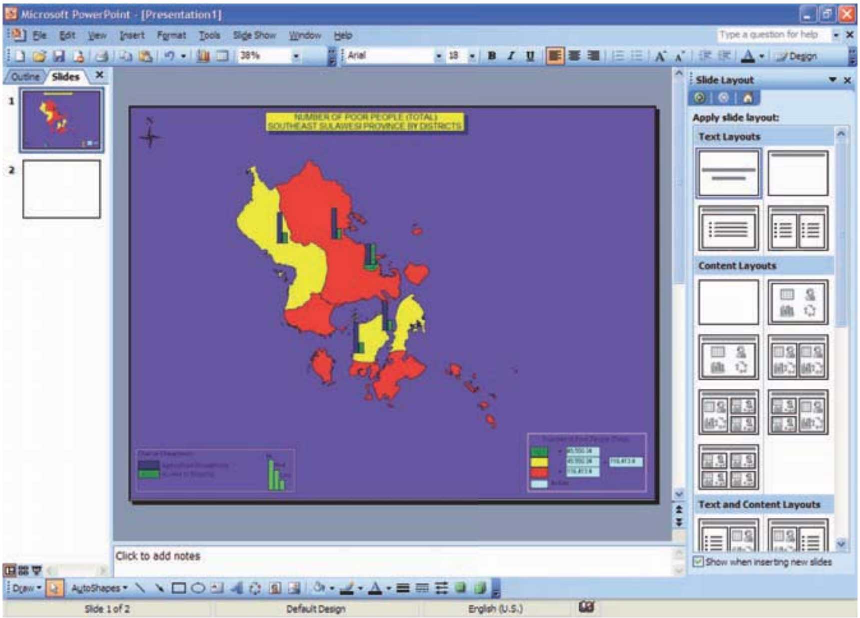
Using the Maps in Microsoft Applications

PRISMA allows maps to be used in MS applications using the processes described above or by using the computer's *Print Screen* function. Pressing the *Print Screen* (Prt Sc) key, copies the map currently on the screen to a clipboard from which the map can be copied (by going to Edit and selecting Paste) in MS PowerPoint, MS Word, and MS Excel. The maps can also be used with MS Publisher, MS Access, Paint, and WordPad.

Appendix Figure 6.9 shows the number of poor people in urban and rural areas in the districts Southeast Sulawesi, with an overlaid bar chart of the percentage of agriculture households and the percentage of villages with access to hospitals. The thematic map is transferred to the PowerPoint environment through the use of the print menu. Legends and the north-orientation sign are included. The figure shows that above-average poverty incidence is particularly observed in the eastern and southern part of the province. These areas have a high percentage of households whose heads' primary occupation is agriculture, showing a positive association with poverty. In addition, these areas, as well as those with average occurrence of poverty, have little access to hospitals. The only area where access to hospitals is not a major problem is the provincial capital, Kendari, where the number of poor is below average.

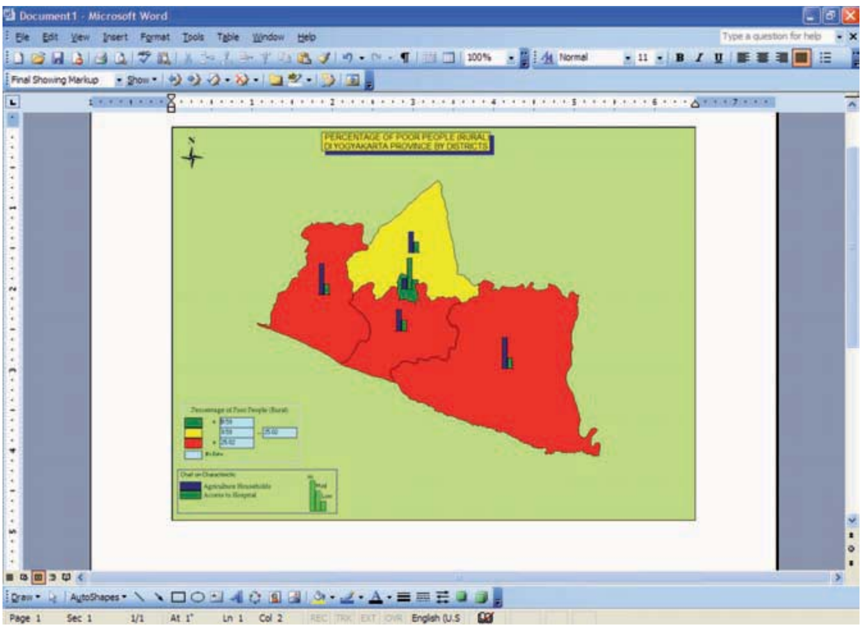
Appendix Figure 6.10 shows the percentage of poor people in rural areas in the districts of Yogyakarta. The map is also overlaid with the poverty characteristics of agricultural households and access to hospitals and is pasted as a picture on a Word document. The map shows high incidence of poverty throughout the province. Agricultural households are also prevalent in these areas and access to hospitals is a major consideration in these poor areas. The background of the picture has been altered and the legends moved to the lower left of the map to improve the presentation of this information.

Appendix Figure 6.9 **Exportation of a map from PRISMA to Microsoft PowerPoint**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

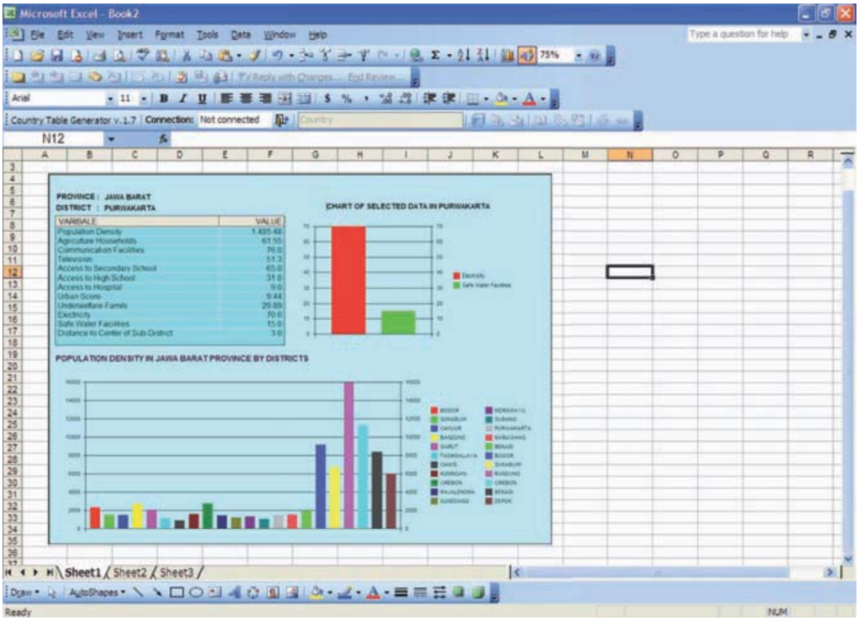
Appendix Figure 6.10 **Exportation of a Map from PRISMA to Microsoft Word**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

Maps and information charts can also be used in MS Excel. For example, Appendix Figure 6.11 is a map in Excel that contains an information table and charts pertaining to the district of Purwakarta in the province of Jawa Barat (West Java). The bar chart on the table's right shows that, in Purwakarta, a high percentage of households have access to electricity, but a low percentage have access to safe-water facilities. The bar chart below the table shows that the district is among those with the least dense population in West Java; the highest is Bandung, followed by Cirebon.

Appendix Figure 6.11 **Exportation of the Information Charts from PRISMA to Microsoft Excel**



Source: Poverty Reduction Information System for Monitoring and Analysis (PRISMA), 2005.

PART TWO

Applications of the CGE Modeling Framework for Poverty Impact Analysis

CHAPTER 7

Computable General Equilibrium Model: Can the Poor in Indonesia Benefit from Trade Liberalization?

Guntur Sugiyarto and Douglas H. Brooks

Introduction

The latest and ongoing round of trade negotiations under the World Trade Organization (WTO) has become commonly referred to as the Doha Development Agenda (DDA). It was set out in the WTO's Doha Ministerial Declaration in November 2001. Earlier trade negotiation rounds took place under the auspices of the General Agreement on Tariffs and Trade (GATT) but, since 1 January 1995, the WTO has been mandated to discuss international trade issues, including multilateral negotiations to create an open trade environment (Table 7.1). The WTO advocates global free trade to raise standards of living and promote greater employment with a large and steadily growing volume of real income and effective demand.[1]

Table 7.1 **Trade Negotiation Rounds**

Year	*Place/Name*	*Main Subjects*	*Countries*
1947	Geneva	Tariffs	23
1949	Annecy	Tariffs	13
1951	Torquay	Tariffs	38
1956	Geneva	Tariffs	26
1960–1961	Dillon Round	Tariffs	26
1964–1967	Kennedy Round	Tariffs and antidumping measures	62
1973–1979	Tokyo Round	Tariffs, nontariff measures "framework" agreement	102
1986–1994	Uruguay Round	Tariffs, nontariff measures, rules, services, intellectual property, dispute settlement, textiles, agriculture, creation of WTO, etc.	123
2001–present	Doha Development Agenda	Agriculture and services	148

Source: Authors' summary.

The Doha round of WTO negotiations was scheduled to be completed by the end of 2004. When it started in November 2001, members gave

1 WTO is an international trade organization complementing the Bretton Woods institutions of the International Monetary Fund (IMF) and World Bank that were started just after World War II. The 23 founding members of the GATT have expanded into the current 151 members of the WTO.

themselves 3 years to conclude their ambitious agreement to further liberalize trade in goods and services. The agreed emphasis was to help the poorest countries, and most of the benefits were expected to come through agricultural trade liberalization. By mid-2007, a deal was nowhere in sight. The delay is unfortunate but unsurprising, and even predictable given that no global trade round has stuck to its original schedule and that this round faces considerable challenges. The Uruguay Round launched in 1986, for instance, took almost 8 years to complete.

Protectionism is not a monopoly of developing countries, where various kinds of trade barriers are rife. In farm trade, for instance, developing countries have been yearning for better access for their products to developed-country markets, while keeping their domestic markets protected. Various agreements in WTO have achieved significant progress in reducing protection in manufactured products, but a reduction or removal of agricultural protection has been problematic. The existing forms and levels of protection result in a thin international commodity market with a relatively small trade volume and less active agents, making commodity trade flows and world prices volatile. As a result, successful agricultural trade liberalization is a crucial part of the DDA. Reduction in global agricultural trade barriers could improve overall welfare because it would lead to the expansion of markets and efficiency benefits, although the sectoral and distributional effects are difficult to predict beforehand.[2] Another major distortion comes from domestic agricultural and food policies, reflected in the wide gap between international and domestic prices of agricultural products.

The trade liberalization of agricultural products under the DDA is built on the long-term objective of the agreement to establish a fair and market-oriented trading system through a program of fundamental reform. The DDA calls for substantial reductions in trade-distorting domestic support and

2 International expansion of agricultural markets will make some sectors expand, while others contract. Depending on factor intensities of sectors, factor prices may either increase or decrease following the increasing or decreasing demand for the particular factor, including labor. This in turn will have different effects on different groups of households. Furthermore, factor demands will change, particularly for labor. These will further affect factor incomes of households. Since factor income is a major source of household income, and since household endowments vary considerably within a country, there will be winners as well as losers.

in all forms of export subsidies,[3] as well as improvements in market access. These are the three *pillars* in the agricultural trade liberalization discussions.[4] Potential gains from improvement in market access have been shown to be the most important among the three. Market access is the key to successful liberalization, for it could account for two thirds of the potential global gains and over half of the potential gains to developing countries (Hertel and Keeney 2005). Within the scope for market access, empirical studies have shown that agricultural market access is one of the most potentially significant issues on the DDA (Achterbosch et al. 2005).

Since the start of the Doha round in 2001, the scope for liberalization in agricultural trade has gradually declined. While the intention is clear, the mechanism to attain this goal is vague. This lack of clarity was the main reason for the failure of the trade ministerial meeting in Cancun in September 2003. Since then, developing countries have argued that future progress in negotiations will only be possible with commitments from developed countries to significantly reduce their import barriers and agricultural subsidies, including subsidies on cotton.[5] Fortunately, the consultations in July 2004 resulted in more optimism for DDA success (see footnote 3 below).

The July 2004 package revealed, however, that WTO members agreed on far-reaching exemptions from reforms in individual products (special products for developing countries and sensitive products for developed

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3 Export subsidies have received much criticism from academics and policymakers and are widely believed to be among the most trade-distorting forms of policies. The issue has received high priority in the current Doha round of negotiations. Between the kick-off of the round with the Doha ministerial declaration (WTO 2001) and the general council decision of July 2004 (WTO 2004), the wording on export subsidies changed from "…reductions of, with a view of phasing out ..." to a much more ambitious "… ensuring the parallel elimination of all forms of export subsidies." This signals a broad consensus that export subsidies will have to disappear over time. Export subsidies are generally a consequence of domestic policy arrangements that aim at stabilizing and increasing domestic prices in agriculture. The European Union's (EU) Common Agricultural Policy (CAP) provides a case in point. The CAP initially shielded the EU from imports through prohibitive tariffs, allowing the successful implementation of domestic market policies, which subsequently led to excess supply in key commodities. This excess supply had to be removed from the EU market in order to maintain high domestic prices, and this eventually required a disposal of surpluses on world markets at subsidized prices.

4 Domestic support concerns commitments to reduce trade-distorting farm income policies. Export competition concerns the promotion of agricultural exports through direct subsidies, export credits, and subsidy elements in food aid and state trading enterprises, and market access concerns reductions in tariffs and tariff rate quotas.

5 The Special Session of the Committee on Agriculture also aims to ensure appropriate prioritization of the cotton issue independently from other sectoral initiatives, given the importance of this product for some countries.

countries). The ambition to reform domestic support in developed countries has become more moderate and a number of developing countries have become less inclined to open their markets through improved access.

Topics of negotiations for agriculture-sector liberalization in the WTO Ministerial Meeting held in Hong Kong, China, in December 2005 touched on the three core areas of the DDA, namely, domestic support, export competition, and market access. On domestic support, reduction commitments–expressed in Aggregate Measure of Support–is classified into three bands. The European Union will be in the top band, facing the highest linear tariff cuts, the United States and Japan in the middle, and everyone else in the bottom band. Notably, the text specifies that overall cuts in trade-distorting domestic support must at least be equal to or more than the sum of the reductions in *amber-box*, *blue-box,* and *de minimis* (minimal) support. All domestic support measures considered to distort production and trade fall into the amber box, except those in the blue and green boxes which include measures to support prices or subsidies to production (permitted subsidies) that are, however, subject to limits. The *de minimis* supports are allowed up to 5 percent of agricultural production for developed countries and 10 percent for developing countries. Green-box subsidies must not distort trade or, at most, cause minimal distortion. They have to be government-funded, that is, not by charging consumers with higher prices, and must not involve price support. The blue box, on the other hand, is an "amber box with conditions" designed to reduce distortion as subsidies are commonly tied to programs that limit production. Any support that would normally be in the amber box, is placed in the blue box if the support also requires farmers to limit their production.

For export competition, the deadline for the parallel elimination of all forms of export subsidies including food aid, subsidized export credit and insurance, and trading by state enterprises is set for the end of 2013. A substantial part of the elimination is to be realized by the end of the first half of the implementation period. The deadline is, however, tentative–pending the resolution of core modalities, that is, the formula for cutting tariffs and subsidies. There is a clear convergence on a number of elements of disciplines with respect to export credits, export credit guarantees, or insurance programs with repayment periods of 180 days and below.

In the improving market access issue, tariffs reduction within four bands has been structured, ranging from low to high, with a provision that tariffs in the higher band will be subject to deeper cuts. This amounts to the acceptance of a nonlinear approach to agriculture tariff reduction advocated by developed countries.

A series of meetings has been conducted following the WTO meeting in Hong Kong, China, with the main purpose of converging on the drafting and finalization of modalities. Unfortunately, agreements have not been achieved.

For an individual country, the DDA relates directly to the domestic system of protection reflected in (among others) commodity taxation[6] and industrial policy. Subsidies and import tariffs, for instance, are usually employed to protect domestic industry. Accordingly, the DDA can be thought of as part of efforts to make the tax system less distorting, more transparent, and therefore more amenable to the administrative capacity of developing countries. This has been a main reason for past tax reforms (Rao 1993, World Bank 1991a).[7]

As a major agricultural importer and exporter, Indonesia is actively participating in the negotiation process. It has a major stake in global efforts to liberalize agricultural trade. However, given the prevailing, quite liberal, trade regime in Indonesia, the expected overall impacts on national income, trade, and production could be limited. Agricultural liberalization offers

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6 Two important aspects of a tax system are the level and structure of taxation. In developing countries, the level of taxation (measured by its share in gross domestic product) varies widely and relates not only to per capita income but also to other factors. On the structure of taxation, the incidence of indirect tax becomes increasingly important, while that of personal income and other direct taxes remains very low. The indirect tax is also characterized by substitution between taxes on international trade and domestic indirect taxes as the economy develops. The role of international trade taxes is usually very important in the early stages of development, but then becomes substituted by domestic indirect taxes. In developing countries, revenue from indirect taxes constitutes on average almost 60 percent of total tax revenue, while the share of personal income taxes remains very small (Rao 1993).

7 Important issues associated with tax reforms in developing countries include how tax (government) revenue is going to be raised and what the consequences of the different options are. This should be perceived in the context of existing government subsidies, import tariffs, and other taxation measures that also reflect domestic protection. A best practice approach to tax reforms includes replacing quantitative restrictions with tariffs, simplifying the tax structure, broadening the tax base, levying lower and uniform tax rates, and exempting taxes on intermediate inputs. A removal of quantitative restrictions avoids rent-seeking activities; a simpler tax structure is easier to administer; a broader tax base yields larger revenues; a lower and uniform tax rate reduces unintended distortions (besides also being easier to administer); and an exemption on intermediate input taxes may encourage domestic production. The best approach to successful tax reform seems to be a pragmatic combination of theory and past reform experience, taking into account administrative, political, and information constraints. "Good" tax reform does not merely change the existing tax system but also includes tax administration and acceptability. These can be the keys to success in tax reform (Bird 1992, Bird and Oldman 1990). Timing and sequencing are also important in designing tax reform. Most successful tax reforms (Japan in 1949/50, Korea in 1962–1965, and Indonesia in 1983–1986) were carried out at a later stage as an integral part of economic reforms (Rao 1993).

positive prospects for externally demanded goods, such as vegetable oils and animal products, while small adverse impacts on the protected rice and sugar sectors can be expected.

Main Purpose

Several important questions arise from the discussion above. First, is there any justifiable reason for agricultural protection in developing countries such as Indonesia? Second, what would be the effects of farm trade liberalization such as what might result from the DDA? Furthermore, as most farm producers are poor farmers, to what extent would the poor benefit from the DDA? Finally, would simultaneous liberalization in other sectors alter the welfare implications of agricultural trade liberalization?

A computable general equilibrium (CGE) model of the Indonesian economy based on the social accounting matrix (SAM) in 1993[8] was developed to answer these important questions by assessing the economy-wide, welfare, and distributional implications of Doha scenarios, especially with respect to different groups of households. The assessment included welfare costs of existing sectoral taxation to view agricultural protection in a broader context. Trade liberalization scenarios were introduced to illuminate the benefits and costs of trade liberalization as in the DDA. This included a complete removal of tariffs on agricultural products, which was then combined with a complete removal of counterpart domestic taxes on agricultural products. The former was to represent a case of complete international access while the latter was to capture the far reaching globalization of agricultural markets. Finally, a full trade liberalization scenario covering all sectors was used to place agricultural liberalization in the broader DDA context.

The next section of this paper provides an overview of Indonesian trade liberalization policies, first highlighting the major developments of Indonesia's foreign trade policy, and then as linked with the DDA. This is followed by a discussion of the main features of the Indonesian CGE model developed in this study. The modeling development itself is presented in Appendix 7.1. The model is then used to measure the welfare costs of existing commodity taxation and marginal excess burden. The former is to assess the sectoral welfare costs due to the commodity taxation imposed, while the latter is to determine if a sector or product is already overtaxed. Effects of removing tariffs on agricultural products are then examined, and combined

8 A more recent SAM has been compiled, but as it still reflects disruptions resulting from the 1997 Asian financial crisis, the 1993 SAM could be more representative of long-term trends in the economy. Real GDP estimates for Indonesia are also based on 1993 data.

with the removal of corresponding domestic taxation. The economic effects and distributional implications of these two policy options, as well as full liberalization, are examined in the last section, which includes conclusions and policy implications.

Trade Liberalization and the Doha Agenda in the Indonesian Context

During the first two decades following Indonesia's independence in 1945, trade taxes continued to be the main source of government revenue, leading to the imposition of devices such as multiple exchange rates and export surcharges. The adoption of a *guided economy* approach at that time led to the government expanding controls over the means of productions by nationalizing foreign companies and introducing various quantitative restrictions. On the fiscal side, it was common for the government to print money to finance its budget deficits. Since 1967, the new government has adopted a "balanced budget"[9] policy, preventing the government from printing money or issuing debt securities to finance its deficits, relying instead on foreign funds to balance the budget. At the same time, the capital account was opened, allowing the private sector to gain access to foreign funds.

In the early 1980s, Indonesia experienced a sharp deterioration in its terms of trade and balance of payments from declining world prices for oil and primary commodities, rising international interest rates, and decreasing foreign capital inflows.[10] These external shocks seriously disrupted development plans and induced extensive structural adjustments. The adjustments were first aimed at restoring external creditworthiness, but then led to changes in the government's development strategy from being public sector–led with an import-substitution industry and repressed financial sector to being private sector–led and export-oriented with a market-based financial sector. The adjustments were also adopted to reduce distortionary threats arising from expansionary policies inherited from the previous oil-boom decade.[11]

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9 This "balanced budget" reflects a political meaning since foreign aid and loans for development are counted as government revenue rather than sources of financing.

10 These external shocks severely hit most highly indebted countries, which then led to the international debt crisis in 1982.

11 Oil prices in world markets increased in 1973/74 and 1978/79, bringing a substantial increase in government revenue. This oil boom, however, led to the over allocation of domestic resources to the booming sector. This "Dutch Disease" phenomenon was then accompanied by overoptimistic predictions of oil prices from the government side. This seriously affected government-planned expenditures since more than two thirds of government revenues at that time were from oil.

These voluntary structural adjustments[12] proved successful in restoring the external situation and providing more favorable conditions for the domestic economy. The policy measures taken included massive devaluations, tax reforms, and trade liberalization. Table 7.2 summarizes trade liberalization measures adopted by the Indonesian government since 1945 (the year of independence) up to the present, classified into six stages to reflect the different government policies in those times.

Despite progress, some problems remain. The government has been reluctant to implement economic reforms as most major policy changes in Indonesia have traditionally been linked to major political and economic crises. It seems that only a crisis can be counted on to trigger the necessary political will to embark on economic reform. Furthermore, most of the changes have also been generated by a fall in petroleum prices or other external problems, such as in the balance of payments. Policy reforms in Indonesia can therefore be thought of as an overall restructuring strategy in response to external factors rather than being motivated by the benefits of economic reform (Pangestu 1996, Hill 1996). In many instances, trade and industrial policy reverted to protectionism and hence became distortionary once problems in the external sector were resolved. As a result, export earnings and government revenue are still highly vulnerable to changes in prices of oil and primary commodities in world markets. Progress on removing the existing barriers and other distortions in domestic markets has neither been very successful nor straightforward.[13]

A further examination of government sources of income reveals that, over the period 1985–1993, the government was becoming increasingly reliant on commodity taxation (see Table 7.3). Revenue from these taxes contributed 15 percent of government income in 1985, which then doubled to 30 percent in 1990, and increased further to 36 percent by 1993. More than a quarter of that revenue was derived from import tariffs, implying that foreign trade policies became more protectionist while domestic industry was increasingly distorted. Revenue from tariffs on agricultural products contributed less than 1 percent of government income, making a good case for agricultural product trade liberalization. The role of domestic commodity taxation on agricultural products in generating government revenue was more significant, although it declined from 6.2 percent in 1985 to 2.7 percent in 1993 (Table 7.4). Detailed information on the structure and level of commodity taxation

12 As distinguished from structural adjustments conducted as part of conditional loans provided by the IMF and the World Bank.

13 Up to mid-July 1997 (just before the crisis started), for example, both price and nonprice controls were still prevalent, especially on transport services, public utilities, fuel products, and other basic and strategic commodities.

Table 7.2 **Summary of Trade Liberalization Measures Adopted by the Indonesian Government, 1945–2007**

Trade Liberalization Measures Adopted in Each Period					
The Chaotic Years (1945–1965)	*Stabilization and Rehabilitation (1966–1973)*	*The Oil Windfalls and Boom Years (1974–1981)*	*Adjustment to External Shocks (1982–1984)*	*Further Trade Liberalization (1985-mid–1997)*	*The Economic Crisis and Beyond (1997–to date)*
• High inflation and frequent economic policy/government changes • Dominant role of taxation on trade • Multiple exchange rates, export surcharges, quantitative restrictions on imports and tariffs	• New investment law, development plan and balanced budget • Abolition of multiple exchange rates and peg to US dollar • Adoption of an open capital account	• Dominant role of oil • Nontradable and import-substituting industry • Dutch disease • Ignoring trade liberalization • More protective	• International debt and Mexico crises • Tax and financial reforms • Export promoting measure (TRIMs) • “Approved” importer system • Promoting use of domestic products • Ambivalence toward trade liberalization	• Regionalism of AFTA & APEC • Signing of GATT Code (on subsidies and countervailing duties) • Rationalization tariffs • Deregulation of shipping and custom unions • Duty exemption and duty drawback • Removal of export licenses and converting quota restrictions with tariffs	• The Asian Crisis and IMF package • Further reductions of tariffs • Abolition of export taxes and import restrictions • Liberalization of domestic markets • Post IMF era and new government’s commitments to reduce more tariffs and nontariff barriers

Source: Authors’ summary.

presented in Tables 7.5 and 7.6 further reveals that not only did the tax rate increase, but so did its dispersion. Increased taxation was applied to both domestic commodities and imports. Note that all taxes and tariffs as well as their dispersion increased over the periods of 1985–1990, 1990–1993, and 1985–1993, except for import tariff dispersion from 1985 to 1990.

Further trade liberalization seems inevitable given the Indonesian government's commitments to the WTO, Asia-Pacific Economic Co-operation (APEC) forum, and Association of South East Asian Nations (ASEAN) to move toward freer international trade. Moreover, tariff reduction, in conjunction with other measures, such as domestic tax reform and the replacement of quantitative restrictions by tariffs, has also been part of the policy package of International Monetary Fund–World Bank conditional loans made to the Indonesian government in the past. The DDA is likely to strengthen trade liberalization in the form of further reductions in tariff and nontariff barriers and all kinds of domestic support such as export subsidies. Foreign or border trade liberalization is likely to be followed by domestic market liberalization,

Table 7.3 **Government Income by Source**

	1985		*1990*		*1993*	
Source of Income	*Value (billion Rp)*	*Share (%)*	*Value (billion Rp)*	*Share (%)*	*Value (billion Rp)*	*Share (%)*
Factor Income/Capital payments	66.9	0.4	1937.8	4.7	4249.8	6.9
Taxation on						
• Households	1817.7	9.7	1997.8	4.8	3848.4	6.2
• Firms/Corporate	13998.3	74.9	24845.3	59.9	31014.8	50.1
• Commodity/Sector	2789.9	14.9	12269.4	29.6	22355.8	36.1
- Domestic	2029.2	10.9	9204.5	22.2	15963.7	25.8
- Import Tariff	760.6	4.1	3064.9	7.4	6392.1	10.3
Rest of the world	29.7	0.2	464.9	1.1	398.5	0.6
Total	18702.4	100.0	41515.2	100.0	61867.2	100.0

Rp = rupiah
Sources: Calculated from the Indonesian SAMs for 1985, 1990, and 1993.

Table 7.4 **Government Revenue from Commodity Taxation (billion Rp)**

Commodity/ Taxation	*1985*		*1990*		*1993*	
	Revenue	*%*	*Revenue*	*%*	*Revenue*	*%*
Agriculture	173.04	6.2	401.34	3.3	610.23	2.7
Nonagriculture	1856.18	66.5	8803.16	71.7	15353.42	68.7
Subtotal	2029.22	72.7	9204.5	75.0	15963.65	71.4
Import Tariff						
Agriculture	13.54	0.5	17.11	0.1	102.98	0.5
Nonagriculture	747.09	26.8	3047.83	24.8	6289.12	28.1
Subtotal	760.63	27.3	3064.94	25.0	6392.1	28.6
Total	2789.85	100.0	12269.44	100.0	22355.75	100.0

Rp = rupiah
Sources: Calculated from the Indonesian SAMs for 1985, 1990, and 1993.

Table 7.5 **Structure and Level of Indirect Commodity Taxation in Indonesia in 1985, 1990, and 1993**

Sector/Commodity	*1985*			*1990*			*1993*			*Change in Tax Rate (%)*		
	Domestic Commodities (billion Rp)	*Revenue (billion Rp)*	*Tax Rate (%)*	*Domestic Commodities (billion Rp)*	*Revenue (billion Rp)*	*Tax Rate (%)*	*Domestic Commodities (billion Rp)*	*Revenue (billion Rp)*	*Tax Rate (%)*	*1985–1990*	*1990–1993*	*1985–1993*
Food Crops	14511.83	97.99	0.68	28510.70	201.23	0.71	35644.84	250.83	0.70	0.03	0.00	0.03
Other Agriculture	13861.25	75.05	0.54	24273.88	200.11	0.82	40866.67	359.40	0.88	0.28	0.06	0.34
Mining	16706.27	20.94	0.13	28375.57	244.44	0.86	35429.98	319.89	0.90	0.74	0.04	0.78
Food Processing	15837.01	677.36	4.28	35298.07	2964.19	8.40	63452.83	6208.18	9.78	4.12	1.39	5.51
Textile	3403.43	32.16	0.94	47156.23	781.87	1.66	80964.10	1363.63	1.68	0.71	0.03	0.74
Construction	20188.33	273.03	1.35	13984.44	191.44	1.37	20336.52	277.75	1.37	0.02	0.00	0.01
Paper and Metals	6504.99	130.84	2.01	20962.82	736.22	3.51	32990.27	1164.09	3.53	1.50	0.02	1.52
Chemicals	19385.74	-682.93	-3.52	40365.52	-484.28	-1.20	61641.10	-771.36	-1.25	2.32	-0.05	2.27
Utilities	1801.91	0.71	0.04	4487.62	19.42	0.43	8252.97	42.92	0.52	0.39	0.09	0.48
Trade	14319.47	877.31	6.13	30874.61	2505.63	8.12	54570.79	3769.46	6.91	1.99	-1.21	0.78
Restaurants	4688.90	135.92	2.90	12028.01	521.78	4.34	18428.32	799.43	4.34	1.44	0.00	1.44
Hotels	933.91	34.82	3.73	2146.18	91.42	4.26	3452.16	147.04	4.26	0.53	0.00	0.53
Land Transport	5614.39	67.12	1.20	11017.22	180.55	1.64	18835.54	313.18	1.66	0.44	0.02	0.47
Other Transport and Communications	3124.32	11.65	0.37	8892.87	74.13	0.83	17047.07	125.76	0.74	0.46	-0.10	0.36
Banking and Insurance	3102.45	17.48	0.56	11420.34	96.69	0.85	19394.18	161.07	0.83	0.28	-0.02	0.27
Real Estate	4831.42	147.71	3.06	9476.41	457.16	4.82	17239.76	802.90	4.66	1.77	-0.17	1.60
Public Services	10547.63	44.58	0.42	18347.00	194.38	1.06	26128.04	304.26	1.16	0.64	0.11	0.74
Personal Services	5030.62	67.48	1.34	11497.83	228.12	1.98	16939.40	325.22	1.92	0.64	-0.06	0.58
Total	*164393.90*	*2029.22*	*1.23*	*359115.30*	*9204.50*	*2.56*	*571614.50*	*15963.65*	*2.79*	*1.33*	*0.23*	*1.56*
Standard deviation			2.08			2.62			2.68			

Sources: Calculated from the Indonesian SAMs for 1985, 1990, and 1993.

reflected in reductions in commodity taxation in the domestic market. This is to make domestically produced goods competitive with imported products. The liberalization of both international and domestic markets for agricultural products is also in line with the DDA on improving market access "behind the border." This liberalization is captured in the modeling simulation.

Main Features of the Model

The CGE model was developed using the Indonesian SAM for 1993. The economy concerned is an open economy, with transactions between the domestic economy and the rest of the world (ROW) in the product (i.e., export and import) markets, factor markets, and capital markets. Production activities are classified into 18 categories, and the commonly used assumption that one sector produces only one good is adopted, so that classifications for sectors and commodities are exactly the same. Each production activity is modeled as a Leontief production function of intermediate inputs and value added. The intermediate input is an Armington aggregation of domestically produced and imported commodities, while the value added is a Cobb-Douglas function of different kinds of labor and capital. Labor is categorized into 8 groups, based on a combination of sector, type of workers, and job status. Some wages (for farmers and production workers) are fixed–allowing for unemployment–to reflect excess supply and various government interventions to control their wages. Wages for other types of workers are allowed to adjust according to their market-clearing levels, which also reflect the marginal productivity of labor. On the capital side, capital is classified into 5 categories based on ownership and the nature of capital.

Households are classified into ten groups, based on a combination of income sources, area of residence, and job status of the head of household (Table 7.7). First, households are divided into agricultural and nonagricultural households. The former is then split into landless employee farmers, small farmers (land size <0.5 hectare), medium farmers (between 0.5 and 1.0 hectare) and large farmers (>1.0 hectare). For the nonfarmers, the disaggregation is based on area of residence (urban and rural), level of income, and a combination of occupation and job status. Based on these variables, the nonfarmers in each area are then classified into low, dependent,[14] and high-income groups. As can be seen, the household classification has been developed based on "real" variables that can easily be identified for policy targeting, which is common in the development of a SAM. Other institutions in the economy are firms, government, and the ROW. Figure 7.1 shows that in terms of per capita income, landless farmers (agricultural employees) and small farmers are among the poorest groups. Their income level is less than one fourth

14 The dependent household group refers to households where the head of the household is not in the labor force, relying instead on income transfers from profit and rental income, relatives, friends, and government.

Table 7.6 **Structure and Level of Import Tariffs in Indonesia in 1985, 1990, and 1993**

Sector/Commodity	*1985*			*1990*			*1993*			*Change in Tariff Rate (%)*		
	Import (billion Rp)	*Revenue (billion Rp)*	*Tariff Rate (%)*	*Imports (billion Rp)*	*Revenue (billion Rp)*	*Tariff Rate (%)*	*Imports (billion Rp)*	*Revenue (billion Rp)*	*Tariff Rate (%)*	*1985–1990*	*1990–1993*	*1985–1993*
Food Crops	421.97	6.92	1.64	632.82	16.26	2.57	1425.18	55.47	3.89	0.93	1.32	2.25
Other Agriculture	391.38	6.62	1.69	198.82	0.85	0.43	449.85	47.51	10.56	-1.26	10.13	8.87
Mining	1157.49	9.53	0.82	2567.25	3.59	0.14	2414.61	38.47	1.59	-0.68	1.45	0.77
Food Processing	211.57	17.86	8.44	1302.65	24.58	1.89	2614.25	310.47	11.88	-6.55	9.99	3.43
Textiles	148.82	15.04	10.11	37.77	1.34	3.55	87.37	20.06	22.96	-6.56	19.41	12.85
Construction	3.53	0.57	16.15	2599.68	226.98	8.73	4901.88	278.18	5.67	-7.42	-3.06	-10.47
Paper and Metals	6393.00	505.20	7.90	23330.13	2202.88	9.44	34970.91	3359.83	9.61	1.54	0.17	1.71
Chemicals	3797.24	195.73	5.15	12317.40	575.91	4.68	18873.12	2242.40	11.88	-0.48	7.21	6.73
Public Services	717.54	0.58	0.08	1587.09	0.07	0.00	2867.21	0.71	0.02	-0.08	0.02	-0.06
Personal Services	246.38	2.48	1.01	964.61	12.46	1.29	1796.20	39.00	2.17	0.29	0.88	1.16
Total	*13488.92*	*760.53*	*5.64*	*45538.22*	*3064.92*	*6.73*	*70400.58*	*6392.10*	*9.08*	*1.09*	*2.35*	*3.44*
Standard deviation (%)			5.27			3.41			6.86			

Sources: Calculated from the Indonesian SAMs for 1985, 1990, and 1993.

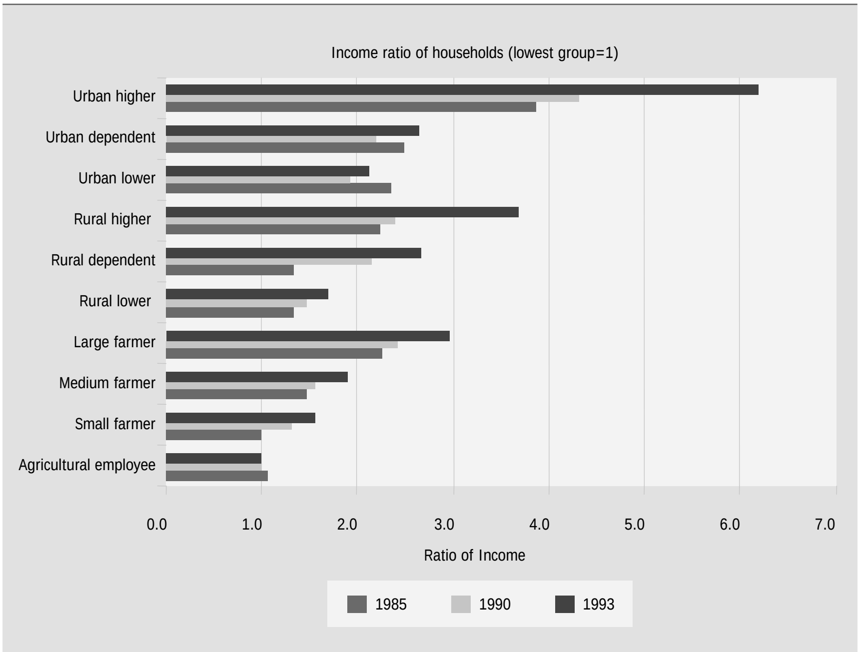
that of the nonagricultural high–income group in urban areas (urban higher). Another group that is relatively poor is the nonfarmer low–income group in rural areas (rural lower). These three groups of poor households, which constitute around 45 percent of total households, are the most important focus in the examination of the poverty impact of the DDA (see Table 7.7 for details).

Table 7.7 **Number of Households by Type and Annual Per Capita Income in 1985, 1990, and 1993**

Types of Household	*1985*			*1990*			*1993*		
	Number (million)	*(%)*	*Income (000 Rp)*	*Number (million)*	*(%)*	*Income (000 Rp)*	*Number (million)*	*(%)*	*Income (000 Rp)*
Agricultural employee	11.5	7.01	255.1	15.7	8.7	441.5	18.7	10.0	508.0
Small farmer	39.1	23.8	242.1	49.7	27.6	575.1	51.3	27.4	798.1
Medium farmer	13.1	8.0	358.9	11.2	6.2	692.5	11.6	6.2	960.1
Large farmer	15.9	9.7	548.6	11.6	6.5	1065.2	12.0	6.4	1507.0
Rural lower	21.9	13.4	323.6	16.2	9.0	650.5	16.6	8.9	862.3
Rural dependent	8.4	5.1	322.3	2.8	1.6	946.3	2.9	1.6	1350.0
Rural higher	13.4	8.2	538.0	23.7	13.2	1061.7	24.3	13.0	1878.3
Urban lower	20.7	12.6	572.1	22.7	12.6	844.9	23.3	12.4	1081.6
Urban dependent	6.3	3.8	600.1	4.7	2.6	967.3	4.8	2.6	1344.7
Urban higher	13.8	8.4	935.3	21.5	12.0	1899.8	22.1	11.8	3138.5
Total	*164.1*	*100.0*	*438.3*	*179.8*	*100.0*	*881.8*	*187.6*	*100.0*	*1303.6*

Sources: Calculated from the Indonesian SAMs for 1985, 1990, and 1993.

Figure 7.1 **Ratios of Income of Different Types of Households: 1985–1993**



Source: Calculated from the Indonesian SAMs for 1985, 1990, and 1993.

Armington specification is employed to introduce imperfect substitutability characteristics between domestically produced and imported commodities. This feature is especially important for trade policy issues, as the assumption of perfect substitutability would systematically exaggerate the power that trade policy has over the domestic price system and economic structure. The assumption of perfect substitutability would also rule out the possibility of two-way trade of the same commodity group. On the other hand, treatment of domestically produced and imported commodities as perfect complements would introduce a great deal of rigidity, because it would imply a tendency toward a high degree of specialization, which mostly contradicts the facts. In this case, trade policy–induced changes in relative prices, such as changes in the exchange rate, would have no direct effect on the structure of the economy. This would create a foreign exchange gap that could not be alleviated by trade and exchange rate policies (Dervis, de Melo, and Robinson 1982).[15]

Production is specified as two-level nesting of Leontief and Cobb-Douglas functions and total production is allocated to domestic demand and exports. On the import side, the "small-country" assumption is adopted, meaning that the domestic economy is a price taker for imports. The final demand in the domestic economy consists of household consumption, government consumption, and investment. Households maximize Cobb-Douglas utility functions, while the government is assumed to have planned consumption, which is not affected by commodity prices or the government's income. Government saving is, accordingly, residual. The government (and domestic firms) also has access to foreign borrowing for balancing its budget. Consistent with the government consumption behavior, aggregate investment is fixed, reflecting the "investment-driven" nature of the economy.

Since it is impossible to determine absolute price levels in a general equilibrium model, it is necessary, therefore, to establish relative prices by setting one price as the numeraire. If the model is going to be used as a tool of policy analyses and formulation: "...it is best to use a price-normalization rule that provides a 'no-inflation' benchmark against which all price changes are relative price changes" (Shoven and Whalley 1992). In this model, the price of the ROW account is used as a numeraire. Accordingly, all prices will be measured relative to the "world price" (the price of the ROW account measured in domestic currency) and the domestic price level then appears based on a real foundation (Drud, Grais, and Pyatt 1986). Given the choice

15 See Greenaway et al. 1993, Shoven and Whalley 1992, and Robinson 1989 for fuller discussions of CGE modeling.

of numeraire, it is also implicitly assumed that the exchange rate is fixed and balance of payment deficits are endogenously determined by the model.[16]

The poor households in the model are affected by trade liberalization through several channels. First, reallocation of resources across sectors triggered by the new relative prices affects overall growth and volume of factor demand. Second, poor countries like Indonesia have generally abundant labor and if resource reallocation takes place in favor of labor, the poor might benefit relatively more in the reform process. Third, the poor households, as consumers, could benefit from availability of cheaper goods, specially the food products, in the market.

Simulation Analysis

The simulation analysis is conducted by: first, calculating welfare costs of the existing commodity taxation; second, the near marginal–tax incidence; and third, DDA simulations. The first calculation indicates the magnitude as well as the share of welfare costs of the existing commodity taxation. As the calculation is conducted for each commodity, the results therefore indicate which sectors and commodities are relatively more distorted than others. The second calculation shows how a small (marginal) increase in the commodity tax will affect total welfare so that one can determine whether the particular commodity is already over- or undertaxed. The last (third) set of simulations explore how the results of the DDA in agriculture might be reflected, first, in complete liberalization of agricultural tariffs, second, combined with complete liberalization of domestic agricultural taxation and, third, with liberalization of other sectors.

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16 The assumption of an endogenous balance of payments deficit, however, suffers from the criticism that there will be seemingly unlimited foreign borrowing available to the domestic economy (Robinson 1989). Nevertheless, the empirical situation prior to the Asian crisis suggests this choice is reasonable. As far as foreign borrowing is concerned, the problem for Indonesia is more in limiting than in getting foreign loans. This may be due to the fact that while the position of the government's foreign loans at that time was already high, the loans were mostly in the form of long-term concessional loans with relatively long grace periods. In addition, the government has consistently made debt repayments a priority, thus maintaining credit-worthiness in the international debt market. Pack and Pack (1990), for instance, concluded that the foreign loans have stimulated private investments. Fane (1996) also suggested that the accumulation of Indonesian foreign loans has been reflected more in the growth of investment than in the growth of consumption. In 1994, Indonesia—as the head of the Non-Aligned Movement—was even asked to help manage foreign loans of other low-income highly indebted countries (*Far Eastern Economic Review*, September 1994).

Welfare Costs of the Existing Commodity Taxation

The welfare costs (loss) of the existing commodity taxation can be calculated for both tariffs and indirect taxes on domestic commodities. The results are then compared with sectoral outputs and tax revenues.[17] Table 7.8 shows that some sectors are much more distorted than others. For example, the three sectors of textiles, food processing, and chemicals each contribute more than 10 percent of total output (i.e., 14.2, 11.1, and 10.8 percent, respectively), but their contributions to the tax revenue amounted to 38.90, 8.54, and even –4.83 percent (i.e., the net subsidized chemical sector). Another sector that contributes nearly 10 percent of output but has more significant contribution in tax revenues is the trade sector. Its output share is about 9.6 percent but it contributes 23.6 percent of total indirect taxes from domestic commodities. This sectoral imbalance is made worse by its impacts on welfare. Roughly two thirds of the welfare loss originated from the food processing industry (52 percent) and the trade sector (15 percent).

The sectoral imbalance is also recorded on the import side, as most government revenues from tariffs were collected from paper and metal products (about 53 percent) and chemicals (35 percent). The latter results from protecting the domestic chemicals sector. Note that the welfare impact of tariffs differs from that of domestic taxation. Welfare costs of sectoral tariffs are in line with the value of sectoral imports, making them more predictable. Welfare loss of commodity taxation is also predictable since it is in line with value of tax collection.

The welfare-cost impacts show that the existing indirect taxes and tariffs generate relatively high distortions in the economy. For every unit of indirect tax collected, there are 1.3 units of welfare costs, while for imports the ratio is 0.8. This suggests that the existing tax system is not an efficient mechanism for collecting revenues. Sectors with the ratio of welfare cost to revenue collected more than unity are food crops, other agriculture, food processing, construction, utilities, restaurants, banking and insurance, real estate, and public and personal services.

On the import side, the most distortionary tariffs are those on food processing and construction, (118 and 101 percent, respectively). Food processing is also among the most highly taxed sectors in the domestic market, amounting to 39 percent of total indirect tax on domestic commodities.[18]

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[17] See Shoven and Whalley (1984) and Ballard et al. (1985) for detailed discussions on this topic.

[18] Food processing contributed around 11 percent of the total output in 1993 (CBS 1996).

Table 7.8 **Welfare Costs of the Existing Commodity Taxation, 1993**

Indirect Taxation

Sector / Commodity	Output Value (billion Rp)	Output (%)	Tax Revenue Value (billion Rp)	Tax Revenue (%)	Welfare Costs Value (billion Rp)	Welfare Costs (%)	Welfare Costs as % of Sector Output	Welfare Costs as % of Total Output	Welfare Costs as % of Sector Tax	Welfare Costs as % of Total Tax
Food Crops	35,644.8	6.24	250.80	1.57	485.8	2.41	1.36	0.08	193.66	3.04
Other Agriculture	40,866.7	7.15	359.40	2.25	499.6	2.48	1.22	0.09	139.00	3.13
Mining	35,430.0	6.20	319.89	2.00	145.9	0.72	0.41	0.03	45.62	0.91
Food Processing	63,452.8	11.10	6208.18	38.89	10427.7	51.75	16.43	1.82	167.97	65.32
Textiles	80,964.1	14.16	1363.63	8.54	741.3	3.68	0.92	0.13	54.37	4.64
Construction	20,336.5	3.56	277.75	1.74	282.2	1.40	1.39	0.05	101.61	1.77
Papers and Metals	32,990.3	5.77	1164.09	7.29	1018.8	5.06	3.09	0.18	87.52	6.38
Chemicals	61,641.1	10.78	-771.36	-4.83	-620.2	-3.08	-1.01	-0.11	80.41	-3.89
Utilities	8,253.0	1.44	42.92	0.27	45.7	0.23	0.55	0.01	106.46	0.29
Trades	54,570.8	9.55	3769.46	23.61	2959.4	14.69	5.42	0.52	78.51	18.54
Restaurants	18,428.3	3.22	799.43	5.01	1025.1	5.09	5.56	0.18	128.23	6.42
Hotels	3,452.2	0.60	147.04	0.92	138.5	0.69	4.01	0.02	94.18	0.87
Land Transport	18,835.5	3.30	313.18	1.96	279.8	1.39	1.49	0.05	89.34	1.75
Other Transportation and Communication	17,047.1	2.98	125.76	0.79	114.4	0.57	0.67	0.02	90.94	0.72
Banking and Insurance	19,394.2	3.39	161.07	1.01	168.6	0.84	0.87	0.03	104.70	1.06
Real Estate	17,239.8	3.02	802.90	5.03	839.2	4.16	4.87	0.15	104.52	5.26
Public Services	26,128.0	4.57	304.26	1.91	322.6	1.60	1.23	0.06	106.04	2.02
Personal Services	16,939.4	2.96	325.22	2.04	401.5	1.99	2.37	0.07	123.45	2.52
Total	*571,614.5*	*100.00*	*15963.70*	*100.00*	*20151.1*	*100.00*	*3.53*	*3.53*	*126.23*	*126.23*

Imports

Sector / Commodity	Imports Value (billion Rp)	Imports (%)	Tariff Revenue Value (billion Rp)	Tariff Revenue (%)	Welfare Costs Value (billion Rp)	Welfare Costs (%)	Welfare Costs as % of Sector Import	Welfare Costs as % of Total Import	Welfare Costs as % of Sector Tariff	Welfare Costs as % of Total Tariff
Food Crops	1425.2	2.02	55.47	0.87	13.93	0.28	0.98	0.02	25.11	0.22
Other Agriculture	449.9	0.64	47.51	0.74	40.12	0.80	8.92	0.06	84.44	0.63
Mining	2414.6	3.43	38.47	0.60	30.97	0.61	1.28	0.04	80.50	0.48
Food Processing	2614.2	3.71	310.47	4.86	365.03	7.24	13.96	0.52	117.57	5.71
Textiles	87.4	0.12	20.06	0.31	2.70	0.05	3.09	0.00	13.45	0.04
Construction	4901.9	6.96	278.18	4.35	280.93	5.58	5.73	0.40	100.99	4.39
Paper and Metals	34970.9	49.67	3359.83	52.56	2408.84	47.81	6.89	3.42	71.70	37.68
Chemicals	18873.1	26.81	2242.40	35.08	1870.88	37.13	9.91	2.66	83.43	29.27
Total	*70400.6*	*100.00*	*6392.10*	*100.00*	*5038.63*	*100.00*	*7.16*	*7.16*	*78.83*	*78.83*

Rp = rupiah

Sources: Output and tax revenue were calculated from the Indonesian SAMs for 1993, while the welfare costs were from simulation results.

Furthermore, using a ratio of sectoral welfare loss to revenue of one half as a cutoff point for the possibility of raising taxes to increase revenue, it seems that this can only be done through increasing taxation in mining and textiles. On the import side, this can be made possible with increasing tariffs on food crops and textile products.

Total welfare losses associated with the implementation of indirect taxation on domestic commodities is nearly four percent of the total production. The actual welfare loss could be much higher, should the effects of the subsidy be more fully incorporated. On the import side, the total welfare loss is more than seven percent of total import value.

Near Marginal–Tax Incidence

Literature on marginal-tax incidence (Newbery and Stern 1987, Ahmad and Stern 1991) is concerned on how a very small change in a tax (T) has impacts on welfare (W). Defining λ as the ratio of changes between the two:

$$\lambda = \frac{\delta W}{\delta T}$$

It then follows that a positive (negative) λ means that welfare can still be improved (reduced) by increasing tax. Accordingly, the value of λ can be used as an indicator of whether a particular sector or commodity is already over- or undertaxed. A positive λ means that an increase in tax results in a welfare improvement, showing that the sector or commodity is still undertaxed, and vice versa.[19] Table 5.9 summarizes the results of this simulation (introducing a one percent increase in the tax rate), with sectors ranked by the value of λ.

The results show that nearly all sectors and commodities have already been overtaxed, except for the utility sector, implying that the existing tax system has generated distorted industrial and domestic markets. The results also highlight the costly method of collecting and possibly raising further revenue through taxation as any increase in the tax rate will reduce welfare. The distortions are very significant, such that every unit of revenue collected from the commodity taxation actually creates more welfare loss.

The value of λ in the utility sector (consisting of electricity, water, and gas) should be interpreted carefully as there is direct government provision

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19 In the CGE context this "near marginal" concept can be simulated by introducing a small increase in the tax rate while maintaining fiscal neutrality with offsetting transfers to ensure constant real government consumption. As the marginal increase in welfare is compared with the marginal increase in the tax revenue, the value of λ also reflects the marginal excess burden (MEB) per additional unit of tax revenue collected.

and intervention in this sector. The same caution should also be applied to the chemical sector, which is a net subsidized sector which can be seen from the net negative transaction between government and this sector in the SAM or the negative tax revenue of Rp771.36 billion[20] (Table 7.8). Table 7.9 also shows that the negative values of λ vary from 32 percent (mining) to 203 percent (food crops), implying that any project should produce benefits of at least 1.32 per unit cost if the project is to be welfare improving.[21]

Table 7.9 **Near Marginal–Tax Incidence**

Sector/Commodity	*Marginal Change in*		
	Welfare	*Tax Revenue*	*λ*
Food Crops	-4.262	2.092	-2.037
Food Processing	-95.570	47.301	-2.020
Other Agriculture	-4.402	3.020	-1.458
Restaurants	-9.375	6.468	-1.449
Personal Services	-3.400	2.735	-1.243
Real Estate	-7.629	6.780	-1.125
Chemicals	6.823	-6.584	-1.036
Construction	-2.203	2.170	-1.015
Paper and Metals	-9.313	9.361	-0.995
Public Services	-2.607	2.672	-0.976
Trades	-26.870	29.631	-0.907
Land Transport	-2.192	2.664	-0.823
Banking and Insurance	-1.105	1.407	-0.785
Hotels	-0.761	1.199	-0.635
Textiles	-6.686	11.103	-0.602
Other Transportation and Communication	-0.565	1.096	-0.516
Mining	-0.875	2.698	-0.324
Utilities	0.116	0.401	0.289
Total	*-180.429*	*125.518*	*-1.437*

λ = ratio between the change of its tax and welfare
Source: Simulation results.

Simulations of Trade Liberalization

Three scenarios are simulated here, namely: a complete removal of tariffs on agricultural products (Doha Partial), the same combined with a complete removal of domestic taxes (Ag Complete), and full (border) trade liberalization (Total Trade Liberalization, or TTL). The first is to capture the increasing access for agricultural products demanded by the DDA, while the second is to show the effects if government is proactive in agricultural product liberalization by also removing domestic taxation to level the playing field, and the third is to reflect broader cross-sectoral implications.

20 Rp stands for rupiah

21 Ballard et al. (1985) found that the MEB for the US is in the range of 17–56 cents per dollar of extra revenue, much lower than the Indonesian case.

The results of introducing the three scenarios are summarized in Table 7.10 and Table 7.11. The assessment is based on key variables such as macroeconomic aggregates, external performance, welfare, household income and consumption, and variables for the poor household groups. The economic indicators, summarized in Table 7.10, are calculated as percentage changes from the benchmark (business as usual) data. In most cases, a positive number reflects an increase or improvement, and vice versa.

Table 7.10 **Economy-Wide Effects of the Doha Development Agenda and Total Trade Liberalization**

Indicators	*Doha-Partial*	*Ag-Complete*	*Total Trade Liberalization*
GDP	-0.03	0.15	3.41
Employment	-0.10	0.24	5.75
Real exports	0.10	-0.05	-1.03
Real imports	0.23	0.43	10.54
Trade balance	-1.39	-5.52	-133.19
Domestic absorption	-0.01	0.24	5.79
Household income	-0.12	0.33	9.55
Household real consumption	-0.02	0.51	10.77
Agriculture household income	-0.21	0.45	9.94
Rural household income	-0.10	0.30	9.11
Urban household income	-0.05	0.25	9.52

Doha-Partial = complete removal of tariffs on agricultural products; Ag-Complete = removal of tariffs on a agricultural products and domestic taxes
Source: Simulation results.

The Doha Partial results indicate that increasing agricultural border market access alone would generate additional adverse effects on the domestic economy when all other distortions are maintained. Notably, the poor and other farmers are worse off in this scenario. Urban income groups improve their welfare from availability of food at cheaper rates. But, the majority of people residing in rural areas and dependent on agricultural income lose. The tariff removal increases imports but does not stimulate domestic production, bringing repercussions to the domestic economy in such forms as reductions in gross domestic product (GDP), lower employment levels, less total domestic absorption, and a loss of household welfare.[22] This helps to explain the reluctance of many developing countries to embrace agricultural trade liberalization when it is applied to their own markets as well as their export markets.

However, if the agricultural tariff removal is combined with similar removal of domestic agricultural taxes, i.e., the Ag-Complete scenario, the results are very different. The removal of taxes in both border and domestic

22 Note that agricultural trade liberalization considered here is not multilateral but unilateral on the part of Indonesia. Hence, market access by Indonesia to other countries is not considered here.

Table 7.11 **Welfare Effects of the Doha Development Agenda and Total Trade Liberalization on Different Household Groups**

Household Equivalent Variation	Doha-Partial			Ag-Complete			Total Trade Liberalization		
	billion Rp	*% of Income*	*% of Consumption*	*billion Rp*	*% of Income*	*% of Consumption*	*billion Rp*	*% of Income*	*% of Consumption*
Agriculture employee (landless farmer)	-9.137	-0.10	-0.10	56	0.59	0.62	946	9.96	9.69
Small farmer	-41.135	-0.10	-0.11	269	0.66	0.73	4636	11.32	11.41
Medium farmer	-12.502	-0.11	-0.14	85	0.76	0.92	1537	13.80	14.76
Large farmer	-15.532	-0.09	-0.11	132	0.73	0.97	2308	12.76	15.04
Rural low-income group	0.801	0.01	0.01	72	0.50	0.59	1427	9.97	10.67
Rural dependent–income group	0.812	0.02	0.02	9	0.23	0.27	68	1.75	2.02
Rural high-income group	-0.980	0.00	0.00	230	0.50	0.73	5276	11.56	15.11
Urban low-income group	5.055	0.02	0.02	82	0.33	0.38	1900	7.54	8.31
Urban dependent–income group	0.313	0.00	0.01	28	0.43	0.53	600	9.30	10.41
Urban high-income group	28.355	0.04	0.06	260	0.37	0.55	7816	11.27	14.92
	-43.949			1223			26515		

Doha-Partial = complete removal of tariffs on agricultural products; Ag-Complete = removal of tariffs on a agricultural products and domestic taxes
Source: Simulation results.

markets reduces production costs and stimulates domestic production, which is then followed by its ramifications on the economy as reflected in increased GDP, higher employment levels, more total domestic absorption, and greater household welfare. The poor (landless farmers, small farmers, and rural low-income group) get clear benefits from the complete removal of agricultural tax barriers. Indeed, the Ag-Complete scenario is a Pareto-optimal situation in so far as household groups considered in the model are concerned. In addition, contrasting the first two simulation results confirms that the existing domestic commodity taxation is an expensive way of collecting revenue, as shown by its associated welfare costs and the benefits from its removal.[23]

However, liberalizing one sector alone can also send false signals to resource allocation in the broader economy. This, together with different relative interests in different sectors by different countries, underlies the more comprehensive nature of negotiations under the auspices of the WTO, where trade-offs between sectors are incorporated.

In the TTL scenario, in which border trade is liberalized for all sectors, the results are substantially superior for GDP, employment, domestic absorption, household income, and household real consumption. Even more striking, household welfare is improved for all household groups. The trade balance deteriorates from a surplus to a deficit, but the deficit is small (less than one percent of GDP).

Conclusions and Policy Implications

The CGE model developed in this study has been employed to shed some light on issues related to trade liberalization by simulating what the likely effects of the DDA would be for a developing country such as Indonesia. The assessment is conducted at the economy-wide level, including welfare and distributional implications for different household groups. Moreover, to view agricultural protection in a broader context, the assessment includes the welfare costs of existing sectoral taxes.

The near marginal–tax incidence results indicate that nearly all sectors have already been overtaxed, except for the utility sectors. The existing tax system has distorted the economy so that a unit of revenue collected

23 In the model results, government consumption is found to be lower in the Doha-Partial scenario than in the baseline, but higher in the Ag-Complete scenario, and higher still under TTL. Note, however, that residual government financing is assumed to be readily available from international sources. Therefore, a reduction in government revenues due to trade liberalization may increase transfers from the ROW to the government, which can take the form of increased foreign borrowing.

increases welfare loss. The analysis then suggests that any project financed by new tax money should produce benefits of at least 1.32 times its cost if the tax collection is to be welfare-improving.

A further elaboration of the welfare costs of the existing commodity taxation reveals that some sectors are much more distorted than others. This applies for both tariffs and domestic indirect taxes, even though the welfare costs of tariffs are relatively less than those of domestic taxes. Domestic agricultural commodity taxation as it currently exists, however, is associated with relatively high welfare costs and removing them would be more beneficial.

The simulation of Doha-Partial (only removing agricultural border taxes) indicates that increasing market access alone will generate more adverse effects for the domestic economy, since all other distortions remain. Doha-Partial does not stimulate domestic production, increase employment, or improve welfare. Perhaps, most importantly, the result is not pro-poor.

In the Ag-Complete scenario, however, the results are very promising. The removal of both agricultural tariffs and domestic taxes boosts domestic production, which has positive effects on the economy. Welfare is improved and the poor benefit.

The detailed results also show that full benefits of trade liberalization cannot be obtained by piecemeal trade liberalization. Liberalizing one sector alone will generate misleading signals for resource allocation in the economy. The TTL scenario yields the greatest benefits for the poor and for the economy as a whole. This calls for more comprehensive trade liberalization, aligned with domestic industrial and other policies. The government could expand the benefits of the DDA by further liberalizing both international and domestic markets. This, however, requires strong commitments as well as collaboration with other trading-partner countries. Collaborating with partners is essential since unilateral trade liberalization is not as desirable a course of action.

Appendix 7.1

Modeling Development

Production / Supply Side

In the model, output was specified as an input-output function of intermediate input and value added. The intermediate input consumption *(INT)*$_i$ was set as a constant elasticity of substitution (CES) aggregation of domestically produced and imported commodities (allowing imperfect substitution between the two commodities, with a different degree of substitution for each type of commodity as reflected by the value of elasticity used) in the form:

$$INT_i = A\left[\alpha_d D_i^{(\sigma_i - 1)/\sigma_i} + (1-\alpha_d) M_i^{(\sigma_i - 1)/\sigma_i}\right]^{\sigma_i/(\sigma_i - 1)} \qquad \text{(S.1)}$$

where A = scale parameter, α_d share parameter for domestically produced commodities as a share of total commodities available in the domestic economy ($0 < \alpha_d < 1$), and D_i and M_i are domestically produced and imported commodities, respectively. The elasticity of substitution between domestically produced and imported commodities is represented by σ_i.

The value added was set as a Cobb-Douglas function of different types of labor and capital. Total production was allocated to domestic demand and exports.

Demand Side

Total final demand in the domestic economy consists of demand for consumption and for investment purposes. Consumption is the sum of household and government consumption, while the demand for investment is generated by the aggregated saving-investment (capital) account. The figure below shows a schematic representation of the demand system of the model. A Cobb-Douglas utility function is assumed for the households, while the government is assumed to have planned consumption reflected in a Leontief specification, which is not affected by commodity prices or the government's income. Aggregate investment is fixed to reflect the investment-driven nature of the economy. In addition to the main functional specifications for production and final demand, there are other equations in the model to define prices (for activities, commodities, and factors); incomes and expenditures (by institutions); and to balance the model.

Price Equations

The domestic price of each composite commodity (P_i) can be written as a CES function of the domestic prices of imported (PM_i) and domestically produced goods (PD_i):

$$P_i = \left[\alpha_d \, PD_i^{(\sigma_i - 1)/\sigma_i} + (1-\alpha_d) PM_i^{(\sigma_i - 1)/\sigma_i}\right]^{\sigma_i/(\sigma_i - 1)} \quad \text{(P.1)}$$

On the import side, the adoption of the small-country assumption implies that the domestic economy is a price taker and there is unlimited supply from the rest of the world (ROW) at the given world price. The domestic price of imports is given by

$$PM_i = \overline{PW}_i \,(1 + tm_i)\,\overline{ER} \quad \text{(P.2)}$$

where $\overline{PW_i}$ is the world price, $\overline{ER}$ is the exchange rate, and *tm* is the tariff rate on imported commodities. The bar sign indicates that the variable is fixed. Assuming that domestic products sold in the international market face a downward sloping demand curve, the export price *(PWE)* can be represented as

$$PWE_i = PD_i \,/\, (1 + te_i)\,\overline{ER} \quad \text{(P.3)}$$

where *te* is the export-subsidy rate.

Income and Expenditure Equations

Household incomes (Y_h) consist of factor incomes (i.e., wages and rent payments for factors used domestically and abroad, expressed by the first two parts on the right-hand side) of equation I.1 and transfer incomes from the government $(TGH)_h$, domestic firms $(TFH)_h$, other households $(THH)_h$, and the ROW $(TWH)_h$. These incomes can be written as:

$$Y_h = \begin{bmatrix} \sum_i \sum_k W_k L_{kih} + \sum_i (PN_i X_i - \sum_k W_k L_{ki})_h \\ + (TGH)_h + (TFH)_h + (THH)_h + (\overline{TWH})_h \overline{ER} \end{bmatrix} \quad \text{(I.1)}$$

Firms' incomes (YF) include payments for capital used in production, transfers from other firms *(TFF)*, and transfers from the ROW $(TWF)_f$, which is set as a residual. It is given by:

$$YF = \left[\sum_i (PN_i X_i - \sum_k W_k L_{ki})_f + (TFF) + (TWF)\ \overline{ER} \right] \quad \text{(I.2)}$$

Government income (YG) can be categorized into payments for capital used in production activities, income taxes from domestic institutions (households, domestic firms, and government-owned companies), income from indirect taxes levied on commodities, and transfers from the ROW *(TWG)*, which is endogenously determined by the model. It is given by:

$$YG = \begin{bmatrix} \sum_i (PN_i X_i - \sum_k W_k L_{ki})_g + \sum_h t_h Y_h + \sum_f t_f Y_f + \\ + \sum_i td_i X_i^S PD_i + (TWG)\ \overline{ER} \end{bmatrix} \tag{I.3}$$

Transfer payments from the ROW to households are set exogenously (as shown by a bar sign on the variables in the equations), while transfers to government and firms are set endogenously (as residuals). This is consistent with the behavior of domestic firms as well as the fiscal policy of the government; both rely on foreign sources for funding their deficits. These transfer payments consist of foreign loans, grants, and other transfers.

Household expenditure (E_h) consists of consumption of composite commodities, direct tax payments to the government, transfers to other household groups, and savings:

$$E_h = (\sum_i CH_i)\ + (\sum_h t_h Y_h)\ + (THH)_h + S_h \tag{E.1}$$

The expenditures of firms (EF) consist of transfers to households, direct tax payments to the government, transfers to other firms (retained profit), transfers to the ROW *(TFW)*, and savings:

$$EF = (TFH)_h + (\sum_f t_f Y_f)\ + (TFF)\ + (TFW) + SF \tag{E.2}$$

Government expenditure (EG) consists of consumption of composite commodities, transfers to households $(TGH)_h$, transfers to the government *(TGG)*, transfers to the ROW *(TGW)*, and savings:

$$EG = (\sum_i CG_i)\ + (TGH)_h + (TGG)\ + (TGW)\ + SG \tag{E.3}$$

Saving-Investment Equations

Total savings in the domestic economy consists of household savings (S_h), firms' savings (SF), government savings (SG), and capital injections from the ROW (SW):

$$S = \sum_h S_h + SF + SG + \overline{SW} \tag{S-I.1}$$

In equilibrium, total saving equals total investment, which is distributed to each sector based on fixed shares.

$$S = I$$
$$I_i = \sum_i \overline{\delta_i}\, I \quad \text{and} \quad \sum_i \overline{\delta_i} = 1 \qquad \text{(S-I.2)}$$

Aggregate final demand (total final consumption of composite commodities) is accordingly given by

$$C_i = \sum_i CH_i + \sum_i CG_i + I_i \qquad \text{(S-I.3)}$$

where

$$C_{ij} = \delta_{ij}\ (1 - \overline{MPS}_j)(1 - t_h)Y_j, \quad j = h, g$$

Employment and Wages

For nonagricultural and nonproduction workers in Indonesia, wages are set in competitive markets and reflect the marginal product of the workers:

$$PN_i\,(\partial\ X_i / \partial\ L_{ki}) = W_k \text{ with } \quad L_k^D = \sum_{i=1}^{n} L_{ki} \quad \text{and} \quad L_k^D = \overline{L_k^S} \multimap \qquad \text{(L.1)}$$

For labor in the agricultural sector and production workers, wages are fixed and the last part of the equation above becomes

$$L_k^D = L_k^S \text{ where } L_k^S < L_k^{*S} \text{ and } W_k = \overline{W_k} \qquad \text{(L.2)}$$

thus allowing for unemployment in the agricultural sector and among production workers. *D* and *S* in the equations above refer to demand and supply while W_k is the wage at equilibrium level. L_k^{*S} is the optimum labor supply.

Foreign Trade

The export demand equation is

$$\mathrm{E_i} = \overline{\mathrm{E_i}}(\mathrm{AVE_i}/\mathrm{PWE_i})^{\eta_i} \qquad \text{(F.1)}$$

where $\overline{E_i}$ = exports when $AVE_i = PWE_i$, PWE = supply price of domestic exports in foreign currency, AVE = average world price of the commodity, η= the export demand elasticity.

The import demand equation is

$$M_i = (\delta_i / 1 - \delta_i)^{\sigma_i} (PD_i / PM_i)^{\sigma_i} D_i \quad \text{(F.2)}$$

where: δ = share parameter and D_i = total demand for domestic use The balance of payments equilibrium equation is given by:

The balance of payments equilibrium equation is given by:

$$\left[\sum_i \overline{PW_i} M_i + (TGW) + (TFW) + \sum_k (RMTW)_k \right] = \left[\sum_i PWE_i E_i + \sum_k \overline{(RMFW)}_k + \sum_h \overline{(TWH)_h} + (TWF) + (TWG)\right] \quad \text{(F3)}$$

The left-hand side of the equation above is the ROW revenue that consists of imports, capital flight, transfers from government and firms, and capital payment from foreign capital used in domestic production for the ROW. On the right-hand side is the ROW total expenditure, covering exports, capital payments, and transfers to domestic households, firms, and government. Since the transfers from the ROW to domestic firms and government are set as residuals, the current account–deficit equation is given by

$$[(TWF) + (TWG)] = \left[\sum_i \overline{PW_i} M_i + (TGW) + (TFW) + \sum_k (RMTW)_k \right] - \left[\sum_i PWE_i E_i + \sum_k \overline{(RMFW)}_k + \sum_h \overline{(TWH)}_h \right] \quad \text{(F4)}$$

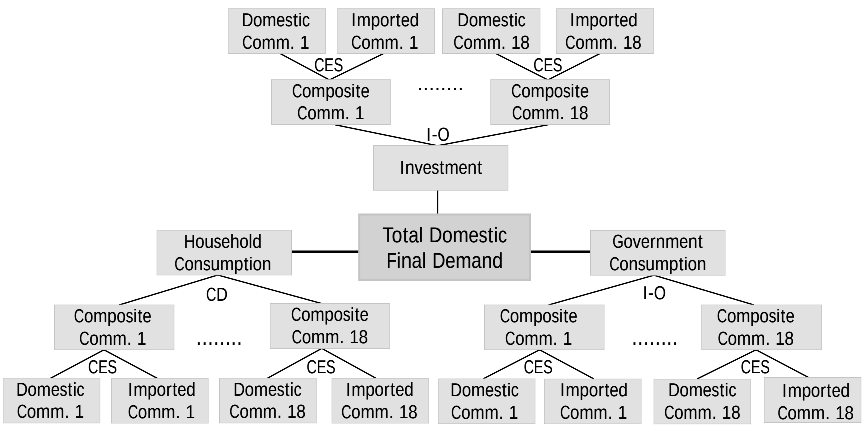
The model provided by the equations above is then used to examine the welfare costs of the existing import tariff, and various trade liberalization scenarios.

Appendix 7.2

Calculation of the Welfare Costs of the Existing Import Tariffs

In a CGE context (see Shoven and Whalley 1984), the calculation of welfare loss of the existing import tariff is conducted by simulating the removal of import tariffs individually in the context of maintaining government revenue from taxation. The result is summarized in Table 6. Notice that most government revenue from tariffs is collected from Papers & Metal Products (about 53%) and Chemicals (35%). The latter is actually a net subsidized sector, implying that this sector is the most protected one (in 1993, the net subsidy of this sector amounted to 771 billion rupiah or about 5% of total revenue from indirect taxation on domestic commodities). From the welfare loss calculation, it shows that the existing tariff generates relatively high distortions, i.e., 0.8 for every single unit of currency collected from the import tariff. This suggests that the existing import tariff is an inefficient mechanism for collecting revenues. For some sectors, namely Food Processing and Construction, the ratios of welfare cost to revenue collected are even more than unity (i.e., 118% and 101%, respectively), implying the distortionary nature of these tariffs. Moreover, food processing is also among the most highly taxed sectors in the domestic market, accounting for around 39% of the total tax on the domestic commodities, while this sector contributed around 11% of the total output in 1993 (CBS 1996).

Schematic Representation of Final Demand



Comm = Commodity
Source: Authors' framework

CHAPTER 8

Computable General Equilibrium Model: Infrastructure Development and Poverty Alleviation in the People's Republic of China

Li Shantong

Introduction

This study assesses the contribution of infrastructure development to reducing poverty in the People's Republic of China (PRC) using a computable general equilibrium (CGE) model with disaggregated households, segmented urban and rural labor markets, and endogenous labor supply of households. It extends an existing economy-wide CGE model of the PRC by further disaggregating the households and including labor migration. The extensions enable the CGE model to examine the poverty alleviation and distributional implications of infrastructure development.

Unlike other commonly used econometric methods and case-study techniques of analyzing the linkages between infrastructure development and poverty alleviation, the CGE model is comprehensive, covering the essential features of the economy, its institutions, and their economic interdependencies. The optimization process inherent in the CGE model enables it to provide quick feedback for any policy changes in or shocks to the economy. Therefore, the results not only indicate the magnitude of the influences of infrastructure and economic growth on each other, but also reveal comprehensively how additional infrastructure facilities enhance economic growth. These results highlight the importance of more and better-quality infrastructure in eliminating the problem of poverty.

This chapter consists of six sections. The next section provides an overview of the situation and trends of rural poverty in the PRC. This is followed with an analysis of how infrastructure construction impacts poverty reduction. The fourth section describes the structure of the CGE model of the PRC economy, especially including resident grouping, labor migration, and issues related to infrastructure construction. The fifth section focuses on the design, implementation, and interpretation of the results of the various policy simulations using the CGE model. In the sixth and last section of this paper, the main implications and observations of the study, as well as the implications of this study's findings on the directions of related research in the future, are summarized.

Rural Poverty in the PRC: Situation and Alleviation Programs

Poverty Situation

Poverty, particularly in rural areas, is one of the most serious challenges confronting human society, and how to eliminate it is a common concern all over the world. The PRC is the largest developing country with the largest population, so its achievements in poverty alleviation will have a critical impact on this worldwide effort. Since the PRC started making major reforms and opening up to the rest of the world in 1978, it has devoted considerable efforts and achieved dramatic progress in the fight against poverty. The number of its poor has been reduced from 250 million in 1978 to 26 million in 2004.

According to the National Bureau of Statistics (NBS; RSO 2004), the incidence of absolute poverty in rural areas dropped to 26.1 million at the end of 2004, or 2.9 million fewer than in 2003. This accounted for 2.8 percent of the entire rural population, which declined by 0.3 percentage points from the preceding year. In 2004, those in rural areas, who have access to food and clothing but nonetheless continue to be vulnerable to hunger and deprivation of other basic needs, had decreased to 49.8 million, which is 0.7 percent fewer than in 2003. This gain was 5.3 percent of the entire rural population or 6.4 million fewer poor households compared with the preceding year.

Table 8.1 and Figure 8.1 illustrate the remarkable accomplishment of the PRC in reducing the rural poverty rate, based on the official rural poverty line, since 1978. World Bank estimates, which were assessed using World Bank poverty threshold income levels, also show a drop in poverty rates in the PRC from 1990 onward. However, when comparing the statistics on poverty estimated by NBS with those using international poverty lines, the poverty alleviation gains suggested by the official statistics in Figure 8.1 are greater. International estimates using the $1-a-day per capita poverty line indicate that poverty alleviation has been modest. The rural poverty rate remains high before 1993 and then declines gradually from 1993 to 1996. After completing its decline in 1996, the poverty rate stabilized at about its 1996 level.

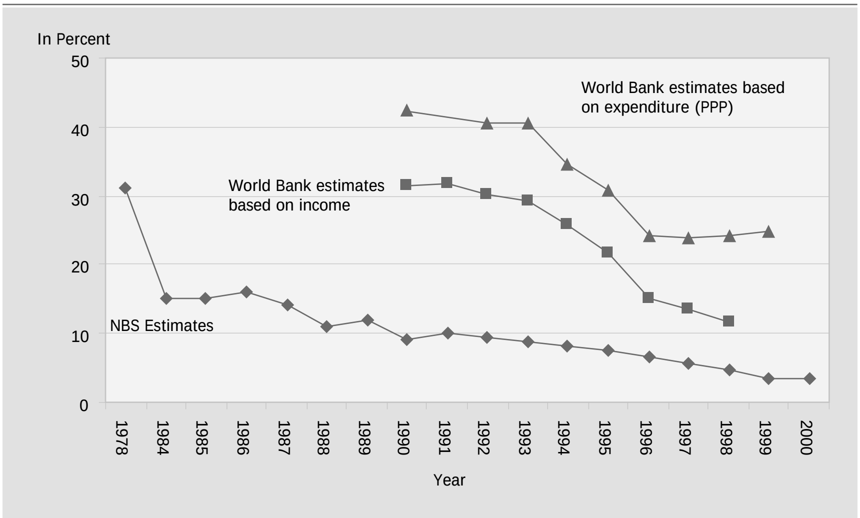
The Chinese government has modified its rural poverty line in terms of the annual consumption price index applicable to rural areas. However, the

Table 8.1 **Rural Poverty Rate in the Peoples' Republic of China, 1978–2000**

		World Bank Estimates	
Year	*NBS Estimates*	*Income PPP* [a]	*Consumption PPP* [b]
1978	31.0	...	...
1984	15.0	...	...
1985	15.0	...	...
1986	16.0	...	...
1987	14.0	...	...
1988	11.0	...	...
1989	12.0	...	...
1990	9.0	31.3	42.5
1991	10.0	31.7	...
1992	9.4	30.1	40.6
1993	8.8	29.1	40.6
1994	8.2	25.9	34.6
1995	7.6	21.8	30.8
1996	6.7	15.0	24.1
1997	5.8	13.5	24.0
1998	4.6	11.5	24.1
1999	3.4	...	24.9
2000	3.5	...	...

NBS = National Bureau of Statistics
a A dollar a day per capita as the poverty line at purchasing power parity (PPP) rates
b A dollar of expenditures per day as the poverty line converted at PPP rates
Sources: Rural Survey Organization (2000 and 2001); World Bank (2001); Chen and Wang (2001).

Figure 8.1 **Estimates of Rural Poverty in the Peoples' Republic of China, 1978–2000**



Sources: Rural Survey Organization; NBS (2000 and 2001); World Bank (2001); Chen and Wang (2001).

line is still far below the per capita poverty line of a $1-a-day used by the World Bank. Table 8.2 portrays the changes in the rural poverty line, size, and proportion of the poor population in the PRC since 2000.

Table 8.2 **Rural Poverty Rate in the Peoples' Republic of China, 2000–2004**

	Absolute Poor			*Low–Income*		
Year	*Threshold (CNY per capita per year)*	*Individuals ('000)*	*Rate (%)*	*Threshold (CNY per capita per year)*	*Individuals (in '000)*	*Rate (%)*
2000	625	32,090	3.5	865	62,130	6.7
2001	630	29,270	3.2	872	61,020	6.6
2002	627	28,200	3.0	869	58,250	6.2
2003	637	29,000	3.1	882	56,170	6.0
2004	668	26,100	2.8	924	49,770	5.3

Source: Rural Survey Organization (2004).

The serious consequences of rural poverty in the PRC are manifested in the hard living conditions of its poor. From national survey data of rural households in 2002, the Rural Survey Organization of the NBS identified the prominent features of the rural poor: They tend to be less educated, live in isolated communities exposed to harsh environmental conditions, have relatively large families, and are severely resource-constrained. Table 8.3 compares the natural and social living environment, demography, and economic status of the rural poor and nonpoor.

Table 8.3 **Comparison of the Poor and Nonpoor in Rural Areas of the Peoples' Republic of China** by Selected Attributes in 2002

Comparative Index	*Poor*	*Low Income*	*Others*
Location and Access to Infrastructure (%)			
Proportion of households living in mountainous areas	50.4	46.8	23.0
Proportion of villages with highways	93.1	94.5	97.3
Proportion of villages with telephones	77.6	84.4	94.5
Proportion of households with access to electricity	85.1	90.8	94.2
Proportion of households using safe drinking water	55.2	56.1	69.4
Family Size, Human Resource Development, and Employment (% except where indicated)			
Family size (individual members)	5.3	4.8	4.1
Education (years of schooling)	6.6	7.0	7.9
Illiteracy rate of the labor force	16.3	13.6	6.4
Rate of employment in rural areas	90.9	89.2	84.6
Enrolment rate of children 7 to 12 years old	91.8	94.5	97.1
Enrolment rate of children 13 to 15 years old	79.7	85.6	91.7
Economic Situation (CNY except when indicated)			
Per capita net income	531.0	813.1	2,773.9
Per capita expenditure	559.0	760.0	1,968.5
Engel coefficient (percent)	69.2	64.4	45.2
Per capita expenditure for purchasing productive fixed assets	44.3	44.7	90.6
Per capita deposit and cash on hand at the end of the year	373.9	500.3	1,962.4

Source: Rural Survey Organization (2003).

Most of the rural poor live in the mid-western and southwestern areas of the PRC, where transportation and communication with the rest of the world are very difficult to access. Many residents lack basic production tools, housing, access to education, and other personal needs. Consequently, they have very limited career and livelihood options. Despite all efforts, these harsh conditions continue to endure and require drastic improvement (RSO 2003). The Chinese government remains confronted with the paramount challenge of helping the PRC's rural population escape poverty.

Poverty Reduction Policies

Since 1978, the Chinese government has set policies aimed at reducing rural poverty. Before 1978, the task of reducing rural poverty was subsumed under the national effort of promoting economic development. As indicated in the summary of the China Rural Poverty Reduction Development Outline, the overall work in the PRC of reducing the incidence of rural poverty has been carried out since 1978 largely in three stages (State Council Leading Group Office of Poverty Alleviation and Development 2003).

In the first stage of this poverty reduction work program from 1978 to 1985, the Chinese government introduced incentives–particularly in agriculture–by assigning land-management rights to households. The government implemented a contract-responsibility system with remuneration at the household level. Within the system, peasants were sufficiently motivated to increase agricultural production. The government followed this reform with a series of policies and measures, such as deregulating the prices of agricultural products and developing township enterprises. These reforms freed up the productive forces and made it possible to reduce rural poverty in new ways.

From 1986 to 1993, the government set in motion the second stage of its poverty reduction program, which involved a large-scale development-oriented poverty relief drive. Working under the motto of "turning blood transfusion into blood production," the government encouraged rural residents and poor communities to be more self-reliant, to make use of local natural resources, and to create income-generating opportunities by and for themselves. The Work Relief project was implemented during this period.

With the promulgation of its seven-year Priority Poverty Alleviation Program (PPAP) in 1994, the Chinese government set into motion the third stage of its development-oriented poverty relief work by tackling key problems. The government implemented poverty-relief measures that targeted 592 poor national counties. The different provinces assumed responsibility for implementing these measures within their respective territories. In addition, the government encouraged rural residents to increase their incomes by looking for jobs in nonagricultural industries. By the end of 2000, the government attained the basic objectives of its Seven-Year PPAP. The number of rural poor fell to 30 million in 2000, and the poverty incidence rate dropped to about three percent (see Table 8.2).

In 2001, the central government officially issued its *Outline for Poverty Alleviation and Development of China's Rural Areas (2001–2010).* It pointed out in the plan that PRC's poverty alleviation work is a long-term and arduous process. The plan also emphasized the importance of the coordinated development of the economy and society in poor areas, highlighting sustainable development as one principle of poverty reduction.

In summary, rural poverty reduction in the PRC underwent a process from promotion by system and government aid to development-oriented poverty relief and self-development. During this process, the government played a dominant role throughout: setting up development funds for poor areas, encouraging exploratory production and construction, and extending access to work in nonagricultural sectors. Particularly, the long-term investment in infrastructure construction has improved the production and living conditions in poor areas, and thus has been very helpful for the alleviation of rural poverty.

Work Relief is one of the most effective projects for reducing poverty. This project employs residents from poverty-stricken areas to work in useful capital construction activities in these areas. The workers are paid for the work they render under the program, instead of obtaining cash transfers from the government. For example, in the year of 2000, the central government invested CNY6 billion[1] in work-relief funds. With these resources, the work-relief program built 3 million *mu*[2] of basic farmland, irrigated 7 million *mu* to raise the land's productivity, prevented water and soil loss in 6.8 million *mu*, and constructed 0.38 million kilometers of village roads. All of these accomplishments not only improved agricultural production conditions and productivity, but also directly supplemented farmers' incomes (RSO 2003).

In addition, the economic development and poverty alleviation of western PRC also benefited from the improvement of infrastructure to a considerable degree. With the adoption of the Great Western Development Strategy, the government put in place a series of small- and medium-scale projects that were directly related to farmers' benefits, while undertaking the construction of key infrastructure projects. By 2000, under the project, the

1 CNY stands for yuan

2 A *mu* is a Chinese land measure equivalent to 1/15th of a hectare.

construction of bituminous macadam in each county had been designed, and 20,000 kilometers of blacktop highway and 17,000 kilometers of highway which connect poor counties with national highways had been constructed.

With the implementation of another project to transmit electricity to the countryside, about 700 villages and towns gained access to electricity. The project also provided villages with access to radio and TV. The residents of about 8,000 newly electrified administrative villages gained radio and TV facilities. All these projects have undoubtedly played an active role in the growth of productivity and nonagricultural employment. The World Bank (1994) reported that one of the key factors for township enterprises' success in the PRC is their access to needed transportation, telecommunication, and power services.

The rapid development of infrastructure facilities in recent years has had favorable social and economic benefits. This affirms the effectivity of the government's development-oriented strategy for poverty alleviation based on infrastructure development in rural areas. With international organizations ready to provide long-term funding for infrastructure projects, there have been excellent successive opportunities for making the strategy succeed.

At present, most of the PRC's rural poor are distributed in the less-developed middle and western regions of the country. Enhancing local productivity and the export of labor services are two important approaches to poverty alleviation. Realizing the integration in terms of physical accessibility and communication of the poor regional areas of the PRC with the outside world is indispensable. Continuing to accelerate rural infrastructure construction is crucial but arduous. It will play a vital role in future economic growth and poverty alleviation.

Contribution of Infrastructure Improvement to Poverty Alleviation

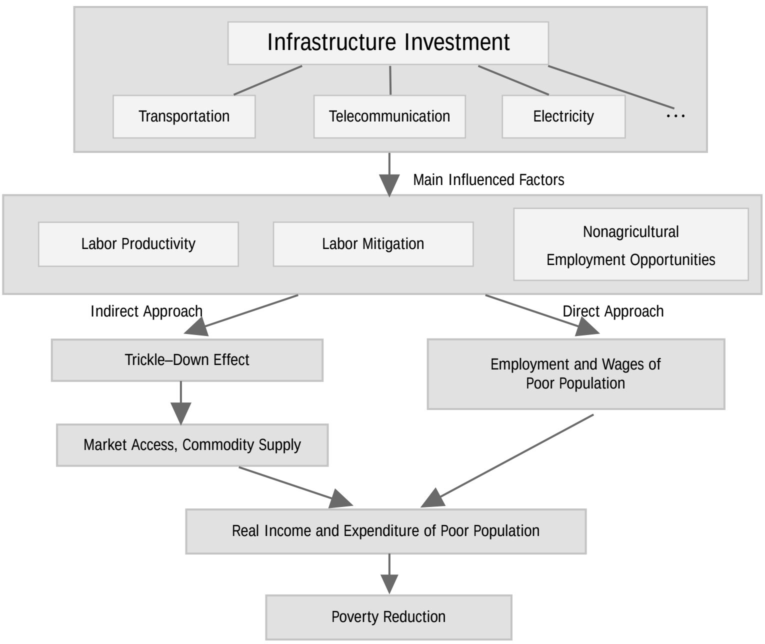
Analytical Framework

This study highlights two aspects of infrastructure development. On one hand, infrastructure development includes the processes of financing and building infrastructure facilities. On the other hand, it means the activation of various infrastructure facilities such as those providing transportation, telecommunication, electricity, and irrigation services.

Figure 8.2 presents a simple framework for analyzing the contribution of infrastructure development to poverty alleviation. Infrastructure improvement has three direct consequences that alleviate rural poverty, namely, improving productivity, reducing the cost of labor migration from rural to urban areas, and enhancing opportunities for nonagricultural employment of the rural poor. These consequences are channeled through two effects. Its direct distribution effect is indicated by more of the rural poor becoming employed and increasing their respective incomes. The other channel is the trickle-down effect, that is, the rural poor benefit indirectly from economic progress in rural areas and elsewhere in the economy, resulting in higher aggregate real disposable income and expenditure.

In the process of infrastructure construction, vast capital construction investment stimulates production and final demands of related industries, such as of construction, mining and quarrying, and building-materials manufacturing. These induced economic activities directly push the growth of the national economy. In Wuhan City, for example, a CNY100 increase of infrastructure-related investment tends to generate CNY172 of added value (Wuhan Bureau of Statistics 2004). In addition, the trickle-down effect tends to ameliorate the welfare of the rural poor to a certain degree. If agriculture is mainly responsible for economic growth, the effects on rural poverty alleviation are more evident (Huang, Rosselle, and Zhang 2004).

Figure 8.2 **Framework for Infrastructure Development and for Poverty Reduction**



Source: Author's framework.

The effects of infrastructure investment on poverty reduction are more directly reflected in employment. Infrastructure construction and the development of related industries create more jobs, especially for unskilled rural migrants. Labor migration from rural to urban areas and from agricultural to nonagricultural sectors is an important channel for poverty alleviation. According to some studies on this subject, the proportion of households in the poorest villages engaged in agriculture-related work tends to be very high. In contrast, rural households with medium or low income are more likely to migrate out and seek jobs in cities, while those with high income tend to work in manufacturing companies or be self-employed (Mohapatra 2001).

In recent years, with the rapid development of township enterprises and urbanization in eastern coastal areas, the gaps of employment opportunities and income levels among PRC's different regions, particularly between urban and rural areas, have progressively widened. Most of the surplus rural labor in the middle and western areas moves into coastlands and into mid-sized to large cities.

In 2004, Beijing had 2.9 million rural migrants–90.4 percent more than in 1999–who accounted for nearly two thirds of the city's total immigrant population. Among Beijing's rural immigrants, a little over a fourth of them worked in the construction industry, which topped other industries in terms of providing employment (Population and Employment Section of Beijing Bureau of Statistics 2005). Therefore, expanding the level of investments in infrastructure construction would tend to be very useful in reducing rural poverty by creating more nonagricultural employment opportunities and directly increasing the incomes of the poor population in rural areas.

The completed infrastructure would also contribute to poverty reduction. Facilities for supplying clean drinking water and environmental sanitation equipment significantly improve people's health and reduce incidence of disease. Advanced irrigation systems result in higher and more stable income for farmers and strengthen their capability to manage risk.

The development of transportation and telecommunication systems enhances labor productivity and improves lifestyles. Presently, the lack of transportation and telecommunication facilities comprises two major bottlenecks, slowing down the PRC's effort at reducing rural poverty. The export to cities of labor services from rural areas represents a viable and important way of reducing poverty in inland areas. Therefore, the improvement of transportation and telecommunication facilities has an extraordinary contribution to poverty alleviation. Consistent with this observation, the study selected these two infrastructure sectors for analysis.

Transportation and communication infrastructure facilities open new opportunities for poor areas to integrate with the outside world. The linkages would facilitate the employment of local resources by reducing the cost of labor movements and thus allowing the rural poor to avail of better opportunities elsewhere in the country. A case study involving seven poor counties from Zhumadian City and Xinyang City in Henan province finds that better transportation infrastructure significantly increased tourist visits in the province, facilitated the adjustment of agricultural industries, and sharply increased farmers' incomes. With access to a better transportation system, farmers tended to be more mobile, as the cost of rural-urban migration fell. The improved system created more employment opportunities in nonagricultural sectors for the poor population in rural areas. In contrast to the experience of the control regions in this case study, i.e., regions where the level and quality of transportation infrastructure remained unchanged, the regions with better transportation facilities achieved higher regional gross domestic product (GDP) growth, rural industrialization, higher incomes for farmers, and more effective poverty reduction (Dong and Fan 2004).

Telecommunication infrastructure such as telephones, TV cables, and networks establishes communication channels, which provide more information about employment in urban areas and reduce information-searching costs. With the establishment of modern mass media, traditionally pessimistic ideas among the poor population particularly in rural areas would gradually be replaced with modern ideas such as self-dependency, gender equity, and having fewer and healthier children, which would help in reducing poverty.

The contribution of transportation and telecommunication infrastructure construction to reducing poverty in rural areas is also embodied in labor productivity gains. Higher labor productivity would not only increase production directly, but would also strengthen the migrants' competency in job markets. Thus, the poor in rural areas would have more access to knowledge and information, and acquire greater chances to learn about the outside world and broaden their horizons. Besides formal schools, they could also be educated or trained in other formal or informal ways. Previous studies show that in the 1980s, one more year of schooling could stimulate a 10 percent increase in out-migration of peasants and an increase by 6 percent of the number of available jobs in the nonagricultural sectors. Interestingly, the impact more than doubled in the 1990s, wherein one extra year of schooling could translate into an 18 percent increase in out-migration of peasants and an increase of 17 percent in the number of nonagricultural jobs (Huang and Rozelle 1996). Currently, nonagricultural wages are much higher than those in agriculture and, thus, the export of labor is the key to increasing peasants' incomes.

A point worth noting is that the improvement of infrastructure would be beneficial to both workers and employers. For any production sector, transportation and information collection are two indispensable factors in the production process and supply chain, and the development of transportation and telecommunication infrastructure will necessarily reduce the cost of production and logistics. In addition, improved infrastructure facilitates labor migration and intensifies the competition in labor markets, thus making it possible for employers to reduce labor costs. Therefore, infrastructure construction would play an active role in poverty alleviation, benefit both employers and workers, and would contribute to the overall development of the economy.

Accomplishments in Infrastructure Development

Since the implementation of its large-scale development-oriented poverty reduction program, PRC's government has focused on transportation infrastructure development. Under the PPAP, the government invested CNY700 million each year in highway construction to alleviate rural poverty. After nearly 20 years of continuous investment, a relatively comprehensive transportation system has been set up in the poor western regions consisting of highways, railways, inland river channels, flight routes, and underground oil pipelines.

In the 1990s, the PRC's telecommunication industry sustained relatively rapid growth. Telecommunications investments rose sharply producing, among other results, a significant improvement of telecommunication facilities in the country's rural areas. By the end of 2003, the number of telephone subscribers in rural areas reached 91.7 million, 62 times the number in 1990. Of these, 83.9 million or 91.5 percent were residential telephone subscribers. Their number was 27,300 percent of the total residential subscribers in rural areas in 1990 (NBS 2004).

Average national broadcasting and TV coverage rates by the end of 2003 reached 93.7 percent and 94.9 percent, respectively. In the western regions, the number of households with access to national broadcasting and TV increased by 90 percent over its coverage in 1990 (Data Center of DRC Net 2003). All of these remarkable achievements have enabled farmers to learn more about the outside world and obtain ideas about how they may improve their living conditions.

Tables 8.4 and 8.5 describe the trends of infrastructure investments and improvements in the transportation and telecommunication sectors since 1999. The ratio of investments between transportation and telecommunication was about 7 to 1 in 1990, as shown in Table 8.4. This ratio fell to about 4 to 1 in 2000 because of the relatively rapid increase of investment in the telecommunication sector. Within the transportation sector, railways and highways are the two major facilities–accounting in the 1990s for 80 percent of total investments in the sector. Investments in highway construction have risen more rapidly than those in railways since 1996. The investments in the remaining three transportation subsectors have been relatively stable over time.

Table 8.4 **Investments in Infrastructure Construction, 1990–2000**

Year	Transportation and Telecommunications (100 million CNY)	Transportation (%)						Post & Telecommunication
		All Facilities	Railways	Highways	Water	Aviation Routes	Pipelines	
1990	207.16	87.1	32.20	26.60	22.20	5.60	0.50	12.9
1991	330.62	90.7	36.40	24.30	18.90	10.60	0.40	9.3
1992	448.25	87.7	25.70	37.80	15.40	7.90	0.80	12.3
1993	886.08	84.8	35.80	17.80	6.90	11.20	0.60	15.2
1994	1,353.68	82.9	33.70	21.00	5.70	8.30	0.10	17.1
1995	1,563.65	82.2	29.60	23.80	4.30	7.70	0.30	17.8
1996	1,810.46	82.7	25.80	27.60	2.20	7.10	0.80	17.3
1997	2,150.70	84.0	23.10	31.10	1.90	6.30	0.30	16.0
1998	3,186.39	85.0	19.90	33.30	1.30	5.40	0.20	15.0
1999	3,304.83	85.8	20.60	34.10	1.40	6.30	0.20	14.2
2000	3,557.98	80.9	18.90	37.00	1.30	5.90	0.70	19.1

Source: Department of Statistics (2002).

These investments translated into real improvements in the physical transportation, post, and telecommunication infrastructure sector, as shown in Table 8.5. The development indicator for the transportation infrastructure sector is the actual length of railways, highways, waterways, civil aviation routes, and petroleum and gas pipelines that are available for use. There are three development indicators in post and telecommunication infrastructure: capacity of long-distance telephone exchanges, capacity of local office telephone exchanges, and length of long-distance optical cable lines.

In the transportation infrastructure sector, highways and civil aviation are two subsectors with the most rapid growth. The length of highways in operation increased by 76 percent from 1990 to 2003. Impressive as it was, the performance of the highways subsector was overtaken by that of the civil aviation routes, which expanded by a multiple of 2.45, and by the petroleum and gas pipelines that doubled in length in the same period. On average, the length of highways increased by 5.4 percent per year, while those of civil aviation routes as well as gas and pipelines increased by 17.5 and 7.5 percent, respectively. To the poor in rural areas, railways and highways are more economical and convenient facilities to use to move around and in transporting goods and, thus, would tend to have a more pronounced effect on poverty reduction rather than waterways and civil aviation routes.

Table 8.5 **Indicators of Infrastructure Development, 1990–2003**								
	Transportation (in 10,000 kilometers)					*Post and Telecommunications*		
Year	*Railways*	*Highways*	*Waterways*	*Civil Aviation Routes*	*Petroleum and Gas Pipelines*	*Capacity of Long-distance Telephone Exchanges (in circuits)*	*Capacity of Local Office Telephone Exchanges (in 10,000 lines)*	*Length of Long-distance Optical Cable Lines (in kilometers)*
1990	5.78	102.83	10.92	50.68	1.59	161,370	1,232	3,334
1991	5.78	104.11	10.97	55.91	1.62	286,325	1,492	6,490
1992	5.81	105.67	10.97	83.66	1.59	521,885	1,915	14,388
1993	5.86	108.35	11.02	96.08	1.64	1,206,091	3,041	38,666
1994	5.90	111.78	10.27	104.56	1.68	2,416,296	4,926	73,290
1995	5.97	115.70	11.06	112.90	1.72	3,518,781	7,204	106,882
1996	6.49	118.58	11.08	116.65	1.93	4,162,009	9,291	130,159
1997	6.60	122.64	10.98	142.50	2.04	4,368,305	11,269	150,754
1998	6.64	127.85	11.03	150.58	2.31	4,491,595	13,824	194,100
1999	6.74	135.17	11.65	152.22	2.49	5,032,026	15,346	239,735
2000	6.87	140.27	11.93	150.29	2.47	5,635,498	17,826	286,642
2001	7.01	169.80	12.15	155.36	2.76	7,035,769	25,566	399,082
2002	7.19	176.52	12.16	163.77	2.98	7,730,133	28,657	487,684
2003	7.30	180.98	12.40	174.95	3.26	8,693,998	35,083	594,303

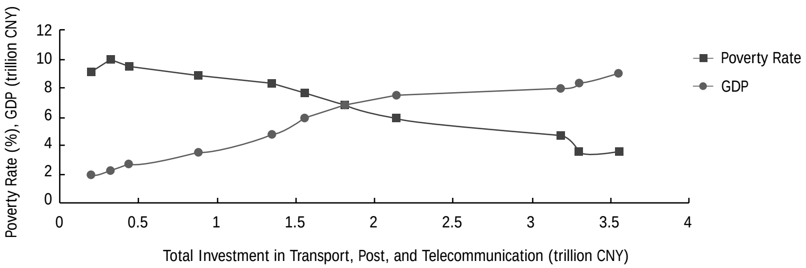
Source: National Bureau of Statistics (2004).

The growth of infrastructure in post and telecommunication facilities exceeded that of the transportation infrastructure sector. A basic medium for communication, the telephone, has been increasingly used in the PRC. By the end of 2003, the capacity of local office telephone exchanges had increased to 350 million lines, while that of long-distance telephone exchanges was close to 8.7 million circuits. Both capacities are 28 and 53 times their respective levels in 1990. The total length of long-distance optimal cable lines increased by a multiple of 12.7 annually, reaching nearly 594,300 kilometers in 2003 from 3,334 kilometers in 1990. All these remarkable accomplishments have laid a solid foundation for further development of telecommunication infrastructure.

Figure 8.3 illustrates a key relationship between GDP and poverty alleviation, or between total infrastructure investments and GDP. GDP correlates positively with total investments in transportation as well as post and telecommunications infrastructure; while rural poverty correlates negatively with both. There is a clear basis for this relationship and it is encouraging to note that the empirical record appears to support it.

This empirical relationship is further explored in Figures 8.4 and 8.5, wherein rural poverty incidence is correlated with the components of transportation infrastructure as well as with those of telecommunications. In Figure 8.4, all components of transportation infrastructure are measured on the primary vertical axis while that the poverty measurement is indicated on

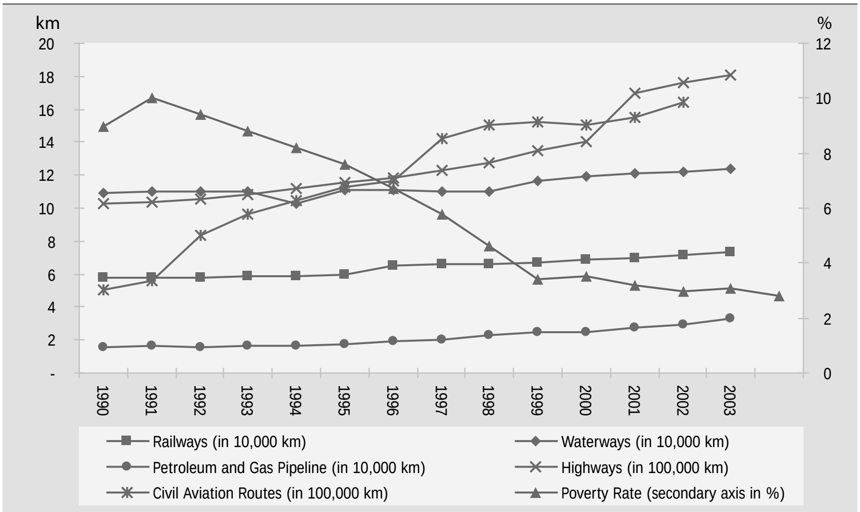
Figure 8.3 **Infrastructure Investments, Poverty Rate, and Gross Domestic Product**



Source: Author's calculation.

the secondary axis. It is interesting to note that, among all items in Figure 8.4, it is the highways which appeared to have the clearest positive impact on rural poverty alleviation.

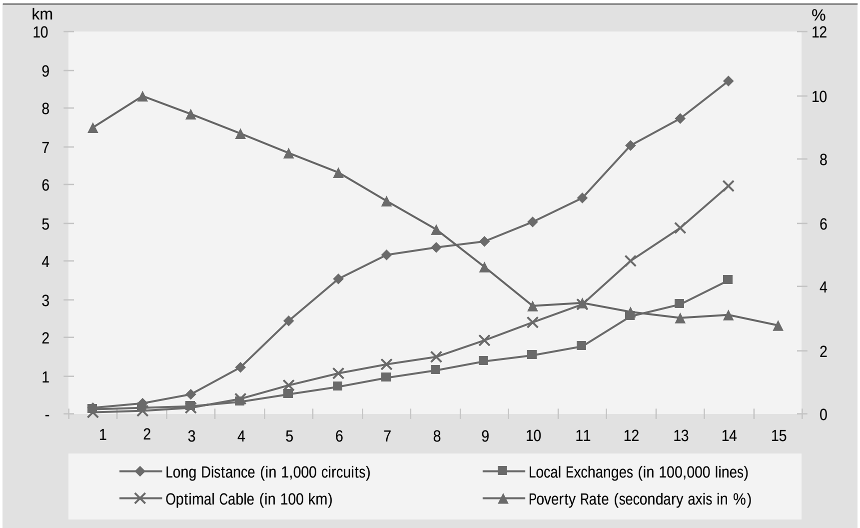
Figure 8.4 **Transportation Infrastructure Development and Poverty Incidence**



Source: Author's calculation.

A similar theme is portrayed in Figure 8.4, which shows the relationship between poverty alleviation and improvements in telecommunication-related infrastructure facilities. Poverty is negatively correlated with these improvements. Of the three components, long-distance telephone facilities apparently contributed substantially to poverty alleviation. The information in Figures 8.4 and 8.5 support the key theme, which is that continuously improving transportation and telecommunication infrastructure has the potential of stimulating and sustaining poverty alleviation.

Figure 8.5 **Post and Telecommunications Infrastructure Development and Poverty Rate**



Source: Author's calculation.

These results are consistent with expectations. Thus, it would be more useful to further assess the role of the improvement of infrastructure in reducing poverty and the magnitude of the effect using a CGE model. One advantage of the model is that it is designed to capture in some useful detail the constraints and relationships between institutions and sectors. With the help of this linkage mechanism, policy simulation would produce results that reflect the chain of effects from external shocks to poverty alleviation, which help in understanding more deeply the relationship between infrastructure development and poverty. The simulation results elaborate further the above discussion on the analytical and empirical aspects of this relationship. The study first assesses, in the next subsection, the related literature to be able to come up with a useful design of the policy scenarios for the simulations. The more detailed features of the model are introduced in the next section.

Empirical Assessment

The contribution of investment in infrastructure development to poverty alleviation particularly in rural areas has been studied extensively as it involves the problems of direction of capital flow and capital efficiency. Summers and Heston (1991) find that some infrastructure facilities such as for telecommunication, electricity, highways, and potable water are closely associated with per capita GDP growth. The mix of infrastructure varies with the level of economic development. In poor countries, rudimental infrastructures like water supply and irrigation are most important; for medium- or low-income countries, transportation infrastructure becomes increasingly important with the decline of agriculture's share in the country's GDP; and telecommunication facilities tend to receive the largest proportion of infrastructure investment in rich countries. However, most current studies on the relationship of infrastructure and poverty reduction focus on water supply, irrigation, and transportation sectors, rather than on electricity and telecommunication sectors.

Even for countries with similar levels of economic development, the packages of infrastructure facilities that they invest in vary because of their different socioeconomic characteristics. The International Food Policy Research Institute observed this variance based on the samples of infrastructure projects they selected in the PRC, India, and Thailand. The results of its assessment demonstrated that in the PRC and India, road construction in rural areas is more useful for poverty reduction than investments in irrigation facilities. In Thailand, a rural electricity network was found to be the most effective approach to poverty alleviation (Weiss 2003).

Many studies have explored the effects of transportation infrastructure construction on economic growth and poverty reduction in developing countries and have provided some useful observations. These studies can be grouped into two categories based on the methodology they use: econometric analysis and case studies. With case studies, researchers evaluate the adoption of certain policies by comparing indicators of different regions or during different time periods. Using econometric models, researchers estimate elasticities of dependent variables to independent factors.

In a case study of road construction in rural areas of Viet Nam; Glewwe, Gragnolati, and Zaman (2000) found that the likelihood of reducing poverty in rural areas with a better-developed road system was 67 percent higher than in those areas with a deficient road system. In another case study, Van de Walle and Cratty (2002) evaluated a road maintenance project in Viet Nam with World Bank funding. They observed that the project was most beneficial to the poorest rural households. With the project completed, 40 percent of rural poor households saved a substantial amount of their traveling time and improved to a good extent their capability to communicate with the outside world.

Compared with case studies that tended to focus on the poverty alleviation outcomes of policy implementation, econometric studies paid more attention to quantifying the linkages between the adoption of policies and poverty reduction. Kwon (2000) explored the direct and indirect channels through which infrastructure contributed to poverty alleviation, and found that the improvement of road status will benefit the poor through economic growth.

For provinces with better road systems, an increase of 1 percent of GDP decreases the poverty rate by 0.33 percent. In contrast, those provinces with inferior road networks had lower GDP elasticity of poverty alleviation of 0.09 percent. At the same time, the improvement of road facilities also benefited the poor population by increasing their wages and creating more job opportunities. An increase of investments in road construction by 1 percent translates into a 0.30 percent decline in the poverty rate.

Balisacan and Pernia (2002) used provincial data to examine the effects of road construction on poverty in Philippines. Their results revealed that if the construction is accompanied by an improvement in educational facilities, then a 1-percent increase of the length of the road system increased the average income of the poor by 0.11 percent, and induced a further increase of the same by 0.32 percent through the trickle-down effect of economic growth.

Fan, Zhang, and Zhang (2002) measured the effects of different types of government expenditures on economic growth and rural poverty alleviation in the PRC. They found that road facilities significantly reduced poverty incidence through agricultural productivity growth and nonagricultural employment opportunities. The estimated elasticities with respect to road density were 0.08 for per capita agricultural GDP, 0.10 for nonagricultural employment, and 0.15 for nonagricultural wages in rural areas. In similar research, Jalan and Ravallion (2002) estimated that an increase of 1 percent in road density induced a rise by 0.08 percent in household consumption expenditures.

Other studies explored the influence of infrastructure construction on productivity. The authors of some of these studies argued that the variance of economic development in various regions within the same country was partly due to differences in infrastructure development. Poor infrastructure development would not only directly dampen productivity growth, but would also deny the poor access to medical treatment, education, and communication with developed areas. By analyzing a time series survey data from 17 states of India; Nagaraj, Varoudakis, and Veganzones (2000) found that agricultural productivity kept growing with the increase of road length. An increase of 10 percent in productivity increased average income by 3.4 percent.

The improvement of road facilities was closely correlated with electrical consumption and residents' health status. Using the panel data of India's rural areas, Zhang and Fan (2001) estimated the influence of road construction on agricultural total factor productivity (TFP) in India. The growth elasticity of agricultural TFP to road density ranged between 0.043 and 0.078, depending on the specific econometric method used. In a similar study, Deichmann et al.

(2000) compared productivities of manufacturing in northern and southern areas of Mexico. They found that good road construction extended the potential and opportunity of market entry and that an increase of 10 percent in market channels translated into a 6 percent increase in productivity.

All of the above studies did not indicate the specific nature of the cause-and-effect relationships among economic variables. Moreover, the empirical results depended on selected methods, definitions of specified equations, and the data used in the analysis. However, these results can help clarify the important role of infrastructure construction in poverty reduction and to identify the relevant parameters of the CGE model.

On the other hand, not all studies provided similar results regarding the positive contribution of infrastructure development to poverty alleviation. In a study on Nepal's rural road facilities, Jacoby (1998) found that although the construction and improvement of rural road networks brought about substantial benefits, the poor captured only a small share of the gains. This is an important finding since without the poor obtaining more gains from infrastructure investments than the rich, the construction and improvement of rural road networks would hardly reduce poverty.

Besides quantitative methods, a number of scholars employed qualitative research techniques, such as concentrated interviews. In one such study in two provinces of the Central Highlands of Viet Nam, Songco (2002) noted that the social benefits from the improvement of rural roads were generally perceived as larger than economic ones. The surveys conducted by the World Bank (2002) and the Asian Development Bank (2002) also showed that the rural poor generally regarded roads as the necessary facility with the lowest construction cost. Roads can facilitate their access to medical treatment, education, and communication with developed areas, which they need for their personal development.

There are only a few studies that have examined the effects of telecommunication infrastructure on poverty reduction or economic growth. Uchimura and Gao (1993) analyzed the effects of infrastructure development as represented by the expansion and improvement of transportation, water supply, and telecommunication facilities on sectoral outputs. The elasticity of output[3] to infrastructure level in Korea was 0.19, while this figure was 0.24 in Taipei,China. Shah (1988, 1992) aggregated electricity, telecommunication, and transportation, and examined the effect of composite infrastructure on outputs. He estimated an elasticity of 0.05 in Mexico. Another study (Easterly

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3 This elasticity is defined as the influence of 1 percent change of infrastructure stock on percentage of output.

and Rebelo 1993) involving multiple countries showed that the average output elasticity was 0.16.

In summary, the literature is replete with empirical support to the proposition that infrastructure development alleviates poverty. This study takes the analysis further and explores the nature of the specific relationships among variables using a CGE model. In building the model, the framework described in Figure 8.2 above is followed. The study explores as well the influences of infrastructure development on labor migration, nonagricultural employment, and households' incomes and expenditures.

A CGE Model of the PRC's Economy

The CGE model used in this study is the latest version of the CGE model developed and maintained by the Development Research Center of the State Council in Beijing. Earlier versions of the model had been used to analyze the effects of the PRC's accession to the World Trade Organization (WTO) on economic growth (Development Research Center 1998) and urban unemployment (Zhai and Wang 2002), and the potential implications of trade and tax reform on income distribution (Wang and Fan 1998). After disaggregating households and labor, Hertel, Zhai, and Wang (2004) applied the model to examine the impact of the PRC's accession to the WTO on poverty alleviation. This study extends the model by improving the description of trade and tax policies and incorporating appropriable variables of investment in infrastructure construction.

Model Structure

In this part of the section, the basic structure and assumptions of the model is described. The discussion about the features of the model, which allow it to capture the effects of infrastructure development on poverty reduction is taken up in the last part of this section.

Model Dimensions. The model has 49 production sectors, 3 production factors (labor, capital, and land), and 2 households–one representing urban households and the other rural households. Of the 49 sectors, 6 are agriculture-related sectors, 36 are industrial and construction sectors, and 7 are service sectors. Labor and capital are mobile across sectors subject to restrictions mentioned below, while land is restricted to moving among the six agricultural sectors. There are three types of labor; namely, urban labor, rural nonagricultural labor, and rural agricultural labor. Each of type of labor is further disaggregated into three categories: unskilled labor (illiterate or semiliterate), semiskilled workers (with a middle or high school education), and skilled workers (schooling above high school). Both rural and urban households are each disaggregated into 100 subgroups according to their main sources and levels of income. The disaggregation would allow a better tracking of the effects of policy shocks on the economic status of each of these households and is further discussed below.

Production and Factor Markets. All sectors in the model are assumed to operate under constant returns to scale and it is also assumed that firms maximize profits of their respective production activities. The technologies of the production activities are represented by a nesting of constant elasticity of substitution production functions. The market is assumed to be perfectly competitive. Each type of labor resource is assumed to be fully mobile across sectors, except for agricultural labor which works only in the six agricultural sectors and rural nonagricultural workers who are employed only in nonfarm sectors in rural areas. Agricultural labor and production workers are not substitutable with one another. The PRC presently maintains significant barriers for rural workers to migrate to urban areas. The model captures this segmented labor market by incorporating partial mobility of agricultural laborers and production workers into the cities. The conversion between different types of labor is determined by the relative wage and the transformation elasticity.

Foreign Trade. The PRC exports and imports goods to and from the rest of the world. The amount that the PRC exports of a given locally produced good to the rest of the world is a constant elasticity of transformation function of the volume of the local good produced. Locally produced goods are imperfectly substitutable with imported goods. Thus, Chinese products are assumed to be differentiated from imported products, and exported merchandise are assumed to be qualitatively different from those sold in domestic markets. The demand for exports is a constant-elasticity function of their respective own prices. The price elasticities are high but less than infinite. Therefore, the terms of trade for the PRC are endogenous in the simulation. In the case of imports, the PRC is assumed to be a price taker in these markets, considering the country's small share in global import markets. Since foreign trade is not the focus of this research, this model does not differentiate the foreign trade regime. The taxes and subsidies of both imports and exports are also not further described.

Income Distribution and Demands. Factor incomes accrue to four institutions: enterprises, households, government, and the off-budget public sector. Household income comprises incomes from ownership of capital, labor, and land resources. Additionally, households receive distributed enterprise profits and transfers from the government and rest of the world. The model assumes that all the land endowments in the model belong to the rural households. Rural households earn their labor income from selling both agricultural labor and rural nonagricultural labor services. The urban households obtain their wages as urban workers. Returns to capital services are distributed among households and enterprises. Enterprise earnings are equal to the gross returns to capital services net of corporate income taxes. A part of enterprise earnings is allocated to households as distributed profits based on fixed shares, which are the assumed shares of capital ownership by households. Another part of these earnings is used to pay for fees to off-budget public sectors. The residual enterprise earnings are assumed to be the retained earnings, i.e., corporate savings for new investment and capital depreciation replacement. Household disposable income is allocated to final consumption of goods and services and to savings. Households maximize utility using the extended linear expenditure system which is an extension of the Stone-Geary demand system. The utility function involves saving as a covariate, which is evaluated using the consumer price index.

The government derives revenues from corporate income taxes, import tariffs, and two types of indirect internal taxes. The value-added tax is modeled as a tax levied on production factors. Other indirect taxes, including various agricultural taxes and business taxes on construction and services, are treated as a production tax levied on sector outputs. Government expenditure is mainly spent on purchasing public goods, providing subsidies for enterprises (treated as negative income of government), and providing transfers to households. Extra-budget public sectors collect fees from enterprises and households. Their incomes are allocated to consumption and saving. The consumption of extra-budget public sectors and government spending compose a type of final demand, i.e., the social consumption.

Macroeconomic Closure. Macroeconomic, or simply macro closure, determines the manner in which the following three accounts are brought into balance: government budget, aggregate savings and investment, and balance of payments. Real government spending is exogenous in the model. All tax rates and transfers are fixed, while real government savings is endogenous. The macro closure of the balance of payments requires that the value of imports at world price must equal the sum of the value of exports at border prices, net transfers and factor payments, and net capital inflows. An exchange rate is specified to convert world prices into domestic prices. Either this exchange rate or total foreign capital inflow can be fixed, while the other is allowed to adjust to provide alternative closure rules. With foreign savings set exogenously, equilibrium would be achieved through changing the relative price of the tradable to the non-tradable or changing the real exchange rate.

Finally, the total value of investment expenditure must equal total resources allocated to the investment sector: retained corporate earnings, total household savings, government savings, extra-budget savings, and foreign capital flows. In this model, different macro closures were selected for different experiments. In the first simulation, investment in infrastructure increases, the model assumes that the total investment is exogenously determined and the investment-savings balance is realized by the endogenous labor supply (i.e., unemployment exists). This specification corresponds to the Keynesian macroeconomic closure in CGE literature. Therefore, output is determined by demand. In the second simulation, the infrastructure improvement promotes labor migration and productivity growth, which is a relatively long process. Therefore, the model supposes that the aggregate investment is endogenously determined by the sum of the separate savings components that is, the model is savings-driven, which is a feature generally referred to as the neoclassical macro closure in CGE-related literature.

Data. The model is calibrated to the 1997 two-region Chinese social accounting matrix (SAM) developed from the 1997 national input-output table and other macroeconomic data. Some key parameters of the model, such as substitution and income elasticities, are obtained from earlier versions of the model and from the literature. All other parameters such as shift and share parameters are calibrated to the base year using the key parameters and the base data.

Modeling Household Behavior and Labor Migration

To improve the model's capability of assessing the effects of infrastructure on poverty, the number of households in the model is disaggregated to the highest extent possible, as permitted by the sampling design of the survey and the availability of other relevant data. The aggregations of the data from the rural and urban household surveys for three provinces[4] in the year 2000 were obtained from the NBS.

Respondent households in the surveys were grouped into five levels or strata according to their respective primary sources of income. The five household groups were: agriculture-specialized rural households, income-diversified rural households, transfer-specialized urban households, labor-specialized urban households, and income-diversified urban households. Within each stratum, households were ranked from poorest to richest, based

4 The three provinces are Guangdong, Sichuan, and Liaoning. Guangdong represents the relatively wealthy coastal region. Sichuan represents the populous, relatively poor inland region in which agriculture plays a more important role in the economy. Liaoning is a typical "old industrial base," which is heavily urban and highly dependent on state-owned enterprises. Together, these provinces are fairly representative of the diversity within the PRC as a whole.

on their respective per capita income. From the ranking, the stratum was then divided into 20 groups, each layer containing 5 percent of the stratum population. Thus, the model has a total of 100 household groups: 40 rural (20 groups × 2 strata) and 60 urban (20 groups × 3 strata) representative households. By incorporating the data structure into the national SAM, the model reflects the diversity of household earnings and spending. The income variance of the 10 groups of representative households belonging to middle to low income within each stratum provides useful information for studying the poverty problem.

Each household is endowed with three types of labor, namely unskilled, semiskilled, and skilled.[5] The capability of allocating labor to off-farm activities is one of the most important features of this model. Since the middle of the 1990s, agricultural workers have shifted to nonagricultural sectors or have migrated to urban areas. However, because of certain institutional reasons and practical difficulties, the mobility is greatly restricted. For example, households that ceased to farm would lose their property rights over these farm lands. Thus, they had a strong incentive to continue farming at some scale, even if the profitability to do so was quite low (Zhao 1999a). To the low-skilled agricultural workers, access to most of the urban amenities, such as housing and education, is limited and relatively expensive because they are unable to obtain an appropriate registration (*hukou*) to reside legally in an urban area. In addition, higher transport costs and the prospect of not finding a job in the cities deter large-scale rural-to-urban migration. All the above factors impede the flow of migrants from rural to urban areas. On the other hand, the growth in rural nonfarm activities is only modest, which limits the possibility of rural households obtaining local off-farm jobs (Chan and Zhang 1999).

Changes in the supplies of the various types of labor in the model are triggered by induced availability of nonfarm labor and the migration of rural labor to urban areas.

The off-farm labor supply is modeled using results from the econometric work of Sicular and Zhao (2002). They estimated a household labor supply function using labor survey data from the 1997 Chinese Health and Nutrition Survey of nine central provinces. Their research calculated the implicit (shadow) wage of each individual in the sample and the corresponding nonagricultural wage they could obtain if that individual were to work in agriculture or nonagricultural self-employment sectors. Thus Sicular and Zhao estimated labor supply equations for self-employed agricultural labor, self-employed nonagricultural labor, and wage labor.

5 In the model, labor skill is determined by educational attainment.

Based on the estimates of the parameters of the labor supply functions, the labor-transfer elasticities between agricultural and nonagricultural sectors were calculated. These elasticities depict the underlying constraints on labor migration in the system. The results showed that a 1-percent decrease of the shadow wage in agriculture induced 2.67 percent labor migration from farming to nonfarm activities in the model. The transfer elasticity from farm to nonfarm sectors in the case of a wage increase in the nonagriculture sectors was only 0.60. In the benchmark scenario of the model, the latter estimate of labor migration elasticity is used in this study as it apparently better reflects Chinese reality.

The basic equation of nonfarm labor supply is as follows:

$$\begin{cases} \dfrac{\sum_{rh} ls^{rlag}_{sk,rh}}{\sum_{rh}\left(ls^{rl}_{sk,rh} + ls^{ul}_{sk,rh}\right)} = \dfrac{\sum_{rh} als^{rlag}_{sk,rh}}{\sum_{rh} als^{rl}_{sk,rh}} * \left(\dfrac{w_{ag,sk}}{\overline{w}_{nag,sk}}\right)^{\omega^{l}_{ag,sk}} & (1) \\ \overline{w}_{nag,sk} = \dfrac{\sum_{rh} ls^{rl}_{sk,rh} * w_{nag,sk} + \sum_{rh} ls^{ul}_{sk,rh} * w_{sk} * w^{d}_{sk}}{\sum_{rh}\left(ls^{rl}_{sk,rh} + ls^{ul}_{sk,rh}\right)} & (2) \end{cases}$$

where

$ls^{rlag}_{sk,rh}$ Final agricultural labor supply by rural households

$ls^{rlag}_{sk,rh}$ Final nonagricultural rural labor supply by rural households

$ls^{rl}_{sk,rh}$ Final nonagricultural urban labor supply by rural households

$als^{rlag}_{sk,rh}$ Initial agricultural labor supply by rural households

$als^{rl}_{sk,rh}$ Initial nonagricultural rural labor supply by rural households

$w_{ag,sk}$ Agricultural wages by different skill levels

$\overline{w}_{nag,sk}$ Nonagricultural average wages of rural labor

$\omega^{l}_{ag,sk}$ Elasticity of labor transfer from agricultural to nonagricultural sectors

$w_{nag,sk}$ Nonagricultural average wages of rural labor on different skilled levels

w_{sk} Urban wages by skill levels

μ Urban unemployment rate of rural migrant labor

w_{sk}^{d} Coefficient of wage distortion between urban and rural areas

From a long-term perspective, all of the labor resources in the economy are fully employed. However, in the short run, when it is costly to move to other sectors, migration decisions are based on the net benefit of moving. The model depicts the problem by introducing an endogenous unemployment rate of migrants. We assume that urban labor is fully employed. However, migrant rural labor going to cities or seeking jobs in off-farm activities may possibly be unemployed because of the *hukou* restriction or because they lack the skills required by the available jobs. Therefore, it is not the wage difference between rural and urban areas, but the expected income after migration that farmers assess in deciding whether to migrate or not. By introducing $(1 - \mu)$ as the unemployment rate of rural migrants, Equation 2 is modified to obtain the following short-term expression:

$$\overline{w}_{nag,sk} = \frac{\sum_{rh} ls_{sk,rh}^{rl} * w_{nag,sk} + \sum_{rh} (ls_{sk,rh}^{ul} * (1-\mu)) * w_{sk} * w_{sk}^{d}}{\sum_{rh} \left(ls_{sk,rh}^{rl} + ls_{sk,rh}^{ul} * (1-\mu) \right)}$$

Most of the nonfarm labor provided by rural households migrate to urban areas. Based on existing statistics from the Family Planning Committee of China, the volume of the "floating population"[6] in the PRC has risen to 0.14 billion in 2003 from 70 million in 1993. Within the decade, the quantity has doubled and exceeded 10 percent of the total national population. At the end of 2003, the floating population accounted for about 30 percent of the entire rural labor force (Xinhua Net 2005). However, the labor migration from rural to urban areas is far from free in the PRC. Although the relatively significant wage difference is attractive, labor migrants from rural areas continue to face the very high social costs of moving to the cities, such as transport costs, unemployment, housing unavailability, and other uncertainties. Some of these transaction costs are invisible, but, they constitute heavy burdens for migrant rural workers and their families.

Zhao (1999b) claimed that the average annual wage gap between rural and urban areas of unskilled workers of comparable background and ability

6 Chinese demographers classify them as temporary settlers from rural to urban areas in search of work and better life. These people are not officially registered in their temporary abode and are considered "illegal migrants" or "floating population" since they are expected to eventually return to their villages.

in Sichuan Province was CNY2,387.60 in 1995. Most of this gap may be explained by the social costs associated with migration as mentioned above. Shi, Sicular, and Zhao (2002) studied the phenomenon of rural-urban income inequality in greater detail using data from the Chinese Health and Nutrition Survey involving nine provinces of the PRC. The authors observed that the apparent labor market distortion accounted for 42 percent of the rural-urban labor income differential and 48 percent of the hourly earnings differential. When applied to the average wage differential, this distortion plays a role as an ad valorem "tax" accounting for 81 percent of rural wages. In this model, we treat these transaction costs as real costs that are borne by the temporary migrants.

The transaction cost function is postulated as an increasing function of migrants' quantity with fixed elasticity. The cost increases proportionately with the number of rural residents engaged in temporary work. When labor migration reaches a certain level, any further increase in the number of migrants would have only limited effects.

In the long term, with all labor resources fully employed, the equations of household labor supply including rural-urban labor migration are as follows:

$$\begin{cases} ls^{l}_{sk,h} = als^{l}_{sk,h} + lag^{l}_{sk,h} - migl^{l}_{sk,h} & (3) \\ w_{sk} * w^{d}_{sk} = c^{d}_{sk} + (1 + \tau^{C_{ind}}_{sk}) * w_{nag.sk} & (4) \\ \tau^{C_{ind}}_{sk} = \alpha^{C_{ind}}_{sk} * \left(\dfrac{tmigl_{sk}}{\sum_{rh,l} ls^{l}_{sk,rh}} \right)^{\omega^{mig}} & (5) \end{cases}$$

where

$ls^{l}_{sk,h}$ Final labor supply by households

$als^{l}_{sk,h}$ Initial labor supply by households

$lag^{l}_{sk,h}$ Off-farm labor transfer by households

$migl^{l}_{sk,h}$ Migrant labor from rural to urban areas by households

c^{d}_{sk} Direct cost of labor migration

$\tau^{C_{ind}}_{sk}$ Tax-equivalent indirect cost of labor migration

$\alpha_{sk}^{C_{ind}}$ Initial transfer factor of labor migration costs

$tmigl_{sk}$ Total rural-urban labor migration

ω^{mig} Indirect cost elasticity of labor migration

In the short-term scenario, it is important to consider the unemployment problem of rural migrants. The model assumes that migrants would decide to move to the cities when their expected income of doing so exceeds their respective costs of moving. Equation 4 is modified accordingly by the following:

$$w_{sk} * w_{sk}^{d} * (1-\mu) = c_{sk}^{d} + (1+\tau_{sk}^{C_{ind}}) * w_{nag,sk}$$

With nonfarm transfer and rural-urban migration of rural labor featured in the model, the final equilibrium condition of labor markets comprises three components: the supply-and-demand equilibrium of rural agricultural labor, rural nonagricultural labor, and urban labor. The equilibrium equations are as follows:

$$\begin{cases} \sum_{inag} ld_{sk,inag}^{u} = \sum_{uh} ls_{sk,uh}^{ul} + \sum_{rh} ls_{sk,rh}^{ul} * w_{sk}^{d} & (6) \\ \sum_{iag} ld_{sk,iag}^{r} = \sum_{rh} ls_{sk,rh}^{rlag} & (7) \\ \sum_{inag} ld_{sk,inag}^{r} = \sum_{rh} ls_{sk,rh}^{rl} & (8) \end{cases}$$

where $ld_{sk,inag}^{u}$ and $ld_{sk,inag}^{r}$ respectively represent the demand of producers in non-agriculture sectors for urban and rural labor by skill levels. The variable $ld_{sk,iag}^{r}$ is the corresponding demand of producers in agriculture industries.

For the short-term analysis, Equation 1 above is modified in the following form:

$$\sum_{inag} ld_{sk,inag}^{u} = \sum_{uh} ls_{sk,uh}^{ul} + \sum_{rh} ls_{sk,rh}^{ul} * (1-\mu) * w_{sk}^{d}$$

In this study, the transaction costs relating to rural-to-urban migration significantly influence migration decisions and, thus, labor markets. Infrastructure investment and construction have the potential of improving the demand for low-skilled labor and providing more job opportunities for agricultural labor to participate in off-farm activities. Moreover, infrastructure development in urban areas would tend to attract more rural migrants.

However, migrant workers may come from rural areas with less favorable social circumstances, and moving into the cities entails costs, including higher transport fees, living costs, and other indirect transaction costs. Infrastructure improvement would reduce these costs to a certain degree, but, for different types of labor and households, the net gains are not equal. The simulation results in the next section of this chapter, further reveal the nature and mechanism of the influence of infrastructure development on poverty reduction.

Simulations Design and Main Results Analysis

Simulations Design

This study analyzes the contribution of transportation and telecommunications infrastructure improvements, which associate closely with production and household living standards, to poverty alleviation. In doing this, it focuses on two aspects of infrastructure improvements, namely, the increase of infrastructure investment and the improvement of physical infrastructure. These relate to the short- and long-term effects of infrastructure improvements, which are elaborated below.

With regard to the short-term effects of infrastructure investment, this study assumes a 10 percent increase of infrastructure investments and incorporates the increase in the model by increasing total investment in economy.[7] In 1997, which is the base year of the model, the total investment in capital construction of the transportation, post, and telecommunication sector was CNY215.07 billion; the total investment in fixed assets in the sector was CNY2,494.11 billion. With a 10 percent increase of infrastructure investments, the investment reaches about CNY236.58 billion. This translates into a 0.86 percent rise of the total investments in the economy, assuming investments in other sectors remain the same. For this scenario, the model uses *Keynesian closure*, in which the unemployment rate is determined endogenously.

From a long-term perspective, the improvement in infrastructure facilities would substantially reduce transportation, communication, and labor-migration costs. The ensuing enhancement of mobility and access to information of the population accelerates the diffusion of knowledge and technology. This result then stimulates productivity improvements.

7 Because of the lack of detailed statistical data on infrastructure investments and total investments in the economy, this research selects the index of investment in capital construction and total investment in fixed assets instead to reflect the changes of the above two aspects.

In capturing these long-term results in the simulations, the study assesses first the effects on poverty reduction of infrastructure improvements through reduced migration costs. Then the link of improvements of infrastructure conditions to productivity is examined through their effects on agricultural labor productivity.

The model assumes that a 10 percent improvement of infrastructure conditions would reduce migration costs by 1 percent. The share of the rural poor in the benefits from infrastructure improvement depends not only on the availability of the physical infrastructure itself, but also on the conditions of the use of the infrastructure such as traffic fees and telecommunication service tariffs. The assumed discounted impact on migration costs reflects the state of use by the poor of the infrastructure facilities. If the government adopts specific pro-poor measures, such as lowering the telecommunication fees in poor areas and reducing the traffic fees for migrant workers from poor rural areas, then the benefit of infrastructure improvement would be more widely shared by the poor population in rural areas. In such a case, the model assumes that the 10 percent improvement of infrastructure conditions would result in a 5 percent reduction of migration costs.

With regard to the effects of infrastructure improvement on productivity, the empirical literature[8] provides information that in developing countries, the elasticity with respect to road density ranges from 0.043 to 0.080 for agricultural GDP per worker or for agricultural TFP. The estimate produced by Fan, Zhang, and Zhang (2002) based on the regional data of the PRC is used in this study, that is, the elasticity of agricultural labor productivity with respect to road density is 0.080.

However, when it comes to telecommunications infrastructure facilities, the literature is apparently without any elasticity parameter estimations that may be used in the simulation. The PRC is a developing country and its agricultural production technology continues to be traditional. Thus, in contrast to transportation infrastructure, which plays a more basic role in national economy, the telecommunications infrastructure is expected to have a smaller influence on agricultural development. Thus, in the model, the elasticity of agriculture labor productivity with respect to telecommunications infrastructure improvements is 0.040 or half of the transportation infrastructure.

The growth rate of labor productivity in agricultural sectors is described by the following equation:

$$\Delta_{lag} = 0.08\Delta_{trn} + 0.04\Delta_{cmn}$$

8 See the literature review in the subsection on the analytical framework.

where Δ_{trn} stands for the percentage increase of road density and Δ_{cmn} is the corresponding variable for telecommunications infrastructure, including the expansion of telephone-exchanges capacity, enlargement of broadcasting and television networks, and improvement of network coverage rates. Following the equation, the agricultural labor productivity rises by 1.2 percent over its base year level if both transportation and telecommunications infrastructure stock increases by 10 percent.

For the latter simulation on the long-term effects of infrastructure improvement, the model uses *neoclassical* macroeconomic closure. Table 8.6 summarizes the simulations that were done in this study.

Table 8.6 **Summary of Simulations Design**

Experiment		*Description*
1. Infrastructure investment increases	—	Total investments in transport and telecommunication infrastructure construction are exogenously increased by 10% while those in other sectors are held constant. Total investment in national economy exogenously increases by 0.85%.
	—	The labor force in urban areas is fully employed, while the unemployment rate of rural migrants is endogenously determined.
2. Physical infrastructure improves	—	The migration costs are reduced by 1% due to the improvement of infrastructure facilities by 10% and by 5% if the improvement is accompanied by relevant pro-poor measures.
	—	The migration costs are reduced by 5% and the labor productivity in agricultural sectors go up by 1.2% through the improvement of infrastructure conditions with relevant pro-poor measures.

Note: Base year = 1997
Source: Author's design.

Analysis of Simulation Results on Poverty Reduction

Short-term Effects of Infrastructure Investments. Table 8.7 shows the percentage changes of the values of selected macroeconomic indicators from their respective base-year levels. The results show that a 10 percent increase of infrastructure investment increases GDP and the aggregate economic welfare by 0.371 percent and 0.365 percent, respectively. More investments provide more employment opportunities, increasing the employment rate of rural migrant workers by 3.8 percent. The number of migrant workers from rural to urban areas rises by 4.57 percent.

Based on the changes of the production activities of various sectors, the increase of infrastructure investments increases the production of related sectors and creates more job opportunities. Table 8.8 lists the top 15 out of the total 49 sectors of the model in terms of output and labor demand increases, respectively. Except for the construction sector, all the other sectors in the table engaged in manufacturing and most of these are labor intensive. These industries are among the top 15 sources of nonagricultural jobs for rural migrant workers. The electronic components sector, which is capital intensive, does not provide as many new jobs as the other sectors listed in Table 8.8.

Table 8.7 **Economic Effects of a 10% Increase of Infrastructure Investment**

Factors	*Change*	*Factors*	*Change*
Macroeconomic Variables		*Unskilled Wages*	
GDP	0.37	Urban	-3.94
Consumption	-0.08	Nonagricultural Including Migrants	1.60
Investment	0.85	Rural Nonagricultural	-0.41
Welfare (EV)	0.37	Agricultural Without Land Return	0.27
Employment Rate of Rural Migrants	3.81	*Semiskilled Wages*	
Inequality Measurement [a]		Urban	-1.81
Gini coefficient	-0.00160	Nonagricultural Including Migrants	1.19
Urban	0.00017	Rural Nonagricultural	1.78
Rural	0.00003	Agricultural Without Land Return	0.91
Labor Migration		*Skilled Wages*	
Agricultural-Nonagricultural	1.66	Urban	0.50
Rural-Urban	4.57	Nonagricultural Including Migrants	2.60
		Rural Nonagricultural	4.32
		Agricultural Without Land Return	1.23

EV = Economic value, GDP = Gross domestic product
[a] Change of original value, not percentage change.
Source: Author's calculation.

Table 8.8 **Effects of a 10% Increase of Infrastructure Investment on Output and Demand for Nonagricultural Labor**

Sectors	*Percentage Change of Output*	*Rank*	*Percentage Change of Demand for Nonagricultural Labor*	*Rank*
Metal Ore Mining	1.013	1	3.140	1
Metal Smelting	0.887	2	2.874	2
Instruments & Meters	0.886	3	2.859	3
Coal Mining	0.884	4	2.843	4
Construction	0.835	5	2.820	5
Nonmetal Products	0.788	6	2.802	6
Special Equipment	0.780	7	2.793	7
Nonferrous Ore Mining	0.770	8	2.643	8
Machinery	0.741	9	2.817	9
Transport Machinery	0.733	10	2.740	10
Mining	0.713	11	2.742	11
Metal Products	0.678	12	2.662	12
Building Materials	0.644	13	2.651	13
Electric Equipment	0.621	14	2.636	14
Electronic Components	0.581	15	a	a
Other Manufacturing	a	a	2.615	15

[a] Implies this sector was not ranked 15 or better under this category.
Source: Author's calculation.

The workers in the top 15 sectors stand to earn higher wages considering that, with a 10 percent increase in infrastructure investment, the average wage of semiskilled and skilled nonagricultural labor increases by 1.19 and 2.60 percent, respectively, as shown in Table 8.7. On the other hand, migration also alleviates rural employment pressure. The number of rural-to-urban migrant workers increases by 4.57 percent. Those rural workers shifting to off-farm jobs also increase in number by 1.66 percent. Migration increases agricultural incomes. The average wages of semiskilled and skilled agricultural labor increases by 0.91 and 1.23 percent, respectively. All these factors improve the well-being of rural households.

With the increase in infrastructure investments, rural households with medium- and low-income levels are generally better off, as shown in Table 8.9. Urban households, however, have reduced real incomes, except for transfer-specialized urban households, whose incomes rise moderately. The decline of incomes of urban households may be traced to lower wages of unskilled and semiskilled urban workers as portrayed in Table 8.7. In Table 8.9, the cuts in incomes are regressively distributed, i.e., poorer households obtained larger losses of incomes. It is understandable since low income is often linked with low-skilled labor.

Table 8.9 **Effects of a 10% Increase of Infrastructure Investment on the Welfare of Medium and Low Income Households**

Groups (Poorest=1)	*Urban*			*Rural*	
	Transfer Specialized	*Labor Specialized*	*Diversified*	*Agriculture Specialized*	*Diversified*
1	0.115	-1.517	-1.13	0.214	0.261
2	0.233	-1.406	-1.047	0.265	0.317
3	0.201	-0.985	-0.909	0.268	0.298
4	0.224	-1.330	-0.929	0.319	0.282
5	0.244	-0.996	-0.704	0.266	0.290
6	0.256	-0.904	-0.694	0.349	0.304
7	0.272	-0.817	-0.628	0.327	0.296
8	0.188	-0.923	-0.632	0.258	0.320
9	0.204	-0.737	-0.490	0.238	0.297
10	0.201	-0.642	-0.371	0.251	0.305

Source: Author's calculation.

The general improvement of incomes of rural households and the income cuts suffered by a number of urban households have the effect of reducing income inequality. The national Gini coefficient reduces by 0.0016. For urban areas, the coefficient rises by 0.0017, reflecting the result that poorer households suffer relatively larger income losses. However, the coefficient for rural areas hardly changes.

To summarize, the short-term effects of a 10 percent increase of infrastructure investments generally confirm that infrastructure development in transportation and telecommunication helps reduce poverty. Higher outputs and thus more demand for nonagricultural labor provide new job opportunities for rural migrants. This is the most important and direct way by which infrastructure construction helps alleviate poverty.

Long-term Effects of Improvement in Infrastructure Conditions–Lower Migration Costs. Table 8.10 shows the long-term effects of a 10 percent improvement in infrastructure facilities. The results demonstrate that the reduction of migration costs has limited effects on macroeconomic variables like gross output and investment. However, reduced migration costs promotes labor migration. The migration between agriculture and nonagriculture improves by 0.06 percent and the rural-urban migration improves by 0.73 percent. If migration costs are reduced further with complementary pro-poor measures, the number of migrants increases by 0.28 percent and 3.68 percent, respectively. More rural workers find jobs which pay more by migrating to urban areas or working in off-farm production activities. This not only increases the income of the migrants, but mitigates as well the oversupply of rural labor. The respective wages of rural workers with varying skill levels are generally increased. However, under the background of full employment and limited economic growth, the urban workers are adversely affected by the influx of rural migrants in the cities, pulling down urban wages of unskilled and semiskilled workers.

Table 8.10 **Long-Term Economic Effects of a 10 % Increase of Infrastructure Investment, by Alternative Migration Cost Reductions**

	Migration Costs Reduced by			*Migration Costs Reduced by*	
Factors	*1%*	*5%*	*Factors*	*1%*	*5%*
Macroeconomic Variables			*Unskilled Wages*		
GDP	0.02	0.11	Urban	-0.24	-1.17
Consumption	0.00	0.01	Nonagricultural Including Migrants	0.04	0.20
Investment	0.06	0.32	Rural Nonagricultural	0.15	0.76
Welfare (EV)	0.02	0.11	Agricultural Without Land Return	0.05	0.22
Inequality Measurement [a]			*Semiskilled Wages*		
Gini coefficient	-0.00025	-0.00124	Urban	-0.17	-0.85
Urban	0.00016	0.00078	Nonagricultural Including Migrants	0.17	0.82
Rural	0.00003	0.00015	Rural Nonagricultural	0.19	1.00
Labor Migration			Agricultural Without Land Return	0.15	0.73
Agricultural-Nonagricultural	0.06	0.28	*Skilled Wages*		
Rural-Urban	0.73	3.68	Urban	0.04	0.20
			Nonagricultural Including Migrants	0.04	0.20
			Rural Nonagricultural	0.04	0.20
			Agricultural Without Land Return	0.05	0.23

EV = Economic value, GDP = Gross domestic product
[a] Change of original value, not percentage change.
Source: Author's calculation.

Rural households with medium or low incomes are generally better off (Table 8.11). This is particularly true for households with diverse sources of incomes. The well-being of transfer-specialized urban households hardly changes, while those of urban households that are dependent on wage income and those with several sources of income are adversely affected, likely because of the influx of rural migrant workers to the cities. The more migrants, the bigger the welfare loss to the two types of urban households. Overall, welfare improves by 0.02 and 0.10 percent corresponding to the extent of the reduction of migration costs, and similarly the Gini coefficient decreases by 0.0003 and 0.0012, respectively, implying an alleviation of inequality of income distribution between rural and urban areas.

Table 8.11 **Income Effects of a 10% Increase of Infrastructure Investment on Medium to Low Incomes Households, by Alternative Migration Costs Reductions**

Groups (Poorest=1)	*Urban*				*Rural*			
	Labor Specialized Migration Costs Reduced by		*Diversified Migration Costs Reduced by*		*Agriculture Specialized Migration Costs Reduced by*		*Diversified Migration Costs Reduced by*	
	1%	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*
1	-0.23	-1.15	-0.20	-0.98	0.05	0.25	0.12	0.62
2	-0.30	-1.49	-0.27	-1.34	0.04	0.17	0.21	1.05
3	-0.24	-1.18	-0.31	-1.55	0.03	0.15	0.23	1.14
4	-0.41	-2.01	-0.32	-1.59	0.04	0.20	0.23	1.17
5	-0.29	-1.43	-0.30	-1.47	0.03	0.17	0.26	1.33
6	-0.32	-1.59	-0.31	-1.53	0.04	0.17	0.30	1.52
7	-0.31	-1.54	-0.32	-1.57	0.03	0.13	0.33	1.66
8	-0.39	-1.94	-0.38	-1.86	0.03	0.17	0.37	1.89
9	-0.36	-1.75	-0.33	-1.61	0.03	0.13	0.38	1.90
10	-0.33	-1.61	-0.28	-1.40	0.03	0.17	0.42	2.13

Source: Author's calculation.

The simulation results above indicate that the improvement of infrastructure, working through lower migration costs, has limited influence on economic growth and employment. It could, however, improve its contribution to poverty alleviation through its effects on income distribution.

Long-term Effects of Improvement in Infrastructure Conditions–Lower Migration Costs and Higher Labor Productivity. The improvement of infrastructure conditions not only reduces migration costs, it also improves productivity. The network of infrastructure facilities strengthens the connection between undeveloped rural areas of the PRC and the outside world. The growth of agricultural labor productivity has a pronounced role in reducing poverty. Under this long-term assessment, new and improved infrastructure facilities would influence poverty through both productivity and distributive effects. Table 8.12 shows the results of the simulations involving both lower migration costs and higher productivity.

In simulating the effects of both shocks, the study assumes that the 10 percent improvement of physical infrastructure facilities would reduce migration costs by 5 percent and increase agricultural labor productivity by 1.2 percent, which in turn causes GDP to rise by 0.32 percent. The results of the simulation indicate that agricultural sectors attain a larger expansion

Table 8.12 **Long-Term Overall Economic Effects of a 10% Improvement of Physical Infrastructure, 5% Reduction of Migration Cost, and 1.2% Agricultural Labor Productivity Growth, by Alternative Migration Elasticity**

	Labor Migration Elasticity			*Labor Migration Elasticity*	
Factors	*Low (0.60)*	*High (2.67)*	*Factors*	*Low (0.60)*	*High (2.67)*
Macroeconomic Variables			*Unskilled Wages*		
GDP	0.32	0.35	Urban	-1.60	-1.76
Consumption	0.25	0.20	Nonagricultural Including Migrants	-0.24	-0.41
Investment	0.57	0.70	Rural Nonagricultural	0.10	0.12
Welfare (EV)	0.31	0.34	Agricultural Without Land Return	-1.01	-0.66
Inequality Measurement [a]			*Semiskilled Wages*		
Gini Coefficient	0.00102	-0.00072	Urban	-0.64	-1.00
Urban	0.00031	0.00069	Nonagricultural Including Migrants	1.10	0.77
Rural	-0.00006	-0.00003	Rural Nonagricultural	1.25	0.80
Labor Migration			Agricultural Without Land Return	-0.74	-0.01
Agricultural-Nonagricultural	2.00	4.04	*Skilled Wages*		
Rural-Urban	4.19	4.84	Urban	0.53	0.56
			Nonagricultural Including Migrants	0.53	0.56
			Rural Nonagricultural	0.53	0.56
			Agricultural Without Land Return	-1.02	0.19

EV = Economic value, GDP = Gross domestic product
[a] Change of original value, not percentage change.
Source: Author's calculation.

of their respective outputs than nonagricultural industries. Moreover, the demands for off-farm labor in rural areas of various sectors also expand.

Higher agricultural labor productivity induces an excess supply of rural labor, which tends to dampen wages in agriculture. While lower migration costs help cause agricultural labor productivity to grow, they also increase the number of rural-urban migrants by 4.19 percent; which mitigates the adverse effects on rural household incomes of agricultural labor productivity growth. When the number of migrants is inadequate to offset the adverse effects of an oversupply of rural labor, the remuneration for rural agricultural labor would tend to decline in the case of full employment. In such a case, the benefits of economic growth are shared more proportionately by urban households. The Gini coefficient between rural and urban areas increases by 0.001, assuming a low migration elasticity of 0.6.

If the government relaxes its restrictions on labor migration, such as the permanent residence registration system, and provides flexibility to the farmers with respect to the land property system, then the number of migrant workers would expectedly increase. These reforms may be reflected in higher elasticity of rural labor migration to nonagricultural sectors, which is assumed to be 2.67, thus increasing even more the available nonagricultural labor in the model. With this elasticity, the 10 percent improvement of infrastructure conditions causes GDP to rise by 0.35 percent and the number of rural migrants to cities to rise by 4.84 percent as shown in Table 8.12. The induced additional migration alleviates the downward pressure on rural wages caused by an excess supply of rural labor, which agricultural labor productivity growth causes to happen. At the same time, these migrant workers have the potential to earn higher incomes in nonagricultural activities. Thus, the rural households can benefit more from the economic growth and the overall Gini coefficient goes down by 0.00072 units.

These effects are reflected in the changes of household incomes as shown in Table 8.13. The well-being of the transfer-specialized urban households hardly changes, while the effects for the other households vary depending on the migration elasticities. With a small number of migrants, the benefits of economic growth brought by productivity improvement are generally enjoyed by urban households. In rural areas, only the households that have the opportunities to work in nonfarm sectors can improve their welfare to a certain degree. The agriculture-specialized households suffer a welfare loss because the agricultural wage falls due to an excess supply of labor. If there are more migrants, then the real incomes of agriculture-dependent and income-diversified rural households improve, with the latter enjoying more gains compared to the former. However, at a high level, labor migration would induce adverse effects on incomes of the low-income urban households.

Table 8.13 **Long-Term Income Effects on Medium to Low Income Households of a 10% Improvement of Physical Infrastructure, 5% Reduction of Migration Cost, and a 1.2% Agricultural Labor Productivity Growth, by Alternative Migration Elasticity**

	Urban				Rural			
	Labor Specialized Labor Migration Elasticity		Diversified Labor Migration Elasticity		Agriculture Specialized Labor Migration Elasticity		Diversified Labor Migration Elasticity	
Groups (Poorest=1)	Low (0.60)	High (2.67)	Low (0.60)	High (2.67)	Low (0.60)	High (2.67)	Low (0.60)	High (2.67)
1	0.15	-0.72	0.18	-0.34	-0.09	0.20	0.53	0.74
2	0.11	-0.88	0.31	-0.44	-0.07	0.13	0.82	1.21
3	0.38	-0.32	0.70	-0.18	-0.08	0.09	0.76	1.21
4	0.03	-1.09	0.63	-0.27	-0.15	0.09	0.84	1.27
5	0.22	-0.57	0.90	-0.01	-0.12	0.08	0.84	1.33
6	0.57	-0.35	0.87	-0.02	-0.14	0.06	1.06	1.53
7	0.55	-0.35	1.20	0.24	-0.11	0.04	1.21	1.69
8	0.38	-0.70	1.29	0.15	-0.14	0.06	1.28	1.83
9	0.96	-0.13	1.66	0.61	-0.11	0.05	1.21	1.76
10	1.19	0.16	1.80	0.84	-0.12	0.08	1.68	2.12

Source: Author's calculation.

The effects on the welfare of households suggest that the government may cause incomes to be better distributed between rural and urban areas by calibrating the system reforms. With reforms implemented, the rural households may benefit more from economic growth without the urban households being made worse off in the process.

Conclusions and Policy Implications

By including possible poverty reduction channels in the CGE model framework, this study quantitatively analyzed the influences of infrastructure on the macro economy, income distribution, and poverty reduction, and identified the key factors that effectively contribute to poverty reduction.

Higher infrastructure investments promote the growth of the economy and improve the welfare of all rural households by spurring the generation of more off-farm and urban job opportunities. On the other hand, as more and more rural migrants try to work in urban areas, the competition in labor markets in the cities becomes more intense, which has adverse effects on the income and well-being of households in urban areas. Income inequality is thus moderately improved.

The most direct benefit brought to the poor by infrastructure improvements is the reduction of migration costs, which in the long run stimulates further labor productivity growth. Lower migration costs alone have limited effects on economic growth and alleviate rural poverty through their effects on income distribution. The lower the migration costs, the more the rural households benefit. The improvement of agricultural labor productivity strongly promotes economic growth, but the distribution of the benefits is determined by the scale of labor migration.

In closing, infrastructure construction confers both economic growth and social development benefits, but this intervention on its own is not sufficient to ensure poverty reduction. Infrastructure's full contributions to poverty reduction depend on other related policies and measures. These measures may include micro pro-poor measures, such as lowering the telecommunication and traffic fees to reduce the costs of moving to the cities. System reforms, such as the in labor market and in the residence registration system, may also be considered to relax the restrictions on labor migration to a greater extent. Decreasing migration costs and promoting nonfarm employment in urban areas of rural labor are the key approaches through which infrastructure makes contributions to poverty reduction.

CHAPTER 9

Computable General Equilibrium—Microsimulation Model: Economic and Poverty Impacts of Trade Liberalization in Indonesia

Guntur Sugiyarto, Erwin Corong, and Douglas H. Brooks

Introduction

The Indonesian government has actively pursued unilateral, bilateral, regional, and multilateral trade liberalization for the last two decades. All liberalization was done in the context of Indonesia's membership in the World Trade Organization (WTO), Asia-Pacific Economic Cooperation (APEC), Association of Southeast Asian Nations (ASEAN) Free Trade Area, ASEAN–China Free Trade Area, and ASEAN–China, Japan, Korea (ASEAN+3). Indonesia has also played an active role in the WTO by coleading the Group of 33 (G33) countries in the ongoing negotiations for the Doha Development Agenda (DDA).[1] The main objective of the DDA is to help developing countries by removing distorting tariffs and subsidies and improving market access to help promote economic development and reduce poverty.

The government's involvement in these various trade agreements, as well as in structural adjustment programs with the World Bank and the International Monetary Fund, has intensified the country's trade liberalization process. As a result, Indonesia has, in some instances, unilaterally hastened the liberalization pace beyond its commitments with the WTO (WTO 2003).

The rapid pace of unilateral trade liberalization and the imminent agricultural liberalization resulting from the DDA have been the subject of policy debates. Questions have been raised, such as: What are the economy-wide and poverty impacts of trade liberalization? Is there any justifiable reason for still protecting the agricultural sector? What are the effects of farm trade liberalization that might result from the DDA? Since most farm workers are among the very poor, will they benefit from the DDA and, if so, how?

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1 G33 was co-led by Indonesia and the Philippines during the 2001 WTO ministerial meeting.

The objective of this study is to shed light on these issues by examining the economy-wide and poverty impacts of unilateral, but DDA-consistent, trade liberalization in Indonesia using a computable general equilibrium (CGE) microsimulation model (or CGE macro-micro model) for Indonesia. Clarity on these issues is important as further liberalization may bring about different economy-wide and poverty impacts on different households.

Literature Review

Trade liberalization of agricultural products under the DDA is aimed at achieving a long-term objective of establishing a fair and market-oriented trading system through fundamental reform. The DDA calls for substantial reductions in trade-distorting domestic supports, all forms of export subsidies, and improvements in market access. These are the three *pillars* in agricultural trade liberalization.

Improvement in market access is the key to successful liberalization. The potential gains from improvement in market access have been shown to be the most important among the three pillars, accounting for two thirds of the potential global gains. Moreover, over half of the potential gains will go to developing countries (Hertel and Keeney 2005). Within the scope for market access, empirical studies have shown that agricultural market access is one of the most potentially significant issues in the DDA (Sugiyarto and Brooks 2005).

Hertel and Winters (2006) led a team of researchers in analyzing the possible poverty impacts of DDA on a number of developing countries, including Indonesia. The study concluded that a more ambitious DDA would lead to significant poverty reductions in the long run and that developing countries must not only allow for deeper tariff cuts, they must also implement complementary policies aimed at helping households take advantage of greater opportunities arising from the DDA.

For Indonesia, Robillard and Robinson (2005) analyzed the economy-wide and poverty impacts of the DDA and found that full liberalization under the DDA results in a reduction in poverty, as the wage and employment gains outweigh the changes in commodity prices critical to poor households. More importantly, they warned that the poverty impacts of DDA crucially depend on households gains in the labor market. Similarly, Sugiyarto and Brooks (2005) analyzed the economic and welfare impacts of the DDA using a conventional CGE model with representative household groups (RHGs). They observed that the removal of only agricultural tariffs would generate adverse effects, whereas the removal of agricultural tariffs in combination with the elimination of agricultural commodity taxes would marginally benefit the economy. Comprehensive tariff elimination–involving all sectors–appeared to be even more beneficial.

Trade and Poverty Linkage

Winters (2001), Winters et al. (2004), and Hertel and Reimer (2004) stressed the need to investigate possible channels through which trade liberalization may affect households and poverty. These channels include:

- price and availability of goods;
- factor prices, income, and employment;
- government taxes and transfers influenced by changes in revenue from trade taxes;
- incentives for investment and innovation affecting long-run economic growth;
- external shocks, in particular, changes in terms of trade; and
- short-run risk and adjustment costs.

CGE modeling frameworks, because they involve counterfactual analysis, have been the preferred tool in identifying channels through which a certain policy change affects the economy. The models act as policy laboratories by providing numerical evaluation of the economy-wide impacts of a policy shift in a controlled environment, free from influences of other policies.

The use of CGE models to analyze poverty and income distribution can be traced to the initial work of Adelman and Robinson (1978) and Lysy and Taylor (1980). Since then, different approaches have emerged. A popular but restrictive approach is to assume a lognormal distribution of household income within each category where the variance is estimated from the base-year data (De Janvry, Sadoulet, and Fargeix 1991a). Meanwhile, Decaluwé et al. (2000) argued that a beta distribution is preferable to other distributions because it can be skewed to the left or right and thus may better represent the types of intra-category income distributions commonly observed among households. Regardless of the distribution, the CGE model is used to provide the changes in average income for each household category, while the variance of this income is assumed to be fixed.

Robillard and Robinson (2005) employed a sophisticated approach to analyzing the poverty impacts of the DDA for Indonesia. Considering the importance of the labor market, the model employed a CGE-microsimulation model containing a microsimulation of labor allocation. In this case, the CGE model produces price, wage, and aggregate employment vectors, and these vectors are then fed to the microsimulation model to generate changes in individual wages, incomes, employment status, and poverty. Overall consistency is achieved by ensuring that the changes in the microsimulation module correspond to the macro variables generated by the CGE model.

An alternative approach is to use the actual distribution of income among different household categories based on the household survey results without imposing any functional forms. Cororaton, Cockburn, and Corong (2005) used this approach to analyze the poverty impacts of the DDA for the Philippines. Under this framework, the CGE model and the household module are linked in a sequential manner, that is, the CGE model generates the economic, sectoral, volume, and price effects. In turn, the changes in average household income and the cost of the household consumer basket (weighted consumer prices) for each RHG in the CGE model are then applied to all households under the same category in the household survey data. Thus, after each policy change, the corresponding changes in individual household welfare and poverty characteristics can be captured.

The Model

Following Cororaton, Cockburn, and Corong (2005) work on the Philippines, this paper utilized a CGE model developed for the Indonesian economy which is then linked to data of the Indonesian National Socioeconomic Survey (SUSENAS).[2]

Basic Structure of the Model

The model was developed using the 1999 Social Accounting Matrix (SAM)–selected for its correspondence to the 1999 SUSENAS–which has a comprehensive module on income and expenditures on which the poverty indicators can be constructed. The SAM used in the model has 23 production sectors and commodities composed of: 5 in agriculture, fisheries, and forestry; 9 in industry; and 9 in services (Table 9.1). The factors of production are distinguished by categorizing them as either capital (including land) or labor–which are further classified into 7 and 16 categories, respectively (Table 9.2). Labor is classified by location (urban or rural) and by types of work such as agricultural, production, clerical, and managerial. Capital inputs are classified into land, urban, rural, private, government, and foreign capital.

2 The CGE model for Indonesia was adapted from one constructed by Caesar Cororaton for the Philippines in 2004, and extended for poverty analysis by Erwin Corong in 2005 as part of ADB's work on the poverty reduction integrated simulation model initiated and supervised by Guntur Sugiyarto.

The production structure of the model assumes a constant return to scale and is depicted in Figure 9.1. Sectoral output is produced through a three-stage process. The first stage involves a simultaneous determination of optimal capital and labor input. At the second stage, the optimal capital and labor inputs are aggregated through a Cobb-Douglas function to form a capital-labor composite. Finally, the intermediate inputs and the capital-labor composite are combined through a Leontief function to produce sectoral outputs.

Table 9.1 **Description of Production and Commodity Accounts**

Accounts	Description
	Production and Commodity
Agriculture	Food Crops Other Crops Livestock Forestry Fisheries
Industry	Oil and Gas mining Other mining Food processing Textiles Wood and Wood Products Papers and Metal products Chemical Industry Utilities, Electricity, Gas, and Water Construction
Services	Trade Restaurants Hotels Land Transport Other Transport and Communication Banking and Insurance Real Estate Personal Services Public Services

Source: 1999 Indonesian Social Accounting Matrix (SAM).

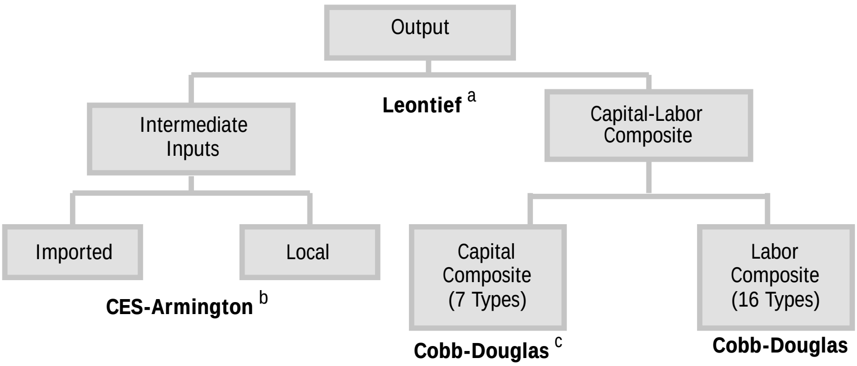
Figure 9.2 illustrates the price relationships in the CGE model. Contrary to the fixed price input-output and SAM multiplier models; in the CGE model, prices are flexible and all prices adjust to clear the factor and product markets. Output price (*px*), affects export price (*pe*), and local prices (*pl*). Indirect taxes are added to the local price to determine domestic prices (*pd*) which, together with import price (*pm*), results in the composite price (*pq*). The transaction cost is then added to the composite price to determine the consumer price (*pc*). The import price (*pm*) in domestic currency is affected by the world price of imports, exchange rate (*er*), tariff rate (*tm*), and indirect tax rate (*itx*).

Table 9.2 **Description of Factors of Production**

Accounts	Description
Capital	Land and agricultural capital Own occupied house Others rural Others urban Private domestic Government capital Foreign capital
Labor	Agriculture employee – rural Agriculture employee – urban Agriculture self-employed – rural Agriculture self-employed – urban Production employee – rural Production employee – urban Production self-employed – rural Production self-employed – urban Clerical employee – rural Clerical employee – urban Clerical self-employed – rural Clerical self-employed – urban Management professional employee – rural Management professional employee – urban Management professional self-employed – rural Management professional non-employee – urban

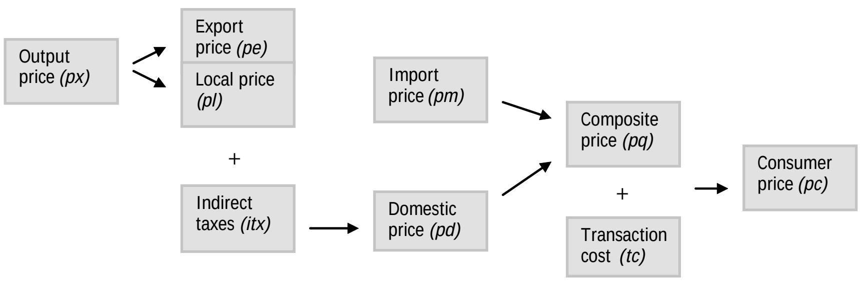
Source: 1999 Indonesian Social Accounting Matrix (SAM).

Figure 9.1 **Production Structure**



a Leontif: Fixed proportion of intermediate input and value added.
b CES-Armington is the constant elasticity of substitution function that allows for a possibility of substitution between imported and local products.
c Cobb-Douglas: Fixed share of two components used in the production to inputs.
Source: Authors' framework.

Figure 9.2 **Basic Price Relationship in the Model**

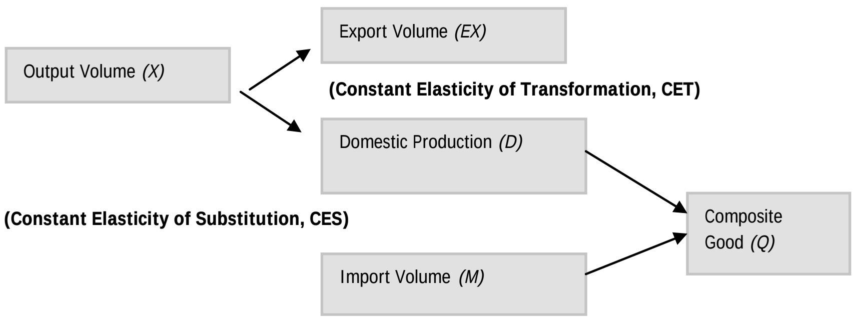


Source: Authors' framework.

Figure 9.3 presents the volume relationships in the model. On the supply side, output (*X*) is specified as a constant elasticity of transformation between export (*E*) and domestic sales (*D*). The allocation between export and domestic sales depends on the export price (*pe*), the local price (*pl*), and the elasticity of substitution between exports and domestic goods. For instance, an increase in the export price relative to the local price results in an increased export allocation, and a corresponding reduction in allocation for domestic sales. The magnitude of reallocation depends on the value of the elasticity of substitution.

The demand side is specified as a constant elasticity of substitution function between imports (*M*) and domestic goods (*D*), otherwise known as

Figure 9.3 **Basic Structure of the Model**



Source: Authors' framework.

the Armington assumption, to account for product differentiation between imported and domestically produced goods. The allocation between imports and domestic goods depends on the import price (*pm*), the domestic price (*pd*), and the elasticity of substitution between domestically produced and imported commodities. That is, a decrease in the local import price relative to the domestic price gives rise to higher import demand vis-à-vis domestically produced goods. Once again, the magnitude of reallocation depends on the value of the elasticity of substitution.

The supply side of the model assumes profit maximization, while the demand side assumes cost minimization. Thus, the first-order conditions on the supply side generate the necessary supply and input demand functions, while the first-order conditions on the demand side provide the necessary import and domestic demand functions.

Households. There are 10 RHGs in the SAM used as a basis for the CGE model (Table 9.3). The households are classified according to agriculture and nonagriculture, and household head participation in the labor market (i.e., dependent or active). In addition, the nonagriculture households are further differentiated by location–urban or rural.

Table 9.3 **Summary Description of Representative Households**

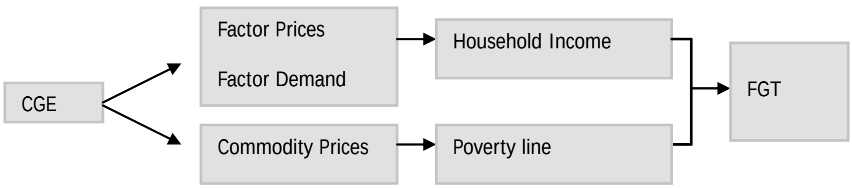
Households	Description
Agriculture	Landless farmers Small farmers Medium farmers Large farmers Rural low-income group Rural dependent-income group Rural high-income group
Nonagriculture	
	Urban low-income group Urban dependent-income group Urban high-income group

Source: 1999 Indonesian Social Accounting Matrix (SAM).

Using the RHGs in the model to assess the household poverty impacts arising from a policy shift is sometimes deemed inadequate. To address this, the 1999 SUSENAS was linked directly to the CGE model. To ensure consistency between the RHGs in the SAM used in the model and the households in the SUSENAS, the households in the latter were classified in the same categories as the RHGs of the SAM. This involved a mapping of household attributes in the SUSENAS to be consistent with the RHGs in the SAM.[3] Therefore, the microsimulation traces the impact of income and price changes at the household in the SUSENAS.[4]

Figure 9.4 provides a stylized illustration of the link between the CGE model and the SUSENAS data set. The CGE model generates economic, sectoral, volume, and price effects of a policy simulation. Then, the changes in disposable income and household consumer basket price (weighted consumer prices) of the 10 RHGs in the CGE model are applied to all households with the same characteristics in the SUSENAS data set. This allows the model to capture the changes in individual household poverty characteristics such that the Foster-Greer-Thorbecke (FGT) class of poverty measures–headcount ratio (HCR), poverty gap index (PGI), and poverty severity index (PSI)–can be calculated.

Figure 9.4 **Development of Poverty Indicators Based on CGE and Household Survey Data**



CGE = Computable General Equilibrium
FGT = Foster, Greer, and Thorbecke
Source: Authors' framework.

3 The use of RHGs is not without its problems: "... simply put, income or employment shocks do not affect all individuals or households belonging to the same RH group in the same way. Occupational changes, transitions across labor-force status, and migrations from rural to urban areas typically are individual- or household-specific and are likely to be extremely income selective" (Bourguignon and Pereira da Silva 2003a, 342). The procedure described in this section, applied to the SUSENAS data, attempts to overcome such difficulties.

4 It is important to note that each household in the sample survey represents a group of households with the same characteristics in the population. Therefore, microsimulation using survey data is actually still operating at a group level, although a lower one.

Poverty Measures. Poverty is measured through FGT, a Pα class of additively decomposable measures (Foster, Greer, and Thorbecke 1984). The FGT poverty measure is[5]

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - y_i}{z}\right)^\alpha \qquad (1)$$

Where:

α is the poverty aversion parameter

n is population size

q is the number of people below the poverty line

y_i is income and

z is the poverty line or poverty threshold.

The poverty line used to calculate the poverty indicators is the official poverty line, which consists of food and nonfood components. The threshold is defined as the cost of basic food and nonfood commodities corresponding to the cost of 2,100 calories per capita plus some basic nonfood expenditures.[6]

The poverty indicators are measured before and after the policy changes using the actual distribution of income among the 10 household categories in the SUSENAS. As seen in the equation above, the FGT poverty measure depends on the parameter values of α. At $\alpha = 0$, the poverty headcount is calculated by measuring the proportion of the population that falls below the poverty threshold. At $\alpha = 1$, the poverty gap is measured, indicating how far on average the poor are from the poverty threshold. Finally, at $\alpha = 2$, the PSI is obtained. The PSI is more sensitive to the distribution among the poor as more weight is given to the poorest below the poverty threshold. This is because the PSI corresponds to the squared average distance of income of the poor from the poverty line.

Model Closure. Nominal government consumption is equal to exogenous real government consumption multiplied by its (endogenous) price. Fixing real government spending neutralizes any possible welfare and poverty effects of variations in government spending. The only variations are due to changes in the nominal price of government consumption.

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5 See Ravallion (1992) for detailed discussion on this issue.

6 See Badan Pusat Statistik (BPS) Statistics Indonesia for detailed calculation of the Indonesian official poverty line (http://www.bps.go.id).

Total nominal investment is equal to exogenous total real investment multiplied by its price. Total real investment is held fixed to account for intertemporal welfare and poverty effects. The price of total real investment is endogenous. The propensities to save of the various household groups in the model adjust proportionately to accommodate the fixed total real investment assumption. This is undertaken through a factor in the household saving function that adjusts endogenously. The macro closure used here is of the classical Johansen (1960) type. Such a closure implicitly assumes that government has sufficient control over the savings and consumption behavior of the people to generate savings required to finance exogenously given investment. One could, for example, think of the operation of a fiscal policy outside the model that helps maintain the investment-savings equilibrium (Rattso 1984).

The current account balance (foreign savings) is held fixed and the nominal exchange rate is the model's numeraire. The foreign trade sector is effectively cleared by changes in the real exchange rate, which is the ratio of the nominal exchange rate multiplied by world export prices, divided by the domestic price index.

The labor market assumes a neoclassical closure in which labor supply is equal to labor demand across all labor categories. Labor is fully mobile across sectors, but is limited within the specific category, whereas capital is sector specific.

Basic Structure of the Economy at the Base

Table 9.4 presents the Indonesian economic structure based on the 1999 SAM. The trade pattern shows the dominance of the industrial and services sectors, accounting for over 90 percent of total exports and imports in the country. In particular, industrial exports and imports comprise more than half of total trade (i.e., 74 and 51 percent, respectively). Meanwhile, services exports and imports contribute to 20 and 42 percent, respectively. In contrast, agriculture contributes the least to exports and imports, with only 5 and 7 percent, respectively. Nevertheless, total agricultural exports share is roughly one fourth of total exports when agricultural-related food processing is included.

The principal exporters are the chemical industry (20 percent), food processing (20 percent), hydrocarbon mining (14 percent), and trade (12 percent). These four sectors generate a combined share of 66 percent of total exports. The primary importers are the chemical industry (23 percent), other transportation and communication (12 percent), and paper and metal products (11 percent).

Table 9.4 **Economic Structure at the Base Period**

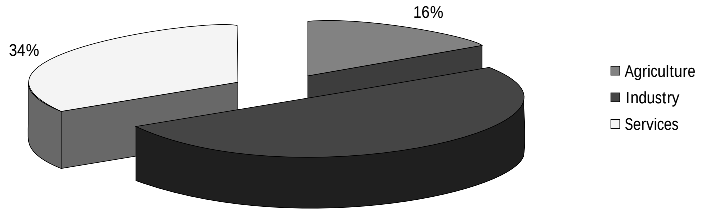
SECTORS	International Trade (%)					Value Added (VA)		
	Exports		Imports		Export-Import Ratio	VA/ Output	VA Share	Labor-Capital Ratio
	Share	Intensities*	Share	Intensities**				
Agriculture	**5.0**	**8.2**	**7.2**	**8.28**	**98.61**	**81.2**	**20.3**	**232.7**
Food Crops	1.3	4.4	3.4	8.15	51.81	87.2	10.1	4.5
Other Crops	1.8	13.8	3.2	17.00	78.20	71.8	3.7	2.9
Livestock	0.4	4.5	0.4	3.16	145.04	69.5	2.5	0.6
Forestry	1.0	19.9	0.2	2.46	982.23	81.1	1.7	0.3
Fisheries	0.5	9.1	0.0	0.31	3216.20	89.7	2.2	4.0
Industry	**74.7**	**38.1**	**51.0**	**23.0**	**206.33**	**52.5**	**41.9**	**63.34**
Oil and Gas Mining	14.3	40.7	2.6	8.19	767.87	88.9	12.7	0.2
Other Mining	1.3	40.9	0.6	18.17	311.98	92.0	1.2	2.2
Food Processing	20.0	28.1	6.6	8.33	429.74	38.6	11.2	1.1
Textiles	5.8	40.3	6.0	33.47	134.11	31.7	1.8	1.3
Wood and Wood Products	3.3	48.2	0.8	14.57	544.89	37.4	1.0	1.1
Paper and Metal Products	9.7	62.3	11.0	57.10	124.19	37.1	2.4	0.7
Chemicals Industry	20.4	59.1	23.3	53.92	123.32	49.8	7.0	0.6
Utilities, Electricity, Gas, and Water	0.0	0.0	0.0	0.00	16.98	52.8	1.4	0.5
Construction	0.0	0.0	0.0	0.00	0.00	88.9	3.2	3.1
Services	**20.3**	**15.1**	**41.8**	**20.7**	**68.43**	**69.3**	**37.9**	**149.58**
Trade	12.1	27.3	3.0	6.26	561.59	77.7	14.0	2.6
Restaurants	0.0	0.1	2.3	11.58	0.71	42.1	2.1	2.4
Hotels	0.0	0.6	2.6	32.82	1.27	79.2	1.2	0.4
Land Transport	2.4	26.3	4.0	29.72	84.52	67.2	2.5	0.9
Other Transportation & Communication	3.4	29.4	12.0	51.27	39.50	48.1	2.2	0.7
Banking and Insurance	1.0	9.3	4.8	25.47	29.92	73.9	3.3	0.7
Real Estate	1.0	8.7	4.4	22.39	33.20	77.6	3.8	0.3
Personal Services	0.0	0.0	1.6	13.39	0.10	75.4	2.2	0.9
Public Services	0.4	1.7	7.1	18.38	7.77	69.4	6.4	4.5
Total	**100**		**100**			**62.8**	**100**	

Note: * Export intensity = Export Supply/Domestic Sales; ** Import intensity = Import demand/Composite demand.
Source: Authors' calculation based on the 1999 Indonesian SAM.

Agricultural imports combined with food processing account for roughly 14 percent of total imports. Fisheries, forestry, and main (hydrocarbon) mining have the highest export-to-import ratio, which may be a reflection of Indonesia's enormous fish, forest, and petroleum resources.

In terms of the value added–to-output ratio, the agricultural sector has the highest ratio (81 percent), compared to industry (53 percent) and services (68 percent). This means that the agricultural sector uses the least amount of intermediate inputs to produce one unit of output. In spite of this, agriculture's contribution to the overall value added is relatively small, only about 20 percent of gross domestic product (GDP), which shows the total domestic value added. The contributions of industry and services sectors, on the other hand, are around 42 and 38 percent, respectively. Labor intensity is uniformly higher in agriculture–implying surplus labor is employed and being absorbed by the sector. Overall, industry has the highest output share with 50 percent, followed by services with 34 percent, and agriculture with 16 percent (Figure 9.5).

Figure 9.5 **Output Share at the Base**



Source: Authors' calculation.

Household Income and Poverty Profile

Income from labor and capital is the major earning source for the entire population. Other income sources include transfers from other institutions in the economy, including inter-household transfers. Total wages paid to laborers account for 70 percent of total household income, while returns to capital account for about 28 percent. Wages paid by the services sector and returns to capital in the industrial sector account for the largest share in total household earnings. On the contrary, wages and return to capital in agriculture have the lowest share. Table 9.5 presents the household income sources in the base or benchmark period, which shows the significant role of wages in household earnings. Landless agricultural households, for instance, receive 90 percent of their total income from wages, while the high-income nonagricultural households in rural areas have the lowest wage-to-income ratio of 50 percent. This household group also has the highest income share from capital, with 47 percent.

Table 9.5 **Household Income Sources at the Base Period**
(Percent share)

	Income					
					Transfers	
Households	Employee	Capital	Dividend	Foreign	Household	Government
Agriculture						
Landless farmers	90.6	5.6	0.1	0.7	1.6	1.4
Small farmers	85.0	13.3	0.0	0.2	0.2	1.2
Medium farmers	83.9	15.0	0.0	0.4	0.2	0.5
Large farmers	75.5	20.4	0.0	3.7	0.1	0.2
Nonagriculture (Rural)						
Low-income group	68.6	30.3	0.1	0.2	0.1	0.6
Dependent-income group	73.5	21.3	0.0	0.5	3.7	1.0
High-income group	49.7	46.6	0.0	3.3	0.3	0.1
Nonagriculture (Urban)						
Low-income group	76.7	23.0	0.1	0.1	0.0	0.1
Dependent-income group	77.5	19.2	0.1	0.2	1.3	1.7
High-income group	55.8	41.8	0.0	2.3	0.1	0.0

Source: Authors' calculation based from 1999 Indonesian Social Accounting Matrix (SAM).

Income from abroad is not a significant source of household earnings. Large agriculture and high-income nonagricultural households in rural areas have the highest income shares from abroad with 3.7 and 3.3 percent, respectively. On the other hand, dependent nonagricultural households in rural areas benefit the most from inter-household transfers.

Table 9.6 presents the poverty indexes in the base period calculated from the SUSENAS. It shows that about 33 million people representing 18.2 percent of the entire population are living below the poverty line. In general, agricultural households are more susceptible to poverty compared to their nonagricultural counterparts. Moreover, among dependent nonagricultural households, rural inhabitants appear to be more prone to poverty relative to their urban counterparts.

Table 9.6 **Poverty Indices at the Base Period**
(Percent)

Households	Poverty		
	Headcount	Gap	Severity
Indonesia	**18.2**	**3.5**	**1.1**
Agriculture			
Landless farmers	28.4	5.1	1.4
Small farmers	27.3	5.2	1.6
Medium farmers	30.5	7.2	2.6
Large farmers	25.0	5.0	1.6
Nonagriculture (Rural)			
Low-income group	18.7	3.1	0.8
Dependent-income group	13.6	2.6	0.8
High-income group	10.5	1.8	0.5
Nonagriculture (Urban)			
Low-income group	10.1	1.7	0.5
Dependent-income group	4.7	0.8	0.2
High-income group	3.0	0.4	0.1
Number of Poor People			**32,843,216**

Source: Authors' calculation based from 1999 Social Accounting Matrix (SAM) and SUSENAS.

Medium farmers have the highest poverty incidence, followed by landless farmer households. High-income nonagricultural and dependent nonagricultural households in urban areas have the lowest poverty headcount with 3.0 and 4.7 percent, respectively.

Policy Experiments

Three policy experiments in line with the DDA were undertaken in this study. These were:

- AGLIB: Full elimination of tariffs on agricultural imports

- AGLIBPRO: Full elimination of tariffs and indirect taxes on agricultural imports as well as agricultural products
- TOTLIB: Full elimination of all tariffs on imported products

AGLIB captures the increasing access for agricultural products demanded by the DDA, which is reflected in tariff elimination on imported agricultural products. AGLIBPRO depicts the impact of a more proactive agricultural-product liberalization, in which the Indonesian government removes not only the agricultural tariffs but also the agricultural domestic taxes to level the playing field. Finally, TOTLIB reflects full tariff elimination in all sectors for broader cross-sectoral trade liberalization. The three simulations are in line with the DDA from the Indonesian perspective. The set of simulations examined in this chapter is consistent with simulations conducted in Chapter 7 of this book, in which the issues were examined using the standard CGE model with RHGs. Results from the model used in this chapter, however, are more complete with the model's greater disaggregation by level of sectors and factors, and the link to the household survey data set, i.e., microsimulation. As a result, estimates of poverty indicators of FGT can be calculated.

Role of Model Closures in Computable General Equilibrium Models

The study discussed in this chapter involves three experiments related to trade liberalization in Indonesia. Chapter 7 of this book also describes similar experiments. These experiments capture effects of resource reallocation and corresponding efficiency increases due to trade liberalization. The results in these two chapters, however, are different in terms of the magnitude of the changes. For example, the gross domestic product increase from trade liberalization in all sectors is 3.4 percent (Table 7.10) in Chapter 7 while it is 0.3 percent in this chapter (Table 9.19). Differences in the Social Accounting Matrix that provides most of the parameters for the CGE framework can explain a part, but not all, of such divergences in results.

The two models operate under different closure rules and, hence, capture more than just trade liberalization effects. It has been the experience of many countries that trade liberalization leads to a loss in tax revenue by the government. This loss could be significant if all tariffs are reduced to zero. The revenue loss is overcome by an implicit assumption that tariff reduction is compensated by capital inflows from abroad in Chapter 7 and by an indirect tax increase in this chapter. Capital flows are costless in a static model, while an indirect tax increase has a demand contraction effect through the price system. This explains why the two models would give different results. This example shows how the approach of the model maker to close the possible income and expenditure gap in a CGE model affects a model's results.

Moreover, it is important to note that the two models adopt different closure rules, which that make the magnitude of the change of the same simulations from the two models not strictly comparable. The directions of the changes should, however, be consistent.

With its link to the household data set, the CGE model used in the CGE microsimulation is less complicated than the CGE model in Chapter 7 of this book. The Box further explains the role of model closure in CGE models.

Simulation Results

AGLIB: Elimination of Agricultural Tariffs

Macro Effects. Tariff elimination on agricultural imports leads to a 0.15 percent reduction in the local price of imported products. As a result, consumption increases by 0.003 percent (Table 9.7). Similarly, the decline in agricultural import prices reduces the domestic production cost by 0.15 percent,[7] raising the real exchange rate (depreciation) by 0.05 percent. This enhances producers' competitiveness of domestic products in the international market as exports become relatively cheaper.

Domestic sales allocation decreases by 0.01 percent, while exports increase by 0.09 percent as producers reallocate resources for the international market. The higher increase in exports relative to that of imports (0.08 percent) sustains the trade surplus which exists at the base. Overall, the decline in local import prices coupled with the reduction in domestic cost of production results in a marginal increase in output and real GDP.

Sectoral Effects. Agricultural tariff elimination produces varying impacts among the three major sectors of agriculture, industry, and services (Table 9.8). Agricultural and services' outputs contract, while industrial output expands. This prompts a decline in agriculture's share in total output, i.e., from 16 to 15 percent (Figure 9.6). In contrast, industry's share in total output increases from 50 to 51 percent, while services' share remains constant at about 34 percent.

Table 9.7 **Macro Effects of Full Elimination of Tariffs on Agriculture Imports**
(Percentage change from base)

Real Gross Domestic Product	0.01
Prices	
Import prices in local currency	-0.15
Consumer prices	-0.15
Local cost of production	-0.15
Real exchange rate	0.05
Import volume	0.08
Export volume	0.09
Domestic production for local sales	-0.01
Consumption (composite) goods	0.003

Source: Simulation results of the model.

The contraction in agriculture stems from the decline in the local price of agricultural imports which induces consumers to substitute imported products for the locally produced agricultural products. The output expansion in industry arises from the reduction in domestic cost of production–mainly from cheap imported intermediate agricultural inputs. Thus, the expansion in industrial output

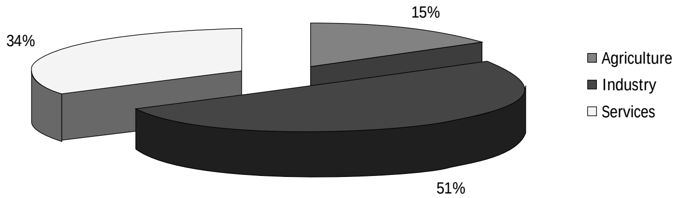
7 Owing to the decline in prices of imported intermediate agricultural inputs.

Table 9.8 **Sectoral Effects of Full Elimination of Tariffs on Agriculture Imports**
(Percentage change from base)

Sectors	Price Changes (%)					Volume Changes (%)				
	Import	Domestic	Composite	Output	Local	Import	Export	Domestic Sales	Output	Composite Demand
Agriculture	**-1.89**	**-0.40**	**-0.53**	**-0.38**	**-0.40**	**2.95**	**0.38**	**-0.05**	**0.21**	**-0.01**
Food Crops	-2.49	-0.42	-0.59	-0.41	-0.42	4.21	0.37	-0.09	0.27	-0.07
Other Crops	-1.16	-0.41	-0.54	-0.38	-0.41	1.37	0.34	-0.14	0.12	-0.07
Livestock	-3.18	-0.37	-0.46	-0.36	-0.37	5.90	0.36	-0.01	0.18	0.01
Forestry	-0.26	-0.35	-0.34	-0.31	-0.35	-0.11	0.38	0.07	0.06	0.13
Fisheries	-4.48	-0.41	-0.42	-0.40	-0.41	8.92	0.52	0.21	0.23	0.24
Industry	**0.00**	**-0.11**	**-0.08**	**-0.08**	**-0.11**	**-0.16**	**0.09**	**0.00**	**-0.03**	**0.04**
Oil and Gas Mining	0.00	-0.05	-0.05	-0.04	-0.05	-0.14	0.04	-0.03	-0.04	-0.01
Other Mining	0.00	-0.09	-0.07	-0.05	-0.09	-0.35	0.00	-0.18	-0.21	-0.11
Food Processing	0.00	-0.17	-0.16	-0.15	-0.17	-0.27	0.21	0.07	0.04	0.11
Textiles	0.00	-0.11	-0.07	-0.09	-0.11	-0.15	0.14	0.06	-0.01	0.09
Wood and Wood Products	0.00	-0.15	-0.13	-0.11	-0.15	-0.31	0.14	-0.01	-0.06	0.06
Paper and Metal Products	0.00	-0.04	-0.02	-0.02	-0.04	-0.13	0.02	-0.05	-0.10	-0.01
Chemicals	0.00	-0.05	-0.02	-0.03	-0.05	-0.13	0.03	-0.04	-0.09	0.00
Utilities, Electricity, Gas, and Water	0.00	-0.07	-0.07	-0.07	-0.07	-0.17	0.05	-0.04	-0.04	-0.04
Construction	—	-0.06	-0.06	-0.06	-0.06	—	—	-0.17	-0.17	-0.17
Services	**—**	**-0.07**	**-0.06**	**-0.07**	**-0.07**	**-0.14**	**0.05**	**-0.02**	**-0.01**	**-0.01**
Trade	—	-0.08	-0.07	-0.06	-0.08	-0.21	0.05	-0.05	-0.06	-0.02
Restaurants	—	-0.16	-0.14	-0.16	-0.16	-0.24	0.20	0.08	0.04	0.08
Hotels	—	-0.08	-0.05	-0.08	-0.08	-0.17	0.07	-0.01	-0.07	-0.01
Land Transport	—	-0.05	-0.03	-0.04	-0.05	-0.15	0.02	-0.05	-0.08	-0.03
Other Transportation & Communication	—	-0.05	-0.02	-0.04	-0.05	-0.12	0.04	-0.02	-0.07	-0.01
Banking and Insurance	—	-0.06	-0.05	-0.06	-0.06	-0.15	0.05	-0.03	-0.06	-0.02
Real Estate	—	-0.07	-0.05	-0.06	-0.07	-0.15	0.06	-0.02	-0.04	-0.01
Personal Services	—	-0.06	-0.05	-0.06	-0.06	-0.16	0.04	-0.04	-0.06	-0.04
Public Services	—	-0.05	-0.04	-0.05	-0.05	-0.09	0.05	0.00	-0.01	0.00
Total	**-0.15**	**-0.15**	**-0.15**	**-0.13**	**-0.15**	**0.08**	**0.09**	**-0.01**	**0.003**	**0.01**

Source: Simulation results of the model.

Figure 9.6 **Output Share after Full Elimination of Tariffs on Agriculture Imports**

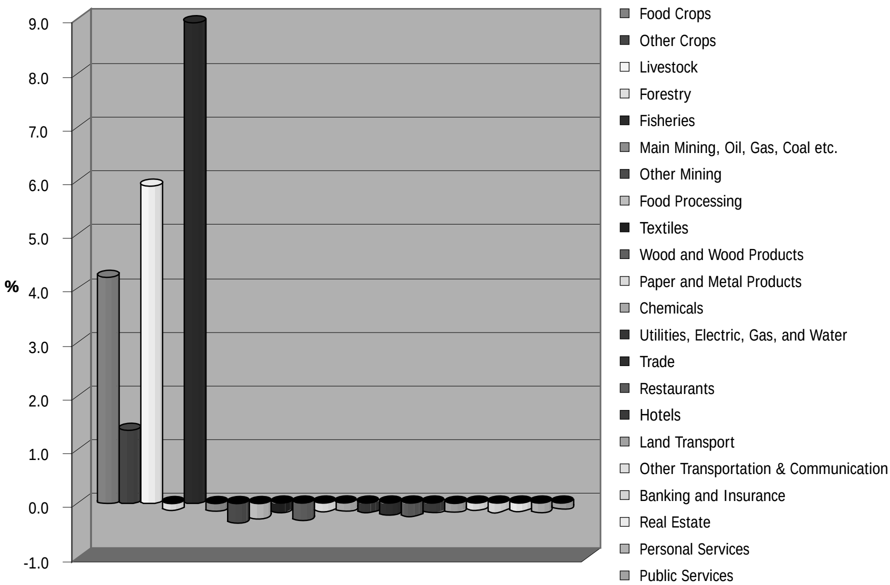


Source: Simulation results of the model.

leads to higher factor utilization in that sector as the industry absorbs displaced workers from other sectors. However, given the greater labor intensity in agriculture, the increase in employment in industry is insufficient to offset the decline in agriculture.

Figure 9.7 shows the changes in sectoral imports. Clearly, agricultural imports increase, whereas imports of industry and services products fall–and the reduction in industrial imports is higher than that of services. On the other hand, the change in export volume is minimally higher in agriculture relative to industry and services.

Figure 9.7 **Change in Import Volume after Full Elimination of Tariffs on Agriculture Imports**



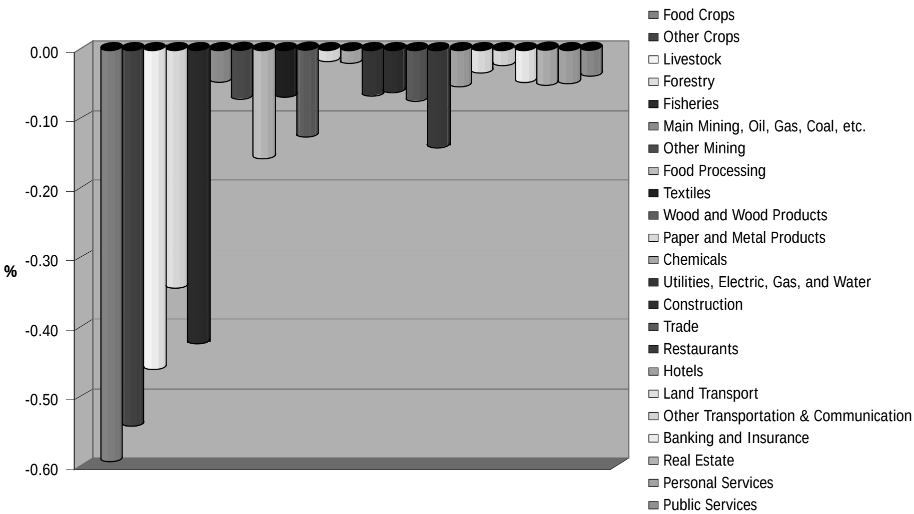
Source: Simulation results of the model.

Overall, the reduction in consumer prices is deeper in agriculture as a result of the significant reduction in agricultural import prices because tariffs were eliminated for only agricultural products. Therefore, consumers pay relatively less for agricultural products (Figure 9.8).

Agriculture. The decline in agricultural import prices induces consumers to substitute toward cheaper imported agricultural products. Total agricultural imports go up by 3 percent, resulting in a marginal reduction in agricultural output (0.01 percent). Fisheries, food crops, and livestock register the highest increase in imports (8, 4, and 6 percent, respectively). Overall, agricultural exports increase by 0.38 percent with fisheries generating the highest increase in output and exports.

Industry. Tariff elimination on agricultural products favors the industrial sector. Indeed, total industrial output and exports increase by 0.04 percent and 0.09 percent, respectively, while imports dip by 0.16 percent. Food processing benefits the most with a decline in the domestic cost of production–

Figure 9.8 **Change in Consumer Prices after Full Elimination Tariffs on Agriculture Imports**



Source: Simulation results of the model.

the result of cheaper imported agricultural imports. Thus, food processing's output, domestic sales, and exports increase.

Services. At first glance, it seems that agricultural tariff elimination does not benefit the services sector as the entire sector's output, consumer demand, and domestic sales decrease. However, closer examination reveals that these decreases are marginal. In addition, total exports increase (0.05 percent), whereas total imports drop (0.14 percent), indicating that the sector gains modestly from the international market.

Factor Market. Table 9.9 summarizes the factor market impacts of AGLIB. Factor returns diminish as the value-added price decreases by 0.10 percent–owing to the decline in both return to capital and overall wage rates. The reduction in wages however is higher (0.13 percent) than the decline in capital (0.02 percent), suggesting that wage workers bear most of the impact of declining factor returns. Self-employed rural workers experience the largest reduction in wages, while self-employed urban production workers bear the lowest wage reduction (Table 9.10 and Figure 9.9). In contrast, both urban and rural production employees attain wage increases, mainly from the expansion of the industrial sector.

Household Income and Commodity Basket Cost. The changes in households' disposable income are presented in Table 9.11. Evidently, factor

Table 9.9 **Factor Market Effects of Full Elimination of Tariffs on Agriculture Imports**
(Percentage change from base)

Sectors	Value Added		Capital Return	Wage
	Volume	Price		
Agriculture	**-0.01**	**-0.40**	**-0.36**	**-0.42**
Food Crops	-0.07	-0.42	-0.49	-0.43
Other Crops	-0.07	-0.40	-0.47	-0.40
Livestock	0.01	-0.38	-0.37	-0.38
Forestry	0.13	-0.34	-0.21	-0.31
Fisheries	0.24	-0.41	-0.18	-0.42
Industry	**0.02**	**0.01**	**0.02**	**0.00**
Oil and Gas Mining	-0.01	-0.04	-0.04	0.00
Other Mining	-0.11	-0.05	-0.16	0.00
Food Processing	0.11	0.10	0.21	0.00
Textiles	0.09	0.08	0.17	0.01
Wood and Wood Products	0.06	0.06	0.12	0.01
Papers and Metal Products	-0.01	-0.01	-0.02	0.00
Chemicals	0.00	0.00	0.00	0.00
Utilities, Electricity, Gas, and Water	-0.04	-0.08	-0.12	-0.01
Construction	-0.17	-0.06	-0.23	-0.01
Services	**-0.01**	**-0.06**	**-0.07**	**-0.05**
Trade	-0.02	-0.07	-0.09	-0.06
Restaurants	0.08	-0.02	0.06	-0.05
Hotels	-0.01	-0.07	-0.08	-0.04
Land Transport	-0.03	-0.04	-0.07	0.00
Other Transportation & Communication	-0.01	-0.03	-0.04	-0.03
Banking and Insurance	-0.02	-0.06	-0.08	-0.04
Real Estate	-0.01	-0.07	-0.08	-0.04
Personal Services	-0.04	-0.06	-0.11	-0.02
Public Services	0.00	-0.03	-0.03	-0.04
Total	**—**	**-0.1**	**-0.02**	**-0.13**

Source: Simulation results of the model.

income of all households declines. Households dependent on agriculture suffer the greatest income reduction (Figure 9.10), mainly because of lower factor returns in agriculture. In contrast, nonagriculture households, both urban and rural, experience a lower reduction in factor income. Overall, high-income nonagriculture households in urban areas suffer the lowest decline in factor income.

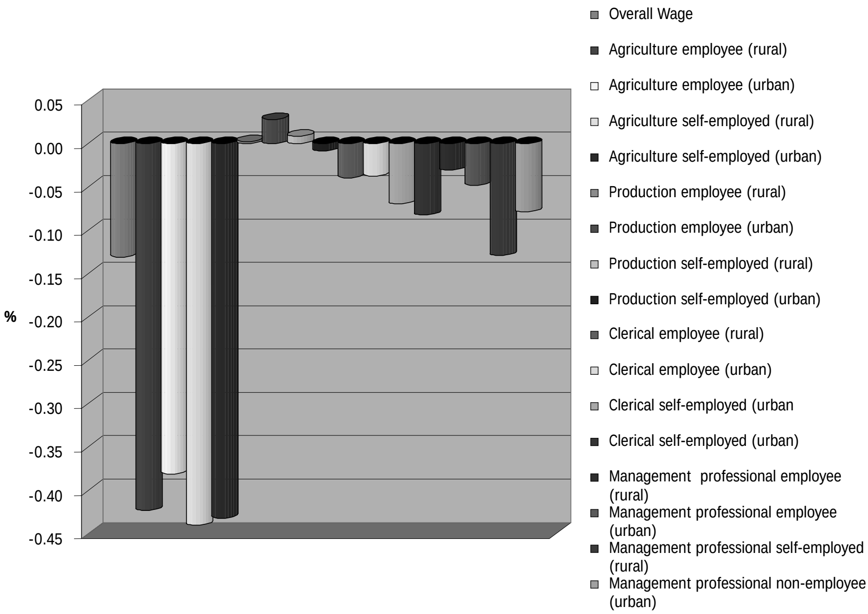
Table 9.11 presents the changes in the cost of the commodity basket or consumption for each RHG. Notably, agricultural households experience the greatest reduction in the cost of the commodity basket followed by rural nonagricultural households (except the high-income group). This is not surprising given that both these household groups consume more agricultural products than the rest.

Table 9.10 **Labor Market Effects of Full Elimination of Tariffs on Agriculture Imports**
(Percentage change from base)

Sectors	Labor Demand																
	L	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
Food Crops	-0.06	-0.07	-0.11	-0.05	-0.06	-0.49	-0.52	-0.50	-0.48	-0.45	-0.45	-0.42	-0.41	-0.46	-0.44	-0.36	-0.41
Other Crops	-0.07	-0.05	-0.09	-0.03	-0.04	-0.48	-0.50	-0.48	-0.46	-0.43	-0.44	-0.40	-0.39	-0.44	-0.43	-0.34	-0.39
Livestock	0.01	0.06	0.01	0.07	0.06	-0.37	-0.40	-0.38	-0.36	-0.33	-0.33	-0.30	-0.29	-0.34	-0.32	-0.24	-0.29
Forestry	0.10	0.21	0.17	0.23	0.22	-0.22	-0.24	-0.22	-0.21	-0.18	-0.18	-0.14	-0.13	-0.18	-0.17	-0.09	-0.14
Fisheries	0.25	0.25	0.21	0.26	0.26	-0.18	-0.20	-0.18	-0.17	-0.14	-0.14	-0.11	-0.09	-0.15	-0.13	-0.05	-0.10
Oil and Gas Mining	-0.04	—	—	—	—	-0.04	-0.07	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.00	0.00
Other Mining	-0.15	—	—	—	—	-0.16	-0.18	-0.17	-0.15	-0.12	-0.12	-0.09	-0.07	-0.13	-0.11	-0.03	-0.08
Food Processing	0.21	—	—	—	—	0.21	0.18	0.20	0.22	0.25	0.25	0.28	0.29	0.24	0.26	0.34	0.29
Textiles	0.16	—	—	—	—	0.17	0.14	0.16	0.18	0.21	0.21	0.24	0.25	0.20	0.22	0.30	0.25
Wood and Wood Products	0.11	—	—	—	—	0.12	0.09	0.11	0.13	0.16	0.16	0.19	0.20	0.15	0.17	0.25	0.20
Paper and Metal Products	-0.02	—	—	—	—	-0.02	-0.05	-0.03	-0.01	0.02	0.02	0.05	0.06	0.01	0.03	0.11	0.06
Chemicals	0.00	—	—	—	—	0.00	-0.03	-0.01	0.01	0.04	0.04	0.07	0.08	0.03	0.05	0.13	0.08
Utilities, Electricity, Gas, and Water	-0.12	—	—	—	—	-0.13	-0.15	-0.13	-0.11	-0.08	-0.09	-0.05	-0.04	-0.09	-0.07	0.01	-0.04
Construction	-0.23	—	—	—	—	-0.24	-0.26	-0.24	-0.22	-0.19	-0.20	-0.16	-0.15	-0.20	-0.18	-0.10	-0.15
Trade	-0.03	—	—	—	—	-0.10	-0.12	-0.10	-0.09	-0.05	-0.06	-0.02	-0.01	-0.06	-0.05	0.04	-0.02
Restaurants	0.11	—	—	—	—	0.05	0.03	0.05	0.07	0.10	0.09	0.13	0.14	0.09	0.10	0.19	0.14
Hotels	-0.04	—	—	—	—	-0.08	-0.11	-0.09	-0.07	-0.04	-0.05	-0.01	0.00	-0.05	-0.03	0.05	0.00
Land Transport	-0.07	—	—	—	—	-0.08	-0.10	-0.08	-0.06	-0.03	-0.04	0.00	0.01	-0.04	-0.03	0.06	0.01
Other Transportation & Communication	-0.01	—	—	—	—	-0.04	-0.07	-0.05	-0.03	0.00	0.00	0.03	0.04	-0.01	0.01	0.09	0.04
Banking and Insurance	-0.04	—	—	—	—	-0.09	-0.11	-0.09	-0.07	-0.04	-0.05	-0.01	0.00	-0.05	-0.03	0.05	0.00
Real Estate	-0.04	—	—	—	—	-0.08	-0.10	-0.08	-0.07	-0.04	-0.04	-0.01	0.01	-0.05	-0.03	0.05	0.00
Personal Services	-0.09	—	—	—	—	-0.11	-0.13	-0.11	-0.10	-0.07	-0.07	-0.04	-0.02	-0.08	-0.06	0.02	-0.03
Public Services	0.01	—	—	—	—	-0.03	-0.06	-0.04	-0.02	0.01	0.01	0.04	0.05	0.00	0.02	0.10	0.05
Change in Average Employee, %	-0.13	-0.42	-0.38	-0.44	-0.43	0.002	0.03	0.01	-0.01	-0.04	-0.04	-0.07	-0.08	-0.03	-0.05	-0.13	-0.08

L = Aggregate labor; L1 = Agriculture employee (rural); L2 = Agriculture employee (urban); L3 = Agriculture self-employed (rural); L4 = Agriculture self-employed (urban); L5 = Production employee (rural); L6 = Production employee (urban); L7 = Production self-employed (rural); L8 = Production self-employed (urban); L9 = Clerical employee (rural); L10 = Clerical employee (urban); L11 = Clerical self-employed (rural); L12 = Clerical self-employed (urban); L13 = Management professional employee (rural); L14 = Management professional employee (urban); L15 = Management professional self-employed (rural); L16 = Management professional non-employee (urban)
Source: Simulation results of the model.

Figure 9.9 **Change in Wage Per Labor Category after Full Elimination of Tariffs on Agriculture Imports**



Source: Simulation results of the model.

Poverty. Changes in poverty indicators arise from changes in household income and in the nominal value of the poverty line as a result of the changes in the weighted price or cost of the household's commodity basket, reflected also in the changes in consumer prices.

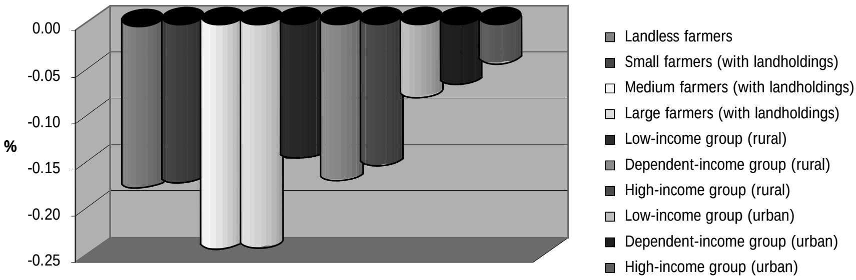
Table 9.11 **Household Income Effects of Full Elimination of Tariffs on Agriculture Imports**
(Percentage change from base)

	Household Income	Consumption Price
Agriculture		
Landless farmers	-0.178	-0.180
Small farmers	-0.172	-0.166
Medium farmers	-0.243	-0.136
Large farmers	-0.241	-0.141
Nonagriculture (Rural)		
Low-income group	-0.145	-0.170
Dependent-income group	-0.169	-0.166
High-income group	-0.153	-0.149
Nonagriculture (Urban)		
Low-income group	-0.078	-0.132
Dependent-income group	-0.066	-0.157
High-income group	-0.042	-0.151

Source: Simulation results of the model.

The percentage changes in the three poverty indicators of HCR, PGI, and PSI are presented in Table 9.12. Overall, the poverty headcount increases marginally by 0.03 percent (also illustrated in Figure 9.11). This is equivalent to roughly 10,308 additional people falling into

Figure 9.10 **Change in Disposable Income of Households after Full Elimination of Tariffs on Agriculture Imports**



Source: Simulation results of the model.

poverty. The national poverty gap and poverty severity increase as well, implying that the already poor, especially agricultural households, become even poorer. Medium farmers experience the highest increase in poverty headcount (0.23 percent), while large farmers suffer the largest increase in poverty gap and severity.

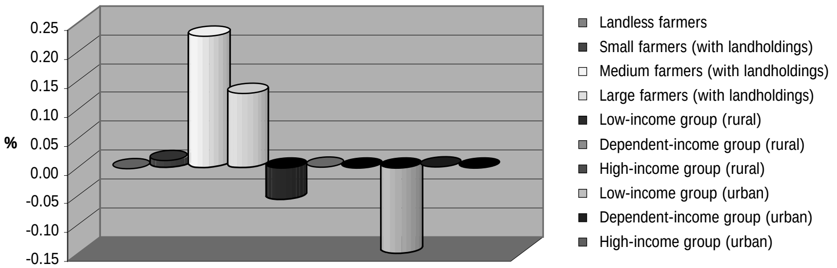
Table 9.12 **Poverty Effects of Full Elimination of Tariffs on Agriculture Imports**
(Percentage change from base)

	Head Count Ratio	Poverty Gap	Poverty Severity
All Indonesia	**0.03**	**0.07**	**0.11**
Agriculture			
Landless farmers	0.00	-0.01	-0.01
Small farmers	0.01	0.02	0.02
Medium farmers	0.23	0.35	0.37
Large farmers	0.13	0.39	0.44
Nonagriculture (Rural)			
Low-income group	-0.06	-0.12	-0.13
Dependent-income group	0.00	0.01	0.01
High-income group	0.00	0.02	0.02
Nonagriculture (Urban)			
Low-income group	-0.15	-0.27	-0.30
Dependent-income group	0.00	-0.46	-0.46
High-income group	0.00	-0.79	-0.78
Additional Poor People (All Indonesia)			**10,308**

Source: Simulation results of the model.

In contrast, low-income nonagricultural households in urban and rural areas benefit from the decline in poverty for two reasons. First, they are able to take advantage of the increase in production wage rates (as a result of the industrial sector expansion). Second, the reduction in the cost of their commodity basket is higher than the decline in their disposable income. This

Figure 9.11 **Change in the Poverty Headcount after Full Elimination of Tariffs on Agriculture Imports**



Source: Simulation results of the model.

is true for dependent and high-income households in urban areas as well, since poverty gap and poverty severity decrease among them.

AGLIBPRO: Eliminations of Agriculture Tariff and Indirect Tax

Macro Effects. The elimination of tariffs and indirect taxes in agriculture to ensure market access for agricultural imports leads to a 0.20 percent reduction in the local price of imported products (Table 9.13). The magnitude of the change in this simulation is higher than in the previous simulation (AGLIB). The elimination of indirect taxes permits a larger reduction in domestic prices. Thus, consumer prices decrease by 0.24 percent, leading to an increase in consumption of 0.02 percent.

Table 9.13 **Macro Effects of Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**
(Percentage change from base)

Real Gross Domestic Product	0.04
Prices	
Import prices in local currency	-0.20
Consumer prices	-0.24
Local cost of production	-0.06
Real exchange rate	0.09
Import volume	0.10
Export volume	0.14
Domestic production for local sales	0.01
Consumption (composite) goods	0.02

Source: Simulation results of the model.

As expected, cheaper agricultural imports flood the domestic market, as total import volume increases by 0.10 percent. This effectively reduces the cost of domestic production by 0.06 percent, paving the way for a real exchange rate depreciation (0.09 percent). The depreciation makes exports cheaper in the international market and thus exports increase by 0.14 percent. The fall in the domestic cost of production allows the industrial sector's output to expand, raising domestic production for local sales by 0.01 percent. The national output rises by 0.04 percent, accordingly.

Sectoral Effects. The output of the three major sectors expands (Table 9.14), with industry experiencing the largest increase (0.07 percent), followed by services (0.02 percent). Agriculture registers the lowest increase (0.01 percent), as the tariff and indirect-tax elimination in the sector allows imported agricultural products to compete in the local market–resulting in consumer substitution toward cheaper agricultural imports. On the other hand, industrial imports go down as the real exchange rate depreciation makes industrial imports relatively more expensive compared with the base.

Agriculture. The decline in import prices brings about an increase in import volume (4.0 percent) of agricultural products. Fisheries, livestock, and food crops subsectors generate the largest increase in import demand with 11.0, 7.6, and 5.6 percent, respectively. However, the decline in agricultural import prices does not translate into a reduction in the domestic cost of production as the price of value added in agriculture increases.[8] Indeed, domestic agricultural producers lose their competitiveness as the weighted agricultural domestic prices and output prices increase (0.22 and 0.23 percent, respectively), resulting in a 0.22 percent reduction in exports. In spite of this, overall agricultural output goes up marginally by 0.01 percent. Livestock, fisheries, and forestry output expands, while food crops and other crops contract.

Industry. The elimination of tariffs and indirect taxes in agriculture benefit the industrial sector as both output and exports increase by 0.07 percent and 0.20 percent respectively. The foremost gainers are wood products, food processing, and textiles, while construction and other mining are the major losers. It is worth noting that the outward-oriented industrial sector benefits from the elimination of tariffs and indirect taxes in agriculture as the sector experiences a decline in the domestic cost of production. This is the reason behind the increase in exports of the industrial sector.

Services. The expansion in both industrial and agricultural outputs stimulates greater demand for service infrastructure. With this, the services sector's output, domestic sales, and exports increase.

Factor Market. The value-added price increases by 0.09 percent, as both capital returns and overall wages increase by 0.01 percent and 0.10 percent, respectively (Table 9.15). The rise in wages is higher than the increase in capital return, implying that benefits accrue more to wage workers. Resources are reallocated to agriculture and services as the price of value added increases in both sectors.

Table 9.16 presents the labor market impacts of AGLIBPRO. Wages of agricultural laborers in the urban area register the highest increase,

8 This will be discussed under factor remuneration. See Table 9.15.

Table 9.14 **Sectoral Effects of Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**
(Percentage change from base)

Sectors	Price Changes (%)					Volume Changes (%)				
	Import	Domestic	Composite	Export	Local	Import	Export	Domestic sales	Output	Composite Demand
Agriculture	**-2.65**	**-0.75**	**-0.91**	**0.22**	**0.23**	**4.06**	**-0.22**	**0.03**	**0.37**	**0.01**
Food Crops	-3.12	-0.39	-0.62	0.26	0.27	5.60	-0.33	-0.12	0.35	-0.13
Other Crops	-1.88	-0.65	-0.86	0.10	0.09	2.04	-0.32	-0.47	-0.04	-0.45
Livestock	-4.68	-1.42	-1.53	0.12	0.13	7.66	0.20	0.65	0.88	0.63
Forestry	-2.49	-1.87	-1.88	0.32	0.38	1.69	-0.17	0.41	0.44	0.29
Fisheries	-5.61	-0.86	-0.87	0.31	0.34	11.02	-0.03	0.62	0.65	0.56
Industry	**0.00**	**-0.21**	**-0.16**	**-0.17**	**-0.21**	**-0.39**	**0.20**	**-0.02**	**-0.11**	**0.07**
Oil and Gas Mining	0.00	-0.34	-0.31	-0.25	-0.34	-0.92	0.23	-0.23	-0.29	-0.05
Other Mining	0.00	-0.46	-0.37	-0.26	-0.46	-1.88	-0.04	-0.98	-1.15	-0.60
Food Processing	0.00	-0.17	-0.15	-0.16	-0.17	-0.10	0.29	0.24	0.21	0.25
Textiles	0.00	-0.12	-0.08	-0.12	-0.12	-0.02	0.23	0.22	0.14	0.23
Wood and Wood Products	0.00	-0.67	-0.57	-0.53	-0.67	-1.20	0.75	0.15	-0.06	0.44
Papers and Metal Products	0.00	-0.10	-0.04	-0.05	-0.10	-0.33	0.03	-0.13	-0.25	-0.03
Chemicals	0.00	-0.17	-0.07	-0.10	-0.17	-0.47	0.10	-0.14	-0.33	0.00
Utilities, Electricity, Gas, and Water	0.00	0.00	0.00	0.00	0.00	0.11	0.05	0.10	0.10	0.10
Construction	—	-0.31	-0.31	-0.31	-0.31	—	—	-0.93	-0.93	-0.93
Services	—	**-0.04**	**-0.03**	**-0.03**	**-0.04**	**0.01**	**0.01**	**0.03**	**0.03**	**0.02**
Trade	—	-0.07	-0.07	-0.06	-0.07	-0.26	0.02	-0.12	-0.13	-0.08
Restaurants	—	-0.25	-0.22	-0.25	-0.25	-0.14	0.44	0.36	0.31	0.37
Hotels	—	0.06	0.04	0.06	0.06	0.15	-0.04	0.04	0.07	0.03
Land Transport	—	-0.01	-0.01	-0.01	-0.01	-0.04	0.01	-0.01	-0.02	-0.01
Other Transportation & Communication	—	-0.01	0.00	-0.01	-0.01	0.00	0.01	0.01	0.00	0.01
Banking and Insurance	—	0.05	0.03	0.04	0.05	0.12	-0.03	0.02	0.05	0.02
Real Estate	—	0.05	0.04	0.05	0.05	0.13	-0.04	0.02	0.05	0.02
Personal Services	—	0.01	0.01	0.01	0.01	0.03	0.00	0.02	0.02	0.02
Public Services	—	-0.01	-0.01	-0.01	-0.01	0.04	0.04	0.06	0.06	0.06
Total	**-0.20**	**-0.25**	**-0.24**	**-0.06**	**-0.06**	**0.10**	**0.14**	**0.01**	**0.02**	**0.04**

Source: Simulation results of the model.

Table 9.15 **Factor Market Effects of Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**
(Percentage change from base)

Sectors	Value Added		Capital Return	Wage
	Volume	Price		
Agriculture	**0.01**	**0.42**	**0.61**	**0.33**
Food Crops	-0.13	0.38	0.25	0.33
Other Crops	-0.45	0.37	-0.09	0.32
Livestock	0.63	0.55	1.18	0.34
Forestry	0.29	0.57	0.86	0.30
Fisheries	0.56	0.40	0.97	0.34
Industry	**-0.01**	**-0.01**	**-0.03**	**0.02**
Oil and Gas Mining	-0.05	-0.25	-0.30	0.03
Other Mining	-0.60	-0.27	-0.86	0.01
Food Processing	0.25	0.26	0.52	0.02
Textiles	0.23	0.20	0.43	0.03
Wood and Wood Products	0.44	0.40	0.84	0.01
Papers and Metal Products	-0.03	-0.01	-0.04	0.03
Chemicals	0.00	0.02	0.02	0.02
Utilities, Electricity, Gas, and Water	0.10	0.25	0.35	0.04
Construction	-0.93	-0.31	-1.24	-0.01
Services	**0.01**	**0.02**	**0.04**	**0.00**
Trade	-0.08	-0.06	-0.14	-0.03
Restaurants	0.37	0.17	0.54	0.02
Hotels	0.03	0.12	0.15	0.04
Land Transport	-0.01	0.00	-0.01	0.01
Other Transportation & Communication	0.01	0.05	0.06	0.04
Banking and Insurance	0.02	0.06	0.08	0.04
Real estate	0.02	0.09	0.11	0.03
Personal Services	0.02	0.03	0.05	0.01
Public Services	0.06	0.05	0.10	0.03
Total	**0.00**	**0.09**	**0.01**	**0.10**

Source: Simulation results of the model.

followed by agricultural laborers in the rural area. On the other hand, urban management professionals (nonemployees) experience the greatest reduction in wages (0.30 percent) because of the decline in factor incomes from the industrial sector (Figure 9.12).

Household Income and Commodity Basket Cost. The increase in factor returns resulting from the rise in wages and capital returns increases all household groups' disposable income (Table 9.17). Large farmers experience the highest increase, while high-income households in urban areas have the lowest increase (Figure 9.13). Accordingly, all households have more ability to purchase goods and services as the cost of the commodity basket declines. Dependent and high-income households in urban areas experience the highest reduction in their commodity basket cost, while medium and large farmers bear the lowest decrease (Figure 9.14). The fall in the commodity basket

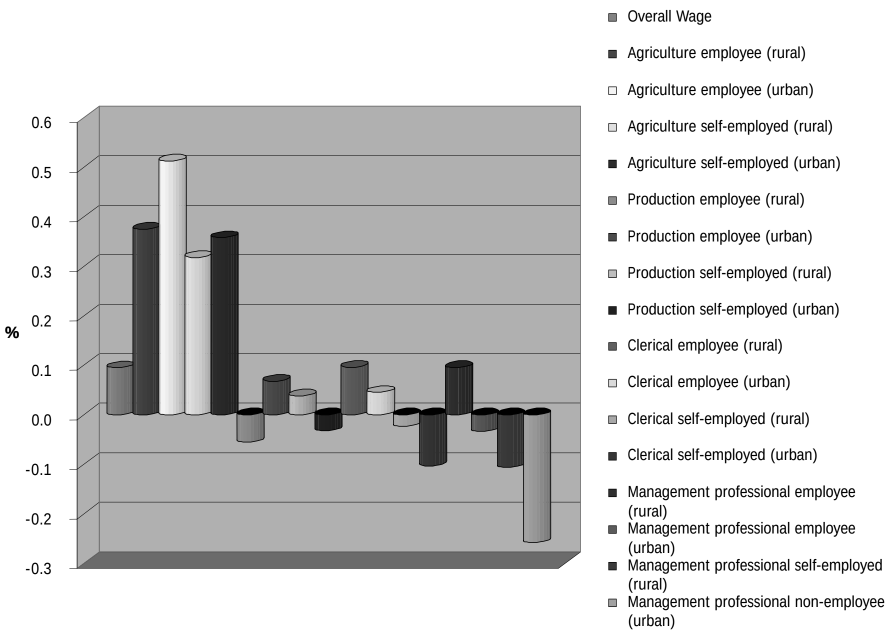
Table 9.16 **Labor Market Effects of Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**
(Percentage change from base)

Sectors	Labor Demand																
	L	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
Food Crops	-0.1	-0.1	-0.3	-0.1	-0.1	0.3	0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.4	0.5
Other Crops	-0.4	-0.5	-0.6	-0.4	-0.4	0.0	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	0.0	-0.2	-0.1	0.0	0.2
Livestock	0.8	0.8	0.7	0.9	0.8	1.2	1.1	1.1	1.2	1.1	1.1	1.2	1.3	1.1	1.2	1.3	1.4
Forestry	0.6	0.5	0.3	0.5	0.5	0.9	0.8	0.8	0.9	0.8	0.8	0.9	1.0	0.8	0.9	1.0	1.1
Fisheries	0.6	0.6	0.5	0.6	0.6	1.0	0.9	0.9	1.0	0.9	0.9	1.0	1.1	0.9	1.0	1.1	1.2
Oil and Gas Mining	-0.3	—	—	—	—	-0.2	-0.4	0.0	0.0	-0.4	-0.3	0.0	0.0	-0.4	-0.3	0.0	0.0
Other Mining	-0.9	—	—	—	—	-0.8	-0.9	-0.9	-0.8	-1.0	-0.9	-0.8	-0.8	-1.0	-0.8	-0.8	-0.6
Food Processing	0.5	—	—	—	—	0.6	0.4	0.5	0.5	0.4	0.5	0.5	0.6	0.4	0.5	0.6	0.8
Textiles	0.4	—	—	—	—	0.5	0.4	0.4	0.5	0.3	0.4	0.5	0.5	0.3	0.5	0.5	0.7
Wood and Wood Products	0.8	—	—	—	—	0.9	0.8	0.8	0.9	0.7	0.8	0.9	0.9	0.7	0.9	0.9	1.1
Paper and Metal Products	-0.1	—	—	—	—	0.0	-0.1	-0.1	0.0	-0.1	-0.1	0.0	0.1	-0.1	0.0	0.1	0.2
Chemicals	0.0	—	—	—	—	0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.1	-0.1	0.0	0.1	0.3
Utilities, Electricity, Gas, and Water	0.3	—	—	—	—	0.4	0.3	0.3	0.4	0.3	0.3	0.4	0.5	0.3	0.4	0.5	0.6
Construction	-1.2	—	—	—	—	-1.2	-1.3	-1.3	-1.2	-1.3	-1.3	-1.2	-1.1	-1.3	-1.2	-1.1	-1.0
Trade	-0.1	—	—	—	—	-0.1	-0.2	-0.2	-0.1	-0.2	-0.2	-0.1	0.0	-0.2	-0.1	0.0	0.1
Restaurants	0.5	—	—	—	—	0.6	0.5	0.5	0.6	0.4	0.5	0.6	0.6	0.4	0.6	0.6	0.8
Hotels	0.1	—	—	—	—	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.1	0.2	0.3	0.4
Land Transport	0.0	—	—	—	—	0.0	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.1	-0.1	0.0	0.1	0.3
Other Transportation & Communication	0.0	—	—	—	—	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.0	0.1	0.2	0.3
Banking and Insurance	0.0	—	—	—	—	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.0	0.1	0.2	0.3
Real Estate	0.1	—	—	—	—	0.2	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.0	0.1	0.2	0.4
Personal Services	0.0	—	—	—	—	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.0	0.1	0.2	0.3
Public Services	0.1	—	—	—	—	0.2	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.0	0.1	0.2	0.4
Change in average employee, %	0.1	0.4	0.5	0.3	0.4	-0.1	0.1	0.0	0.0	0.1	0.0	0.0	-0.1	0.1	0.0	-0.1	-0.3

L = Aggregate Labor; L1 = Agriculture employee (rural); L2 = Agriculture employee (urban); L3 = Agriculture self-employed (rural); L4 = Agriculture self-employed (urban); L5 = Production employee (rural); L6 = Production employee (urban); L7 = Production self-employed (rural); L8 = Production self-employed (urban); L9 = Clerical employee (rural); L10 = Clerical employee (urban); L11 = Clerical self-employed (rural); L12 = Clerical self-employed (urban); L13 = Management Professional employee (rural); L14 = Management Professional employee (urban); L15 = Management Professional self-employed (rural); L16 = Management Professional non- employee (urban)

Source: Simulation results of the model.

Figure 9.12 **Change in Wage per Labor Category after Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**



Source: Simulation results of the model.

costs stems not only from the decline in local import prices but more importantly from the elimination of indirect taxes in agriculture that further brings down the price. Therefore, all households benefit as agricultural products constitute a significant part of their consumption basket.

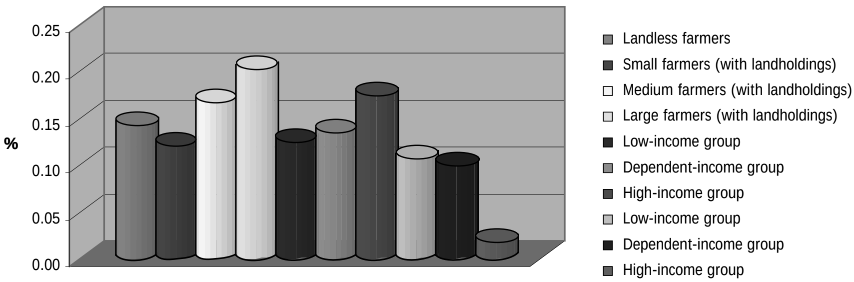
Table 9.17 **Household Income Effects of Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**
(Percentage change from base)

	Household Income	Price
Agriculture		
Landless farmers	0.144	-0.213
Small farmers	0.123	-0.203
Medium farmers	0.169	-0.156
Large farmers	0.203	-0.162
Nonagriculture (Rural)		
Low-income group	0.127	-0.216
Dependent-income group	0.137	-0.209
High-income group	0.176	-0.176
Nonagriculture (Urban)		
Low-income group	0.109	-0.165
Dependent-income group	0.101	-0.234
High-income group	0.019	-0.223

Source: Simulation results of the model.

Poverty. The national poverty headcount decreases by 1.20 percent, representing more than 394,000 people lifted out of poverty (Table 9.18 and Figure 9.15). Low-income households in rural areas achieve the highest reduction in poverty headcount (1.54 percent), whereas high-income households in rural areas attain the smallest reduction (0.76 percent). Notably, the decrease in the poverty gap and poverty severity

Figure 9.13 **Change in Disposable Income of Households after Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**



Source: Simulation results of the model.

Table 9.18 **Poverty Effects of Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**
(Percentage change from base)

	Headcount Ratio	Poverty Gap	Poverty Severity
ALL Indonesia	**-1.2**	**-1.4**	**-1.5**
Agriculture			
Landless farmers	-1.27	-1.62	-1.89
Small farmers	-1.22	-1.37	-1.49
Medium farmers	-0.89	-1.05	-1.13
Large farmers	-1.52	-1.43	-1.59
Nonagriculture (Rural)			
Low-income group	-1.54	-1.68	-1.87
Dependent-income group	-0.77	-1.49	-1.62
High-income group	-0.76	-1.69	-1.74
Nonagriculture (Urban)			
Low-income group	-0.90	-1.33	-1.47
Dependent-income group	-1.10	-1.70	-1.71
High-income group	-1.34	-1.74	-1.68
Poor People Lifted Out of Poverty (All Indonesia)			**394,125**

Source: Simulation results of the model.

is higher than that of the HCR, suggesting an improvement in the poverty status among those who remain poor. The highest reduction in the poverty gap accrues to high-income households in rural areas, while landless farmers benefit the most from reduced poverty severity.

TOTLIB: Elimination of All Tariffs

Macro Effects. Full tariff elimination results in a 3.0 percent decline in the local price of imported goods, a 1.7 percent increase in import volume, and a 1.9 percent fall in local import prices (Table 9.19). Despite the fall in consumer prices, total domestic consumption decreases minimally (0.1 percent) as producers sell less in the domestic market and reallocate toward the international market. This arises from the reduction in domestic costs of production, causing the real exchange rate to depreciate by 1.3 percent. With this, total exports go up (1.7 percent), while allocation for domestic sales shrinks by 0.4 percent. On the whole, total Indonesian output and real GDP increases by 0.1 and 0.3 percent, respectively, with the higher increase in real GDP as a result of export expansion.

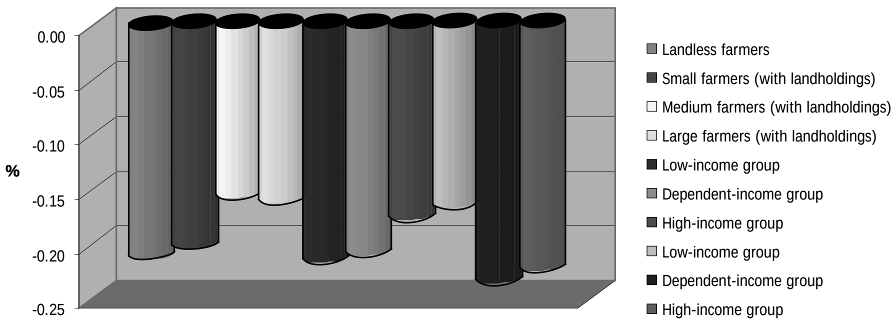
Table 9.19 **Macro Effects of Full Elimination of All Tariffs on Imported Products**
(Percentage change from base)

Real Gross Domestic Product	0.3
Prices	
Import prices in local currency	-3.0
Consumer prices	-1.9
Local cost of production	-1.7
Real exchange rate	1.3
Import volume	1.5
Export volume	1.7
Domestic production for local sales	-0.4
Consumption (composite) goods	-0.1

Source: Simulation results of the model.

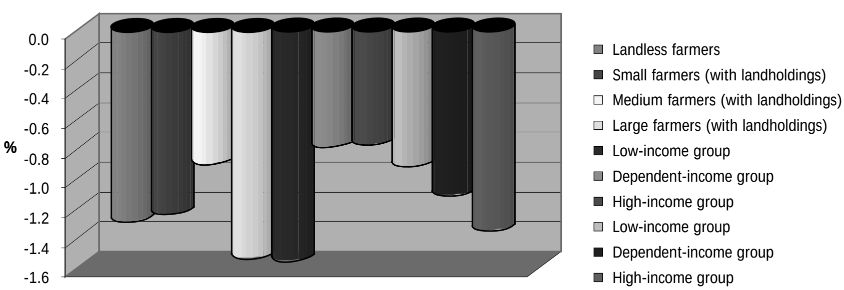
Sectoral Effects. Tariff elimination brings about an output expansion in industry and services (0.11 percent and 0.17 percent, respectively), and a marginal contraction in agricultural output (0.03 percent). Industrial exports and imports increase, while agricultural and service imports fall (Table 9.20). Overall, the price reduction in industry is greater since the sector's weighted

Figure 9.14 **Change in the Cost of the Household Commodity Basket after Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**



Source: Simulation results of the model.

Figure 9.15 **Change in the Poverty Headcount after Full Elimination of Tariffs and Indirect Taxes on Agriculture Imports and Agriculture Products**



Source: Simulation results of the model.

Table 9.20 **Sectoral Effects of Full Elimination of All Tariffs on Imported Products**
(Percentage change from base)

Sectors	Price Changes (%)					Volume Changes (%)				
	Imports	Domestic	Composite	Export	Local	Import	Export	Domestic	Composite	Local
Agriculture	**-1.89**	**-1.88**	**-1.88**	**-1.80**	**-1.88**	**-0.25**	**1.76**	**-0.19**	**-0.20**	**-0.03**
Food Crops	-2.49	-1.80	-1.86	-1.76	-1.80	1.36	1.81	-0.05	0.07	0.03
Other Crops	-1.16	-1.97	-1.83	-1.81	-1.97	-2.16	1.74	-0.53	-0.81	-0.22
Livestock	-3.18	-1.87	-1.91	-1.82	-1.87	2.83	1.94	0.09	0.17	0.17
Forestry	-0.26	-2.21	-2.16	-1.92	-2.21	-5.18	1.56	-1.36	-1.46	-0.78
Fisheries	-4.48	-1.84	-1.84	-1.76	-1.84	5.88	2.00	0.25	0.27	0.41
Industry	**-5.19**	**-2.11**	**-2.87**	**-1.65**	**-2.11**	**4.09**	**1.85**	**-0.97**	**0.24**	**0.11**
Oil and Gas Mining	-2.04	-1.95	-1.96	-1.44	-1.95	-0.98	1.40	-1.17	-1.15	-0.12
Other Mining	-1.47	-2.69	-2.47	-1.80	-2.69	-5.68	1.06	-3.30	-3.74	-1.50
Food Processing	-8.50	-1.82	-2.46	-1.54	-1.82	14.78	1.70	-0.31	1.01	0.26
Textiles	-7.37	-3.16	-4.69	-2.45	-3.16	8.54	2.90	-0.70	2.50	0.76
Wood and Wood Products	-4.94	-2.63	-2.99	-1.85	-2.63	3.61	2.06	-1.24	-0.51	0.36
Paper and Metal Products	-4.46	-2.90	-3.82	-1.85	-2.90	2.28	2.49	-0.98	0.91	1.19
Chemicals	-4.50	-2.73	-3.71	-1.62	-2.73	1.63	1.75	-2.05	-0.03	0.20
Utilities, Electricity, Gas, and Water	0.00	-1.12	-1.12	-1.12	-1.12	-2.05	1.23	0.18	0.18	0.18
Construction	—	-2.06	-2.06	-2.06	-2.06	—	—	-3.10	-3.10	-3.10
Services	**—**	**-1.06**	**-0.84**	**-0.98**	**-1.06**	**-1.67**	**1.03**	**0.02**	**0.23**	**0.17**
Trade	—	-1.38	-1.30	-1.14	-1.38	-3.49	1.02	-0.76	-0.93	-0.27
Restaurants	—	-1.43	-1.26	-1.43	-1.43	-2.14	1.81	0.71	0.38	0.71
Hotels	—	-0.71	-0.48	-0.71	-0.71	-1.37	0.74	0.04	-0.42	0.05
Land Transport	—	-1.20	-0.85	-1.05	-1.20	-2.33	1.25	0.06	-0.66	0.37
Other Transportation & Communication	—	-0.96	-0.47	-0.85	-0.96	-1.57	1.15	0.35	-0.64	0.59
Banking and Insurance	—	-0.63	-0.47	-0.60	-0.63	-1.26	0.62	-0.01	-0.33	0.05
Real Estate	—	-0.63	-0.49	-0.61	-0.63	-1.26	0.64	0.01	-0.28	0.06
Personal Services	—	-1.13	-0.98	-1.13	-1.13	-2.00	1.27	0.25	-0.05	0.25
Public Services	—	-0.82	-0.67	-0.82	-0.82	-1.09	1.10	0.55	0.25	0.56
Total	**-3.00**	**-1.66**	**-1.90**	**-1.44**	**-1.66**	**1.48**	**1.68**	**-0.43**	**-0.06**	**0.11**

Source: Simulation results of the model.

tariff rate is higher at the base. Hence, local import prices for industrial products fall more than import prices for agricultural products.

Agriculture. Contrary to AGLIB and AGLIBPRO, the decline in local import prices does not induce consumer substitution toward imported agricultural products. Indeed, consumption falls by 0.20 percent. At first glance, it seems that the decline in consumption, despite the fall in agricultural commodity prices, is counter intuitive. However, the decline in consumption arises from agricultural producers' reaction to the real exchange rate depreciation. As Indonesian agricultural exports become cheaper, producers reallocate toward the international market, thereby selling less in the domestic market.

Industry. Full tariff elimination favors the industrial sector as import protection walls collapse. The proliferation of cheap imports brings down the cost of intermediate inputs, resulting in a reduction in the domestic cost of production. With this, total industry output, exports, and imports increase by 0.11 percent, 1.85 percent, and 4.00 percent respectively. Paper production and textiles benefit the most from tariff elimination as both their output and exports expand the most.

Services. The services sector benefits the most from full tariff elimination. This is traceable to the increase in vital service infrastructure demand by both agriculture and industry. Thus, total consumption for services increases by 0.23 percent. The restaurant subsector registers the highest increase in exports and output.

Factor Market. Table 9.21 presents the factor market impacts of TOTLIB. The economy-wide price of value added decreases by 0.9 percent as both the return to capital and overall wage falls. The reduction in wage rate (1.0 percent) is higher than the decline in return to capital (0.7 percent), implying that wage workers endure the greater impact of lower factor returns. Moreover, the reduction in wages under TOTLIB is higher when compared with AGLIB and AGLIBPRO. Agriculture registers the highest reduction in the price of value added, making agricultural laborers experience the largest decline in wage.

Household Income and Commodity Basket Cost. Table 9.22 shows the changes in households' the disposable income and the cost of the household consumer basket. Clearly, disposable income of all households declines, with agricultural households enduring the highest reduction in factor income. Nonagriculture households based in urban areas experience the lowest decline in disposable income (Figure 9.16).

The cost of the commodity basket of all households falls as a result of tariff elimination (Table 9.23 and Figure 9.17). The removal of import protection

Table 9.21 **Factor Market Effects of Full Elimination of All Tariffs on Imported Products**
(Percentage change from base)

Sector	Value added	Price	Capital Return	Wages
Agriculture	**-0.03**	**-1.71**	**-1.97**	**-1.65**
Food Crops	0.03	-1.69	-1.66	-1.66
Other Crops	-0.22	-1.69	-1.90	-1.63
Livestock	0.17	-1.73	-1.56	-1.60
Forestry	-0.78	-1.85	-2.62	-1.50
Fisheries	0.41	-1.68	-1.27	-1.65
Industry	**-0.10**	**-0.85**	**-0.85**	**-0.84**
Oil and Gas Mining	-0.12	-1.40	-1.52	-0.66
Other Mining	-1.50	-1.70	-3.18	-1.01
Food Processing	0.26	-0.63	-0.38	-0.88
Textiles	0.76	-0.22	0.54	-0.80
Wood and Wood Products	0.36	-0.68	-0.33	-1.00
Papers and Metal Products	1.19	0.92	2.11	-0.74
Chemicals	0.20	-0.44	-0.24	-0.80
Utilities, Electricity, Gas, and Water	0.18	-0.30	-0.12	-0.68
Construction	-3.10	-1.95	-4.99	-0.93
Services	**0.12**	**-0.59**	**-0.39**	**-0.73**
Trade	-0.27	-1.03	-1.30	-0.93
Restaurants	0.71	-0.43	0.28	-0.73
Hotels	0.05	-0.43	-0.38	-0.53
Land Transport	0.37	-0.53	-0.16	-0.92
Other Transportation & Communication	0.59	0.27	0.86	-0.57
Banking and Insurance	0.05	-0.45	-0.41	-0.52
Real Estate	0.06	-0.36	-0.29	-0.57
Personal Services	0.25	-0.55	-0.31	-0.82
Public Services	0.56	-0.28	0.28	-0.41
Total	**0.00**	**-0.9**	**-0.7**	**-1.0**

Source: Simulation results of the model.

generates a decline in all commodity prices, thereby benefiting households indirectly. Indeed, the reduction in the cost of all RHGs' commodity baskets is greater than the fall in disposable income, implying an improvement in the living status of all household groups.

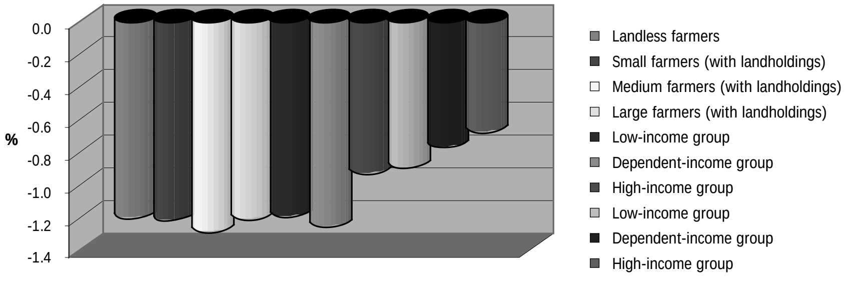
Poverty. Table 9.24 shows the changes in poverty indexes. Poverty headcount falls by 2.6 percent, suggesting that 857,754 people are escaping poverty. In general, poverty reduction favors, relatively, the nonagricultural households–particularly those residing in urban areas. High-income households in urban areas experience the largest reduction in poverty, while medium farmers and dependent households in rural areas experience the smallest reduction in poverty (Figure 9.18). Notably, the decline in the poverty gap and severity is higher than the reduction in poverty headcount, implying an improvement in the status of those who remain poor. As pointed out above, this is because

Table 9.22 **Labor Market Effects of Full Elimination of All Tariffs on Imported Products**
(Percentage change from base)

Sectors	Labor Demand																
	L	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16
Food Crops	0.00	0.09	0.02	-0.01	-0.03	-0.39	-1.03	-0.48	-0.63	-1.22	-1.15	-0.64	-0.45	-1.77	-1.26	-0.43	-0.18
Other Crops	-0.27	-0.16	-0.23	-0.25	-0.27	-0.64	-1.28	-0.73	-0.88	-1.47	-1.39	-0.88	-0.70	-2.01	-1.50	-0.68	-0.43
Livestock	0.04	0.18	0.12	0.09	0.07	-0.29	-0.94	-0.38	-0.54	-1.13	-1.05	-0.54	-0.36	-1.67	-1.16	-0.34	-0.09
Forestry	-1.13	-0.89	-0.95	-0.98	-1.00	-1.36	-2.00	-1.45	-1.60	-2.18	-2.11	-1.60	-1.42	-2.72	-2.22	-1.40	-1.15
Fisheries	0.38	0.48	0.41	0.39	0.37	0.00	-0.65	-0.09	-0.24	-0.83	-0.76	-0.25	-0.06	-1.38	-0.87	-0.04	0.21
Oil and Gas Mining	-0.86	—	—	—	—	-0.25	-0.89	0.00	0.00	-1.08	-1.00	0.00	0.00	-1.63	-1.12	0.00	0.00
Other Mining	-2.19	—	—	—	—	-1.93	-2.56	-2.02	-2.17	-2.75	-2.67	-2.17	-1.99	-3.29	-2.78	-1.97	-1.72
Food Processing	0.50	—	—	—	—	0.91	0.25	0.82	0.66	0.07	0.14	0.66	0.84	-0.49	0.03	0.86	1.12
Textiles	1.35	—	—	—	—	1.83	1.17	1.74	1.59	0.98	1.06	1.58	1.77	0.42	0.95	1.79	2.05
Wood and Wood Products	0.67	—	—	—	—	0.96	0.31	0.87	0.71	0.12	0.19	0.71	0.89	-0.44	0.08	0.92	1.17
Paper and Metal Products	2.87	—	—	—	—	3.43	2.76	3.34	3.18	2.57	2.65	3.18	3.36	2.00	2.53	3.39	3.65
Chemicals	0.57	—	—	—	—	1.05	0.39	0.95	0.80	0.20	0.28	0.80	0.98	-0.35	0.17	1.00	1.26
Utilities, Electricity, Gas, and Water	0.56	—	—	—	—	1.17	0.51	1.08	0.92	0.33	0.40	0.92	1.10	-0.23	0.29	1.13	1.38
Construction	-4.09	—	—	—	—	-3.76	-4.38	-3.85	-3.99	-4.56	-4.49	-4.00	-3.82	-5.09	-4.60	-3.80	-3.56
Trade	-0.38	—	—	—	—	-0.03	-0.68	-0.12	-0.27	-0.86	-0.79	-0.28	-0.10	-1.41	-0.90	-0.07	0.18
Restaurants	1.02	—	—	—	—	1.57	0.92	1.48	1.33	0.73	0.80	1.32	1.51	0.17	0.69	1.53	1.79
Hotels	0.16	—	—	—	—	0.91	0.25	0.82	0.66	0.07	0.14	0.66	0.84	-0.49	0.03	0.86	1.12
Land Transport	0.77	—	—	—	—	1.13	0.48	1.04	0.89	0.29	0.37	0.88	1.07	-0.27	0.25	1.09	1.34
Other Transportation & Communication	1.44	—	—	—	—	2.16	1.50	2.07	1.91	1.31	1.39	1.91	2.10	0.75	1.27	2.12	2.38
Banking and Insurance	0.11	—	—	—	—	0.88	0.23	0.79	0.63	0.04	0.12	0.63	0.81	-0.52	0.00	0.84	1.09
Real Estate	0.28	—	—	—	—	0.99	0.34	0.90	0.75	0.15	0.23	0.75	0.93	-0.40	0.12	0.95	1.21
Personal Services	0.52	—	—	—	—	0.98	0.33	0.89	0.74	0.14	0.22	0.73	0.92	-0.42	0.10	0.94	1.19
Public Services	0.69	—	—	—	—	1.57	0.92	1.48	1.33	0.73	0.80	1.32	1.51	0.17	0.69	1.53	1.79
Change in average employee, %	-1.01	-1.74	-1.68	-1.65	-1.64	-1.27	-0.63	-1.19	-1.03	-0.44	-0.52	-1.03	-1.21	0.11	-0.41	-1.23	-1.48

L = Aggregate Labor; L1 = Agriculture employee (rural); L2 = Agriculture employee (urban); L3 = Agriculture self-employed (rural); L4 = Agriculture self-employed (urban); L5 = Production employee (rural); L6 = Production employee (urban); L7 = Production self-employed (rural); L8 = Production self-employed (urban);L9 = Clerical employee (rural); L10 = Clerical employee (urban); L11 = Clerical self-employed (rural); L12 = Clerical self-employed (urban); L13 = Management Professional employee (rural); L14 = Management Professional employee (urban); L15 = Management Professional self-employed (rural); L16 = Management Professional nonemployee (urban)
Source: Authors' calculation from simulation results.

Figure 9.16 **Change in Disposable Income of Households after Full Elimination of All Tariffs on Imported Products**



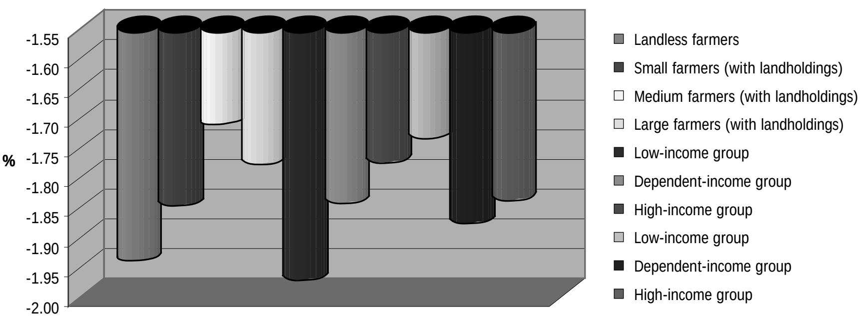
Source: Simulation results of the model.

Table 9.23 **Household Income Effects of Full Elimination of All Tariffs on Imported Products**
(Percentage change from base)

	Household Income	Price
Agriculture		
Landless farmers	-1.19	-1.94
Small farmers	-1.21	-1.85
Medium farmers	-1.28	-1.71
Large farmers	-1.21	-1.77
Nonagriculture (Rural)		
Low-income group	-1.19	-1.97
Dependent-income group	-1.25	-1.84
High-income group	-0.93	-1.77
Nonagriculture (Urban)		
Low-income group	-0.89	-1.73
Dependent-income group	-0.76	-1.87
High-income group	-0.67	-1.84

Source: Simulation results of the model.

Figure 9.17 **Change in the Cost of the Household Commodity Basket after Full Elimination of All Tariffs on Imported Products**



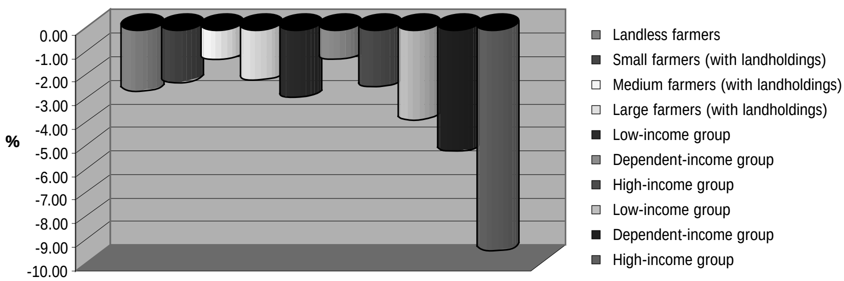
Source: Simulation results of the model.

Table 9.24 **Poverty Effects of Full Elimination of All Tariffs on Imported Products**
(Percentage change from base)

	Headcount Ratio	Poverty Gap	Poverty Severity
All Indonesia	**-2.6**	**-2.9**	**-3.0**
Agriculture			
Landless farmers	-2.7	-3.4	-4.0
Small farmers	-2.3	-2.7	-2.9
Medium farmers	-1.4	-1.4	-1.5
Large farmers	-2.2	-2.3	-2.5
Nonagriculture (Rural)			
Low-income group	-2.9	-3.9	-4.3
Dependent-income group	-1.4	-2.6	-2.8
High-income group	-2.5	-4.1	-4.2
Nonagriculture (Urban)			
Low-income group	-3.9	-4.1	-4.5
Dependent-income group	-5.2	-5.6	-5.6
High-income group	-9.4	-8.2	-8.4
Poor People Lifted Out of Poverty (All Indonesia)			**857,754**

Source: Simulation results of the model.

Figure 9.18 **Change in the Poverty Headcount after Full Elimination of All Tariffs on Imported Products**



Source: Simulation results of the model.

the decline in the cost of the household commodity basket outweighs the decline in disposable income.

The significant change in the HCR compared with those of household income (Table 9.23 and 9.24) indicate that there is better income improvement among the poor households for each group. This means that income distribution also improves following the policy introduction.

Concluding Remarks

The general trend of tariff reduction as part of trade liberalization in Indonesia is in line with the DDA and is economically desirable. Further trade liberalization in the future, however, should be conducted cautiously– especially if its impact on poverty is also to be taken into account. The CGE model developed in this study sheds light on the economy-wide impact of unilateral, but DDA-consistent, trade liberalization in Indonesia. The general results seem to indicate that the existing tariff structure is not only distorting the economy but is also not pro-poor.

The prevalence of agricultural protection may not be beneficial to the Indonesian economy in the long run, as can be seen from the simulation results of eliminating agricultural tariffs only. The presence of cheap agricultural imports as a result of the policy will induce consumers to substitute toward them, resulting in agricultural output contraction and a reduction in the income of farm workers. National poverty headcount, poverty gap, and poverty severity all increase. This implies that the already poor, especially agricultural households, would become poorer.

In contrast, a more proactive stance of adopting complete farm trade liberalization, in which tariffs and indirect taxation of agricultural products are removed, appears more promising. The policy is consistent with the DDA and seems beneficial to the economy and to the poor. Agriculture, industry, and service outputs expand, resulting in an increase in factor returns. In particular, wages of agricultural laborers increase substantially, suggesting that they benefit the most from the resource reallocation effects, especially compared to other workers. To a large extent, the abolition of domestic agricultural taxes allows domestic agriculture producers to compete with agricultural imports. The disposable income of all household groups increases, while the cost of the commodity basket falls, leading to poverty reduction. As a result, HCR, poverty gap, and poverty severity all fall, indicating a clear improvement in the overall poverty condition.

The last alternative of full tariff elimination in all sectors appears to be the best poverty-reducing policy. Industrial and service outputs expand, while agricultural output contracts. Industrial exports and imports increase while agriculture and service imports fall, thereby sustaining the trade surplus. Resources are reallocated from agriculture to industry and services. The adjustment impact is a decline in wages and, consequently, a decline in income for almost all households. However, this fall is outweighed by the reduction in consumer prices as a result of tariff elimination. Hence, poverty decreases substantially. Note that in terms of poverty headcount, poverty severity, and poverty gap, every household group comes out ahead compared with both of the other scenarios and the baseline. This is clearly the dominant strategy of the three for reduction in absolute poverty. Nonetheless, the decline in poverty is higher among nonagricultural households, especially those residing in urban areas, where poverty incidence is already the lowest. This benefit may stem from the ability of nonfarm workers to take advantage of additional opportunities as a result of the expansions of industrial and services sectors. Accordingly, the main challenge for the government is to implement complementary policies especially targeted to farm workers and the poor. Through improved access to labor markets, they would then be able to take advantage of the opportunities being offered by trade liberalization and the DDA.

CHAPTER 10

Poverty Reduction Integrated Simulation Model: Trade Liberalization in the Philippines, The Need for Further Reform

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Introduction

In the 1980s, significant strides were made in Philippine trade policy reform. Tariff rates were reduced, the tariff structure was simplified, and imports of nonessentials, unclassified, or semi-classified products were prohibited. The government initiated three measures: the 1981–1985 Tariff Reform Program (TRP), the Import Liberalization Program (ILP), and the complementary realignment of indirect taxes in 1983–1985. Under the TRP, the peak tariff rate was reduced from 100 percent to 50 percent, while the floor tariff rate was raised from 0 to 10 percent. Indirect taxes were modified such that sales tax rates imposed on imports and their locally manufactured counterparts were equalized. Also, the mark up applied on the value of imports (for purposes of computing the sales tax) was reduced and eventually eliminated (Manasan and Querubin 1997).

When the Aquino administration came into power in 1986, it abolished the export tax on all products except logs. Thus, the number of regulated items liberalized across sectors was reduced significantly from 1,802 items in 1985 to 609 items in 1988 (De Dios 1995). In 1991, the government embarked on another major tariff reform program with the issuance of Executive Order (EO) No. 470. Under this EO, the number of commodity lines with high tariffs was reduced, while the number of commodity lines with low tariff rates was increased. It aimed at clustering the commodity line at the 10–30 percent rate range by 1995. However, about 10 percent of the total number of commodity lines continued to be subjected to 0–5 percent and 50 percent tariff rates by

[1] The author acknowledged the International Development Research Center (IDRC; http://www.idrc.ca) and the Poverty and Economic Policy (PEP; http://www.pep-net.org) research network for providing financial support in the development of the CGE micro-simulation model, which was used as the basis for the development of the PRISM. The model was first introduced in Cororaton and Cockburn 2005. See related article in Cororaton and Cockburn 2007.

the end of 1995. These developments were expected to intensify with the introduction of the Doha Development Agenda (DDA) that would further liberalize trade.

However, the impact of all these developments on the poor is not very clear and is the subject of intense discussion. Do the poor share in the gains from free trade? What alternative or accompanying policies may be used to ensure a more equitable distribution of the gains? What are the channels through which these reforms may affect the poor? These are examples of very challenging policy issues that occupy the ongoing debate on trade reforms.

Given the economy-wide nature of trade reform, this study uses a tool called the Poverty Reduction Integrated Simulation Model (PRISM) to provide insights on how changes in trade policies may affect poverty. The PRISM for the Philippine economy is developed using a computable general equilibrium (CGE) microsimulation model that is calibrated to the 1994 Social Accounting Matrix (SAM). This approach allows researchers to comprehensively and consistently models the link between trade reforms and individual household responses, and their feedback to the entire economy. Moreover, the integration of household data into the CGE model allows changes to be tracked in household income, consumption, and poverty for a given policy change (Cockburn 2002 and Cororaton 2003b). In particular, with PRISM, it is possible to investigate the transmission mechanisms or channels through which households may be affected by changes in factor incomes as a result of factor and output price changes, and by changes in consumer prices.

Therefore, the effects of tariff reform on households may be traced through the income and consumption channels. Through the income channel, tariff reform generates a series of changes in sectoral imports, exports, production, demand for factors and factor payments, and, ultimately, household income. Households which are endowed with factors that are used intensively in the expanding sectors may benefit from the tariff reform. Through the consumption channel, tariff reform may change consumer prices, benefiting those households which consume more goods with declining prices as a result of the tariff reform.

Survey of Literature

A number of researchers, such as Winters, McCulloch, and McKay (2004) and Hertel and Reimer (2004), have investigated the link between trade and poverty through surveys. Both surveys analyze the theoretical link and cite the empirical evidence available so far. In summary, the link between trade and poverty may be found in:

- price and availability of goods;
- factor prices, income, and employment;
- government taxes and transfers influenced by changes in revenue from trade taxes;
- incentives for investment and innovation, which affect long-run economic growth;
- external shocks, in particular, changes in the terms of trade; and
- short-run risk and adjustment costs.

Various methods of analysis can be used to examine the link between trade and poverty, such as partial equilibrium and cost-of-living analysis, general equilibrium models, and econometric models on trade, growth, and poverty. Regardless of the methods used, the empirical evidence indicates that there is no simple general conclusion about the relationship between trade liberalization and poverty.

This paper uses a general equilibrium framework in addressing the issue. There have been many attempts to adopt CGE models for analyzing the poverty issue. The simplest approach is to increase the number of categories of households or representative household groups (RHGs) and examine how different households (rural versus urban, landholders versus sharecroppers, region A versus region B, etc.) are affected by a given shock. However, in this approach nothing can be said about the relative impacts on households within any given category because the model only generates information on the RHGs (or the "average" household). There is increasing evidence that households within a given category may be affected quite differently according to their asset profiles, location, household composition, education, etc. Although this problem of intra-category variation may decrease with a greater disaggregation of households (see, for example, the work of Piggott and Whalley (1985), where over 100 household categories were considered), one still has to impose strong assumptions concerning the income distribution among households within each category in order to conduct conventional poverty and income distribution analysis.

A popular approach is to assume a lognormal distribution of income within each category where the variance is estimated with base-year data (De Janvry, Sadoulet, and Fargeix 1991a). In this approach, the change in income of the representative household in the CGE model is used to estimate the change in the average income for each household category, while the variance of this income is assumed fixed. Decaluwé et al. (2000) argue that a beta distribution is preferable to other distributions such as the lognormal because it can be skewed left or right and thus may better represent the types of intra-category income distributions commonly observed. Cockburn (2002) use the actual incomes from a household survey, rather than assume any given functional form, and apply the change in income of the representative household in the CGE model to each individual household in that category.

Regardless of the distribution chosen, one must further assume that all but the first moment in each RHG is fixed and unaffected by the shock analyzed. This assumption is hard to defend given the heterogeneity of income sources and consumption patterns of households even within much disaggregated categories. Indeed, it is often found that intra-category income variance amounts to more than half of total income variance.

The alternative approach is to model each household individually. As demonstrated by Cockburn (2002), this poses no particular technical difficulties because it involves constructing a standard CGE model with as many household categories as there are households in the household survey providing the base data.

Cororaton (2000) attempted to analyze the effects of tariff reform on household welfare using a CGE model. However, the analysis suffers from two weaknesses: the CGE model used in the simulation was calibrated to the 1990 SAM, which is outdated since much of the tariff reform took place in the mid-1990s; and the household disaggregation was done in deciles. As a result, it is conceptually difficult to pin down the effects of a policy shock at the household level if the groupings are in deciles because households can move in and out of a particular decile group after a policy change. To address these weaknesses, Cororaton (2003a, 2003b) specified a CGE model on the updated 1994 SAM using household groupings in socioeconomic classes that were characterized by household resource endowments such as educational attainment. However, while these socioeconomic household groupings represent a significant improvement over the previous model because the degree of household mobility across groups was much less, it was still inadequate in capturing the effects of tariff reform on poverty. Thus, to address the concern, Cororaton (2003b) applied a CGE-microsimulation approach by incorporating detailed individual household information from the Family Income and Expenditure Survey (FIES). In particular, the approach incorporates the 24,797 households in the 1994 FIES. This approach replaces the usual representative household assumption in a traditional CGE model with individual households in the FIES to capture the interaction between policy reforms and individual household responses, and their feedback to the general economy. This paper is a further extension of Cororaton (2003b). It presents the different scenarios that would be described in the improvement of the poor through trade liberalization.

Trade Reforms

As mentioned earlier, the Philippine government introduced three major trade reforms–the TRP, ILP, and the complementary realignment of indirect taxes–with the view of implementing comprehensive tariff reforms that would reduce the trade imbalance and government deficit. The reform was initially carried out in 14 sectors: food processing, textiles and garments, leather and leather products, pulp and paper, cement, iron and steel, automotive, wood and wood products, motorcycles and bicycles, glass and ceramics, furniture, domestic appliances, machineries and other capital equipment, and electrical and electronics. The reform brought about a reduction in the average nominal tariff rate from 34.6 percent in 1981 to 27.9 percent in 1985 (Table 10.1). In 1983–1985, sales taxes on imports and locally produced goods were unified, removing protection from the differentiated sales tax rates. Also in 1985, the markup[2] applied on the value of imports (for sales tax valuation purposes) was reduced and eventually eliminated in 1986.

Table 10.1 **Average Nominal Tariffs by Sector**
(Percent)

Sector	*1982*	*1985*	*1990*	*1991*	*1995*	*1998*	*2000*
Agriculture	43.2	34.6	34.8	36.0	28.0	18.9	14.4
Mining	16.5	15.3	14.0	11.5	6.3	3.6	3.3
Manufacturing	33.7	27.1	27.5	24.6	14.0	9.4	6.9
Overall	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: The Philippine Tariff Commission.

However, because of the balance of payments, economic, and political crises in the mid-1980s, the import liberalization program was suspended. In fact, some of the items that were deregulated earlier were reregulated in this period, as earlier mentioned.

A reversal of the reforms followed in early 1990s. The government launched a major program in 1991 with the issuance of EO No. 470, which was also called the TRP-II. This was an extension of the previous program, in which tariff rates were realigned over a 5-year period, involving narrowing tariff rates through a series of tariff reductions of commodity lines with high tariffs and an increase in tariffs in commodity lines with low tariffs. In particular, the program was aimed at clustering tariffs within the 10–30 percent range by 1995. Despite the program, about 10 percent of the total number of commodity lines was still subjected to 0–5 percent and 50 percent tariff rates by the end of the program in 1995.

Converting quantitative restrictions (QRs) into tariff equivalents (tariffication) started in 1992 with the implementation of EO No. 8. There

2 The markup effectively increased the total import duties paid because of increases in the tax base of imports.

were 153 commodities subjected to this program. In a number of cases, tariff rates were set up over 100 percent, especially in the initial years of the conversion. However, some sensitive agricultural products continued to be protected by a built-in program that was put into effect in the phase down of tariff rates over a 5-year period. Furthermore, this also realigned tariff rates on 48 commodities.

The tariffication program continued on another 286 items. As a result, by the end of 1992, only 164 commodities were covered under QRs. However, the implementation of the Memorandum Order (MO) 95 in 1993 reversed the deregulation process. QRs were reimposed on 93 items, increasing the number of regulated items under the QRs to 257. This reregulation came largely as a result of the Magna Carta for Small Farmers in 1991.

Major reforms were implemented under the TRP-III under the following EOs:

- EO No. 189 implemented on 1 January 1994 to reduce tariffs on capital equipment and machinery;
- EO No. 204 on 30 September 1994 to reduce tariffs on textiles, garments, and chemical inputs;
- EO No. 264 on 22 July 1995 to reduce tariffs on 4,142 harmonized lines in the manufacturing sector; and
- EO No. 288 in 1 January 1996 to reduce tariffs on nonsensitive components of the agricultural sector.

The tariff restructuring under these EOs refers to reduction in both the number of tariff tiers and the maximum tariff rates. In particular, the program was aimed at establishing a four-tier tariff schedule, namely: a 3 percent rate for raw materials and capital equipment not available locally; 10 percent for raw materials and capital equipment available from local sources; 20 percent for intermediate goods; and 30 percent for finished goods.

Another major component of the overall tariff design was to implement a uniform tariff of 5 percent (this is still under discussion). This scheme was envisioned to eliminate cascading tariff structures, which favors finished or final products over intermediate goods.

Table 10.2 shows the weighted average tariff rates in 1994 and in 2000 across various sectors. The overall rate declined by 65.0 percent over these years, i.e., from 23.9 percent in 1994 to 7.9 percent in 2000. The tariff decline in industry (65.3 percent) was much higher than in agriculture (48.8 percent).

In terms of specific sectors, the largest tariff drop was in the mining sector (88.9 percent), while the lowest decline was in other agriculture (19.9 percent).

Tariff rates in 2000 show that food manufacturing still has the highest rate of 16.6 percent, while other agriculture has the lowest tariff of 0.2 percent. Tariff changes in 1994–2000, are examined in the simulation analysis.

In line with existing foreign trade policies, the Philippine government has reduced import levies to zero on about 60 percent of its products included in the list of the Common Effective Preferential Tariff scheme of the Association of Southeast Asian Nations (ASEAN) Free Trade Area. Rounds of discussions were also undertaken in the People's Republic of China and Japan under the Philippine Economic Partnership Agreement.

Table 10.2 **Weighted Average Nominal Tariff Rates**
(Percent)

Sector	*1994*	*2000*	*Change*
Agriculture	8.8	4.5	-48.8
Crops	15.9	8.7	-45.5
Livestock	0.7	0.3	-57.6
Fishing	34.1	8.0	-76.4
Other agriculture	0.3	0.2	-19.9
Industry [a]	24.1	8.4	-65.3
Mining	44.1	4.9	-88.9
Food manufacturing	37.3	16.6	-55.4
Nonfood manufacturing	21.1	7.6	-64.0
Services [b]	—	—	—
Total	23.9	7.9	-65.0

a includes construction, electricity, gas, and water
b includes trade, government services, and other services
Source: Manasan and Querubin 1997.

Tariff Reform and Government Revenue

Revenue from import tariffs is one of the major sources of government income. Table 10.3 shows government revenue by sources. In 1990, the share of revenue from import duties and taxes to total revenue was 26.4 percent. This increased marginally to 27.7 percent in 1995. However, the share dropped significantly to 19.3 percent in 2000. One of the major factors behind the decline was the tariff reduction program.

The share of direct taxes, a combination of income and profit direct taxes, increased consistently from 27.3 percent in 1990 to 30.7 percent in 1995, and then to 38.6 percent in 2000. On the other hand, the share of government revenue from excise and sales taxes dropped, i.e., from 27.2 percent in 1990 to 23.4 percent in 1995. The share, however, recovered to 28.1 percent in 2000.

Table 10.3 **Sources of National Government Revenue**
(Percent)

	1990	*1995*	*2000*	*2005*
Tax Revenue	83.9	86.0	89.4	86.1
Taxes on net income and profits	27.3	30.7	38.6	—
Excise and sales taxes	27.2	23.4	28.1	—
Import duties and other import taxes	26.4	27.7	19.3	—
Other taxes	3.0	3.9	3.1	—
Nontax revenue	14.9	13.8	10.4	13.9
Grants	1.3	0.3	0.3	0.0
Total	100.0	100.0	100.0	100.0
(Deficit)/Surplus (billion pesos)	(37.2)	11.1	(134.2)	(146.8)
(Deficit)/Surplus (% of GDP)	-3.5	0.6	-4.0	-2.7

Note: Breakdown of tax revenue is taken from Selected Philippine Indicators, Bangko Sentral ng Pilipinas.
Source: ADB (2007).

Since tariffs are a major source of government income, a tariff reduction could therefore have substantial government budget implications especially if it is not accompanied by compensatory tax financing. In this context, a tariff reduction could pose a major policy challenge, especially in the situation of a growing government budget deficit. In 1995–2000, the government budget deficit grew. From a surplus of 0.6 percent of gross national product in 1995, the budget balance flipped to a deficit of 4.0 percent in 2000 (which shrunk to 2.7 percent in 2005). This persistent government imbalance, if unchecked, could create undesirable macroeconomic effects that make the viability of a continued tariff reduction program uncertain. Therefore, other compensatory tax financing measures such as income tax and other excise and indirect taxes are always subject for amendment from any shortfall on budget target.

Structure of the Philippine Economy

The impact of tariff reduction would also depend on the initial conditions of the economy in the base year (which is 1994 in the present context) in terms of the structure of foreign trade (imports and exports), production, household consumption, factor endowments, and sources of income. A brief discussion of these is given in this section. The discussion is based on the constructed 1994 SAM (Cororaton 2003a).

Table 10.4 shows the structure of production. Industry contributes 46.7 percent to the overall gross value of output of the economy. Of the total contribution of industry, 23 percent comes from the nonfood manufacturing sector and another 14.7 percent from food manufacturing. The output contribution of the entire service sector is 39.1 percent, of which 22.1 percent comes from government services, which accounts for 22.1 percent and 11.3 percent from wholesale and retail trade, respectively. Total agriculture contributes 14.3 percent to the total, of which 6.8 percent comes from crops and another 4 percent from livestock.

Table 10.4 **Structure of Production and Factors Used in the Model**

Sector	Total output	Value Added (%)		Factor Shares in VA (%)		Sectoral Factor Shares (%)	
	Share (%)	*VA/X*	*Share*	*Labor*	*Capital*	*Labor*	*Capital*
Agriculture	**14.3**	**71.4**	**20.0**	**47.7**	**52.3**	**21.2**	**19.0**
Crops	6.8	77.7	10.3	50.6	49.4	11.6	9.3
Livestock	4.0	58.1	4.5	50.4	49.6	5.1	4.1
Fishing	2.7	71.7	3.7	35.8	64.2	3.0	4.4
Other agriculture	0.9	82.3	1.4	50.1	49.9	1.5	1.2
Industry	**46.7**	**34.5**	**31.6**	**40.6**	**59.4**	**28.5**	**34.0**
Mining	0.9	55.0	1.0	46.6	53.4	1.1	1.0
Food manufacturing	14.7	30.8	8.8	36.5	63.5	7.2	10.2
Nonfood manufacturing	23.0	29.7	13.4	44.8	55.2	13.3	13.4
Construction	5.3	52.8	5.5	43.8	56.2	5.4	5.6
Electricity, gas, and water	2.7	53.0	2.8	25.2	74.8	1.6	3.8
Services	**39.1**	**63.3**	**48.5**	**46.5**	**53.5**	**50.2**	**47.0**
Trade	11.3	64.1	14.2	34.0	66.0	10.8	17.1
Government	22.1	61.4	26.6	37.9	62.1	22.4	30.0
Other services	5.7	69.0	7.7	100.0	0.0	17.1	0.0
Total	**100.0**	**51.0**	**100.0**	**44.9**	**55.1**	**100.0**	**100.0**

VA = value added; X = output
Source: Cororaton (2005).

The agricultural and service sectors have high value-added content. The value-added shares to their respective outputs are 71.4 percent and 63.3 percent, respectively. Industry has a far smaller value-added ratio of 34.5 percent. Within industry, manufacturing has the smallest value-added ratio: 30.8 percent for food manufacturing and 29.7 percent for nonfood manufacturing. Incidentally, nonfood manufacturing has the lowest ratio among all sectors.

In terms of sectoral contribution to the overall value added, the service sector contributes the largest share at 48.5 percent, followed by the industry sector with a share of 31.6 percent. Of the total industry share, nonfood manufacturing contributes 13.8 percent. About 55.1 percent of the overall value added is payment to capital, while the remaining 44.9 percent is payment to labor. Agriculture has the highest labor payment of 47.7 percent, while industry has 40.6 percent.

Table 10.5 shows the structure of sectoral exports and imports of merchandise and non-merchandise trade. On the import side, industry, particularly the nonfood manufacturing sector, imports the most. Total industry imports 88.8 percent of total imports, of which 76.1 percent is for nonfood manufacturing. The export side is similarly structured with industry exporting almost 60 percent of total exports, in which 48.2 percent is nonfood manufacturing exports.

The dominance of industry, particularly the nonfood manufacturing sector, is largely due to the phenomenal rise of the semiconductor industry in the 1990s. This is seen in Table 10.6, where the breakdown of merchandise export is presented. The export share of electrical and electrical equipment (including electronic products), which is largely dominated by exports of semiconductors, surged from 24.0 percent in 1990 to 59.5 percent in 2000.

Garments used to be a major export item of the country before the 1990s. However, its share dropped significantly in the last decade from 21.7 percent in 1990 to only 6.9 percent in 2000. Over the same period, the same downward trend is also observed in agriculture-based exports. In 1990, agriculture-based exports had a combined share of 18.2 percent, which then dropped to 4.6 percent in 2000.

Table 10.5 **Shares of Imports and Exports**

Sector	*merchandise and nonmerchandise (%)*	
	Imports	*Exports*
Agriculture	**1.5**	**6.5**
Crops	0.7	3.1
Livestock	0.6	0.0
Fishing	0.0	3.4
Other agriculture	0.1	0.0
Industry	**88.8**	**59.7**
Mining	6.5	2.5
Food manufacturing	5.4	8.6
Nonfood manufacturing	76.1	48.2
Construction	0.9	0.3
Electricity, gas, and water	0.0	0.2
Services	**9.7**	**33.8**
Trade	0.0	14.3
Government	9.7	19.5
Other services	0.0	0.0
Total	**100.0**	**100.0**

Source: Official 1994 Input-Output Table and 1994 Social Accounting Matrix (SAM) of the Philippines.

Table 10.6 **Merchandise Exports**

	Value (million US$)			*Shares (%)*		
	1990	*1995*	*2000*	*1990*	*1995*	*2000*
Agriculture-based	**1,487**	**2,134**	**1,710**	**18.2**	**12.2**	**4.6**
Coconut products	503	989	595	6.1	5.7	1.6
Sugar and products	133	74	57	1.6	0.4	0.2
Fruits and vegetables	326	458	528	4.0	2.6	1.4
Other agro-based products	431	575	486	5.3	3.3	1.3
Forest products	94	38	44	1.1	0.2	0.1
Industry-based	**669**	**15,313**	**35,577**	**81.8**	**87.8**	**95.4**
Mineral products	723	893	650	8.8	5.1	1.7
Petroleum products	155	171	436	1.9	1.0	1.2
Manufacturers	5,707	13,868	33,989	69.7	79.5	91.2
Electrical/electrical equipment	1,964	7,413	22,178	24.0	42.5	59.5
Garments	1,776	2,570	2,563	21.7	14.7	6.9
Textile yarns/fabrics	93	208	249	1.1	1.2	0.7
Others	1,874	3,677	8,999	22.9	21.1	24.1
Other exports	114	381	502	1.4	2.2	1.3
Total merchandise exports	**8,186**	**17,447**	**37,287**	**100.0**	**100.0**	**100.0**

Source: Official 1994 Input-Output Table and 1994 Social Accounting Matrix (SAM) of the Philippines.

The semiconductor industry has an extremely small value-added contribution as it is dominated by assembly-type operations; almost all of its input requirements are imported and labor is practically the only local contribution. Furthermore, the sector has a very small link with the rest of the economy. Thus, while the share of the sector's output in the total output is large, its contribution to the total value added is small.

Sources of Income and Structure of Consumption

Table 10.7 shows the sources of household income. The income sources are grouped according to the specification of the CGE model used, which is discussed at length in the next section. The major sources of household income are from skilled production labor and capital in industry and in agriculture, and there are significant differences in various locations in the country.

Table 10.7 **Sources of Household Income in the Philippines**
(Percent)

	Philippines	*NCR*	*Urban*	*Rural*
Labor				
Skilled agriculture	1.7	0.2	1.2	2.9
Unskilled agriculture	7.4	0.1	3.0	19.5
Skilled production	35.1	40.7	39.8	22.2
Unskilled production	7.5	4.9	6.8	9.4
Capital				
Agriculture	6.2	0.2	2.4	16.8
Industry	11.2	9.5	11.3	10.9
Services	15.5	19.6	17.9	8.8
Income				
Dividends	6.7	18.3	9.2	0.0
Transfers	5.6	3.6	5.2	6.8
Foreign remittances	3.1	2.9	3.2	2.7
Total	100.0	100.0	100.0	100.0

Source: 1994 Family Income and Expenditure Survey (FIES).

For example, while 39.8 percent of urban households' total income depends on skilled production labor, 22.2 percent of rural households' income is from skilled production labor and 19.5 percent is from unskilled agricultural labor. In terms of capital income, there are also wide differences. Rural households get 16.8 percent of their income from returns to capital in agriculture, while urban households get only 2.4 percent. Urban households depend heavily on returns to capital in industry and other services.

Another noticeable difference is in dividend incomes. Households in the National Capital Region (NCR) source 18.3 percent of their income from dividends, while for rural households the ratio is zero. Thus, based on these wide differences in household income sources, changes in factor price ratios as a result of the tariff reforms will have different effects across households in various locations.

Table 10.8 presents the structure of household consumption in various locations in the country. There are also differences in the pattern of consumption in urban and rural households, but the differences are not as significant as in the sources of household income. On the whole, 30.4 percent of household consumption comes from the food manufacturing sector. About the same percentage comes from other services. Nonfood manufacturing contributes an average of 14.6 percent to household consumption.

Table 10.8 **Structure of Household Consumption in the Philippines**
(Percent)

	Philippines	*NCR*	*Urban*	*Rural*
Crops	3.9	3.6	4.4	3.3
Livestock	4.4	4.1	5.1	3.8
Fishing	3.5	3.2	4.0	3.0
Mining	0.1	0.1	0.1	0.1
Food manufacturing	30.4	27.8	35.4	25.2
Nonfood manufacturing	14.6	15.2	13.4	15.7
Construction	0.3	0.4	0.2	0.5
Utilities	1.2	1.3	1.1	1.4
Trade and retail	12.5	14.0	9.5	16.0
Other services	29.1	30.3	26.6	31.0
Total	100.0	100.0	100.0	100.0

Source: 1994 Family Income and Expenditure Survey (FIES).

Unemployment, Distribution, and Poverty Profile

Table 10.9 presents the unemployment rate by level of education. One can observe that there is a relatively higher unemployment rate in labor categories with higher levels of education. In fact, for unskilled labor, defined loosely as those with zero education up to third-year high school, the unemployment rate was 5.97 percent in 1990 compared with 11.39 percent for those with an educational level of at least fourth-year high school. The gap in the unemployment rates continued in 2000. For purposes

Table 10.9 **Philippine Unemployment Rate**
(Percent)

Educational Level	*1990*	*1995*	*2000*
No grade completed	6.36	5.82	7.69
Elementary	5.06	5.32	6.51
1st to 5th grade	4.8	5.20	6.00
Graduate	5.30	5.43	6.97
High School	10.11	9.95	11.82
1st to 3rd year	8.94	8.65	10.81
Graduate	10.94	10.81	12.38
College	11.66	11.76	13.16
Undergraduate	12.84	13.29	13.91
Graduate	10.74	10.20	12.46
Not reported	36.00	24.14	25.68
Overall	8.13	8.36	10.14
Unskilled [a]	5.97	6.12	7.62
Skilled [b]	11.39	11.36	12.91

a No grade completed up to third year high school.
b High school graduate and up.
Source: Labor Force Surveys (various years).

of analysis in the paper, the numbers for 1995 are used, i.e., for unskilled workers in agricultural and nonagricultural sectors, the unemployment rate applied is 6.12 percent, while for skilled workers it is 11.36 percent.

To set poverty in the Philippines in a historical perspective, Table 10.10 presents official poverty incidence from 1985 to 2000. Poverty incidence declined by about 10 percentage points in the last 15 years from 49.3 percent in 1985 to 39.4 percent in 2000. However, through the years the gap between urban (particularly, the NCR) and rural poverty incidence widened. While urban areas saw significant decline in poverty incidence from 37.9 percent in 1985 to 24.3 percent in 2000, rural areas experienced stable poverty incidence of more than 50 percent. The largest improvement in the poverty situation is in the NCR, with the incidence dropping from 27.2 percent in 1985 to 11.4 percent in 2000. In 1997, poverty incidence in the NCR even dropped to single digits (8.5 percent).

Table 10.10 **Poverty and Income Inequality Indicators in the Philippines, 1985–2000**

	1985	*1988*	*1991*	*1994*	*1997*	*2000*
Gini Ratio	0.446	—	0.468	0.464	0.487	0.451
Poverty Incidence (headcount ratio)						
Philippines	49.3	49.5	45.3	40.6	36.8	39.4
Urban	37.9	34.3	35.6	28.0	21.5	24.3
Rural	56.4	52.3	55.1	54.3	50.7	54.0

Source: National Statistical Coordination Board (NSCB).

Income distribution indicators did not show favorable signs either. Over the past decade, there was a marked deterioration. In the 12-year period beginning 1985, the top quintile exhibited an increase in its income share, while the other quintiles showed a reduction. The income share of the poorest (first quintile), fell from 5.2 percent in 1985 to 4.9 percent in 1994, before going down further to 4.4 percent in 1997. In contrast, the share of the wealthiest income group improved from 52.1 percent in 1985 to 55.8 percent in 1997.

From 1961 until the mid-1980s, there were very small movements in the income shares of the different income groups. The deterioration in income distribution occurred only in the last two decades. In the period of relatively "stable inequality," the share of the richest income group remained substantially large while that of the poorest income group remained substantially small.

Since 1961, except for the years 1988–1991, the Gini ratio showed slow but steady decline. From 1994 to 1997, however, the Gini ratio worsened from 0.468 to 0.487. The latter represented the highest figure in 35 years. In 2000, the Gini coefficient slid down to 0.451. In 1985, the average income of a family from the top decile was 18 times the income of a family from the lowest decile. In 1997, this ratio went up to 24. In terms of spatial income disparity, the ratio of the average family income in the poorest region increased from 3.2 in 1995 to 3.6 in 1997.

The detailed poverty profile in the Philippine in 1994 is shown in Table 10.11 in which poverty was disaggregated into household head and level of education, urban-rural areas, and regions. The poverty line used was the official poverty line of the Philippines which was different from the $1-a-day poverty line.

Table 10.11 **Philippine Poverty Profile, 1994**

Population		67,430,864
Number of people under poverty thresholds		27,372,971
Poverty incidence (%)		40.6
	Number of people (% distribution)	*Poverty incidence (%)*
Poverty by family head and level of education		
Female, low education [a]	7.1	38.7
Female, high education [b]	0.9	11.2
Male, low education [a]	76.8	55.4
Male, high education [b]	15.1	22.4
	100.0	
Poverty by urban/rural		
Urban	30.7	35.5
Rural	65.7	54.3
Poverty by regions		
National Capital Region	3.5	10.4
Region 1, Ilocos	7.2	54.0
Region 2, Cagayan Valley	4.0	42.3
Region 3, Central Luzon	7.5	31.3
Region 4, Southern Luzon	11.2	35.4
Region 5, Bicol	10.6	60.7
Region 6, Western Visayas	11.0	49.8
Region 7, Central Visayas	6.6	39.8
Region 8, Eastern Visayas	5.7	44.7
Region 9, Western Mindanao	5.0	50.3
Region 10, Northern Mindanao	7.9	54.2
Region 11, Southern Mindanao	8.0	45.2
Region 12, Central Mindanao	4.7	59.0
Region 13, Cordillera Administrative Region	2.7	56.4
Region 14, Autonomous Region of Muslim Mindanao	4.2	65.3

Note: a low education = zero schooling to third year high.
b high education = high school graduate and up.
Source: National Statistical Coordination Board; National Statistics Office.

Of the people living below the poverty threshold in 1994, 76.8 percent belonged to families headed by a male with low education. The poverty incidence of this group was 55.4 percent. The share of the poor among families headed by a female with high education was only 0.9 percent of the total. This group has the lowest poverty incidence of 11.2 percent.

Of the total poor people, 3.5 percent resided in the NCR where poverty incidence was 10.4 percent. In contrast, 65.7 percent were located in the rural areas, where the poverty incidence was 54.3 percent.

The regions with the largest number of poor people were Regions 4, 5, and 6, comprising more than 30 percent of the total. However, in terms of poverty incidence, the Autonomous Region of Muslim Mindanao (Region 14) had the highest rate with poverty incidence of 65.3 percent; followed by Region 5, the Bicol Region, with poverty incidence of 60.7 percent. Outside NCR, the region with the lowest poverty incidence was Region 3, the Central Luzon Region, with poverty incidence of 31.1 percent.

Main Features of the Model

The PRISM used was developed using a CGE-microsimulation model.[3] At present, PRISM only presents the Philippine economy but it can be scaled up to include individual models of other countries. The basic structure of the Philippine model and its price relationship, as well as the other key components of the model, is described in the following subsections.

Basic Structure

The CGE model used in the analysis was calibrated to the 1994 SAM of the Philippine economy. It has 12 production sectors, composed of: 4 agriculture, fishing, and forestry sectors; 5 industries; and 3 services including government services. The model distinguishes two factor inputs, labor and capital, which determine sectoral value added using a constant elasticity of substitution (CES) production function. There are 4 types of labor: skilled agricultural, unskilled agricultural, skilled production, and unskilled production. Agricultural labor is devoted only to the agricultural sector; production labor can move across all sectors; skilled production workers include professionals, managers, and other related workers with at least a high school diploma.

Other features of the model's basic structure are as follows:

- Sectoral capital is fixed. Value added, together with sectoral intermediate input (which is determined using fixed coefficients), determine total output per sector. In both product and factor markets, prices adjust to clear all markets.
- The Armington-CES[4] function is assumed to combine local and imported goods into a composite good consumed on the domestic market, while constant elasticity of transformation (CET) allocates domestic production according to exports and local sales.

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3 A detailed description of PRISM including how to use it is presented in Appendix 10.2.

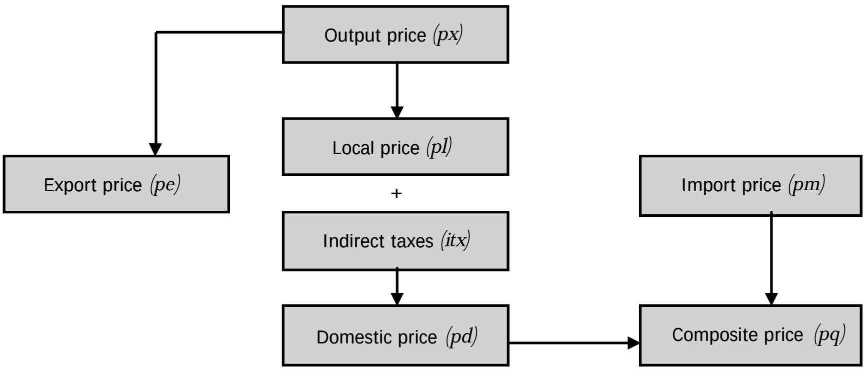
4 See Appendix 10.3 for the implementation of CES function.

- Consumer demand is based on Cobb-Douglas utility functions.
- The model integrates the whole 1994 FIES, which consists of 24,797 households.

Therefore, instead of using RHGs, as in the CGE model, this CGE-microsimulation model uses the complete household samples in the FIES. Accordingly, all macro-variable changes such as prices and factor incomes are transferred directly to the household units. Consumer demand is also derived at the household-unit level.

On price relationships, Figure 10.1 shows the basic price relationships in the model. Output price (*px*) affects export price (*pe*) and local prices (*pl*). Indirect taxes are added to the local price to determine domestic prices (*pd*), which together with import prices (*pm*) will determine the composite price (*pq*). The composite price is the price paid by the consumers.

Figure 10.1 **Basic Price Relationship in the Model**



Note: pm = pwm*er* (1+tm)*(1+itx); Where pwm = world price of imports; er = exchange rate; tm = tariff rate; itx = indirect tax.
Source: Authors' framework.

Import price is in domestic currency, which is affected by the world price of imports, exchange rate (*er*) tariff rate (*tm*), and indirect tax rate (*itx*). Therefore, the direct effect of tariff reduction is a reduction in import prices. If the reduction in import price is significant, the composite price will also decline.

Model Closure

The model closure has the following features:

Investment. Total nominal investment is real total investment multiplied by its price. Total real investment is fixed to avoid any possible intertemporal welfare effects that may arise from the interaction between trade policies and growth by changes in the level of real investment. The price of total real investment is flexible.

Savings and Exchange Rate

- *Foreign Savings.* The current account balance is held fixed to avoid any influence of international resources financing on domestic policy changes. The nominal exchange rate is fixed and the foreign trade sector is cleared by the real exchange rate, which is the ratio of the nominal exchange rate multiplied by the world export prices over domestic prices. Accordingly, exports and imports respond to movements in the real exchange rate.
- *Private Savings.* The propensities to save of the various household groups in the model adjust proportionately to accommodate the fixed total real investment. In this sense, the model is investment driven.

Government

- *Government Budget Balance.* Nominal government consumption is real government consumption multiplied by its price. The former is held fixed, while the latter is flexible. The budget balance is flexible due to the endogenously determined price of total real government consumption. Government transfers to households are held fixed in real terms, while nominal government transfers received by households vary with consumer prices.
- *Government Income.* Total government income is also held fixed. Any reduction in government income from tariff reduction is compensated endogenously by an indirect tax on goods and services.

Model Determinants

The exchange rate, consumer prices, and overseas remittances can be summarized as follows:

Exchange Rate. The nominal exchange rate is fixed and plays the role of a numeraire. The real exchange rate is the ratio of the nominal exchange rate multiplied by the world export prices and divided by the local prices. The real exchange rate can be interpreted as a positive value (real exchange rate depreciation) or a negative value (real exchange rate appreciation).

Consumer Prices. The composite price is the price paid by the consumers. There is no inflation in the model; the weighted change in composite price accounts for the variation in prices paid by consumers relative to the numeraire. Under PRISM, the composite price can be interpreted as a positive value (consumer prices in the local economy increase) or as a negative value (consumer prices in the local economy decrease).

Overseas Remittance. Overseas remittance is held fixed.

Poverty Measurements

The paper assesses the effects of tariff reduction on poverty through the use of poverty measures based on the Foster–Greer–Thorbecke (FGT) poverty indices. In general, the FGT poverty index is given by[5]

$$p_{\alpha} = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z-y}{z}\right]^{\alpha}$$

where n is population size, q is the number of people below the poverty line, y_i is income, z is the poverty line or poverty threshold. The poverty line is equal to the food poverty line plus the nonfood poverty line, which refers to the cost of basic food and nonfood requirements. The parameter α can have several possible values but the following three values, corresponding to three different measures of poverty, are normally used in the literature:

- Headcount index or headcount ratio ($\alpha = 0$). This is the common index of poverty which measures the proportion of the population whose income (or consumption) is below the poverty line.
- Poverty gap ($\alpha = 1$). This index measures the depth of poverty, indicating the distance of the poor below the poverty line to poverty.
- Poverty severity ($\alpha = 2$). This index measures the severity of poverty.

Thus, poverty is affected by household income y and by the poverty threshold z. A change in household income is as a result of changes originating from factor incomes, while poverty threshold change is as a result of changes in consumer prices. To carry out the analysis, the following adjustments were made:

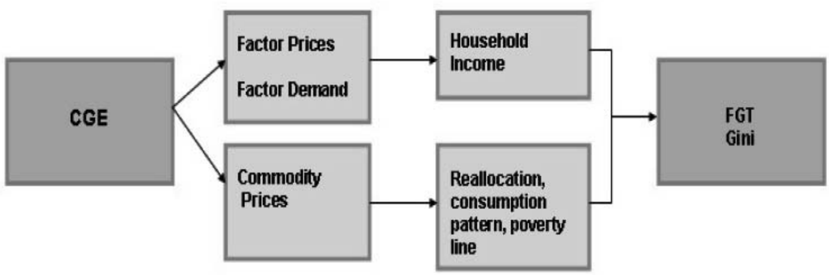
- All results on households were converted to results on individuals by using the household family size and the household-adjusted weighting factor of the 1994 FIES. This converted the 24,797 households in the FIES to 67,430,864 individuals.
- All official poverty thresholds in 1994 were adjusted by deflating them with the results of the consumer price index derived from the simulation. Poverty thresholds are available for the whole Philippines, urban and rural, and for the 14 regions' urban and rural areas. The consumer price index is derived as the weighted composite price (pq_i), where the weights are the shares of the households' consumption basket from the various areas and regions.

5 See Ravallion (1992) for detailed discussion on this issue.

- The results on nominal household income were used in the computation of the various poverty indices instead of nominal disposable income from the compensatory tax imposed on household income.
- To draw more insights from the results, the poverty indices were summarized in four broad groupings of households, namely: households headed by females with low education; households headed by females with high education; households headed by males with low education; and households headed by males with high education. Low education means those with zero education up to third-year high school education, while high education implies those who are at least high school graduates. The results were aggregated for the whole Philippines, the NCR, urban areas excluding the NCR, and rural areas.

The stylized structure below illustrates how poverty impacts at the individual household level can be analyzed within the PRISM framework. After every simulation, a new set of factor and commodity price vectors were derived, thereby affecting households' income and consumer prices, respectively. These changes, in turn, affect households' poverty characteristics and distribution structure (measured through the FGT index and Gini coefficient) as presented in Figure 10.2.

Figure 10.2 **Schematic Representation of CGE-Microsimulation Analysis**



CGE = Computable General Equilibrium
FGT = Foster, Greer, and Thorbecke
Source: PRISM (http://prism/adb_prism).

Scenarios and Simulation Results

Scenarios

This section discusses the simulations results of three scenarios: partial trade liberalization or the application of a low uniform tariff, actual tariff reduction, and full tariff reduction.[6]

The first scenario involved the application of a uniform tariff rate of 5 percent on all sectors.[7] The simulations were expected to result in improved allocations and technical efficiency, greater access to cheaper prices, better quality inputs and superior technologies, and greater domestic competition through a more rational market structure (Tecson 1992).

The second scenario involved actual changes in the nominal tariff rates from 1994 to 2000. Weighted by the value of domestic output and imports, the average tariff rates for each sector were based on the different harmonized nominal tariff rates of all commodities in the sector. As such, the 1994 benchmark in the overall weighted nominal tariff declined by 65 percent in 2000 (see Table 10.2). The decline in industry (65.3 percent) was much greater than in agriculture (48.8 percent), while the smallest decline was in other agriculture (19.9 percent). Tariff rates were successively reduced on the following goods: capital equipment and machinery; textiles, garments, and chemical inputs; manufactured goods; and nonsensitive components of the agricultural sectors.

The third scenario involved total tariff elimination or free trade that would lead to decreased import prices and increased export demand. Full liberalization could also result in reduced poverty if wage and employment gains outweigh the changes in commodity prices critical to poor households (Sugiyarto, Oey-Gardiner, and Triaswati 2006). The impact of full liberalization depends on the mechanism that the government uses to compensate for the foregone revenue derived from tariff rates. For instance, in the study by Cororaton (2005), in the context of indirect taxes as replacement tax, the incidence of poverty falls marginally while the poverty gap and severity increases substantially. He added that if the income tax mechanism is used, all measures of poverty increase.

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6 In the CGE framework, one can predict the impact of shocks and policies on poverty by simply using the unit record data drawn directly from a household survey to represent the size of distribution of economic welfare (Ravallion and Lokshin 2004; Bourguignon, Robillard, and Robinson 2002; Nssah 2005).

7 This means that sectors with tax rates of more than 5 percent are reduced to 5 percent, while sectors with existing tax rates lower than 5 percent are increased to 5 percent, e.g., livestock and other agricultural products.

The Partial or Low Uniform Tariff Scenario

Macro Effects. Table 10.12 presents the simulation results, which involved reducing import tariffs on all commodities to 5 percent. On average, the application of a low uniform tariff results in a decline in the domestic price of imports by 12.1 percent, which causes the composite and domestic price to decline by 3.8 and 3.3 percent, respectively.

Table 10.12 **Macro Effects in the Low Tariff Scenario** (Percent)

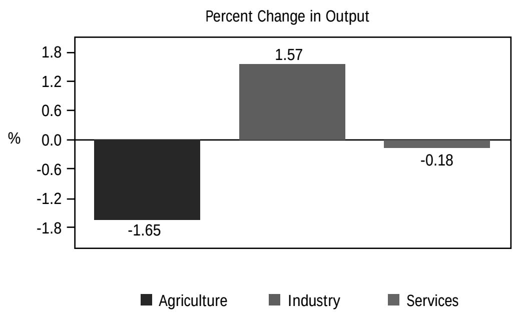
Change in Prices	
Import prices in local currency	-12.08
Consumer prices	-3.84
Local cost of production	-3.31
Real exchange rate change	4.94
Change in import volume	6.36
Change in export volume	6.42
Change in domestic production for local sales	-0.84
Change in consumption (composite) goods	0.53
Change in overall output	0.44

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

The application of a low uniform tariff results in changes in the relative domestic import price ratios, which trigger substitution effects between imports and domestically produced goods. When import volume increases by 6.36 percent, domestic production declines by 0.80 percent. These changes, taken together, result in a marginal improvement in the total supply of goods available in the market–as shown by the increase in the supply of composite goods by 0.50 percent.

The overall decline in local prices creates an effective real exchange depreciation, which in turn increases export competitiveness. The real exchange rate depreciates by almost 5 percent, making Philippine products cheaper abroad. This leads to an overall export growth of 6.4 percent, which in turn increases total output marginally by 0.4 percent. Figure 10.3 further shows that the tariff reduction increases the output of the industry sector by 1.6 percent, while the output of the agricultural and services sectors decline by 1.7 and 0.2 percent, respectively.

Figure 10.3 **Percentage Change in the Volume of Output of the Low Tariff Scenario**



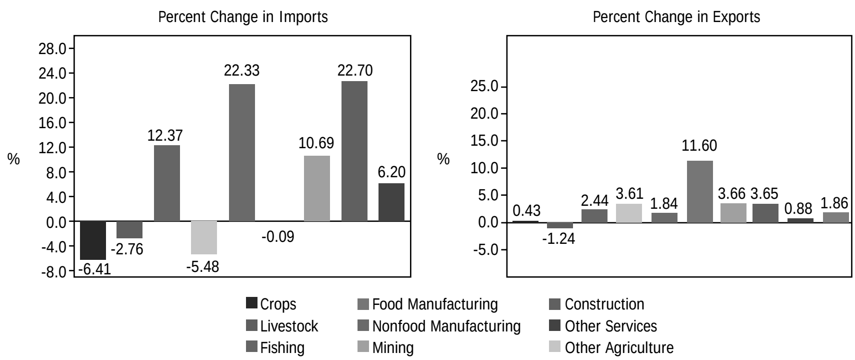
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Sectoral Effects. The sectoral effects vary considerably, triggering the reallocation of output across sectors. The effects are largely due to the differences in the sectoral structure of imports and exports, initial tariff rates, and trade elasticities (Armington and CET elasticities).[8]

The industrial sector experiences the largest drop in import prices (12.1 percent), while the drop in agricultural import prices is only 4.2 percent. In terms of specific sectors, the largest drop in import prices is observed in mining (25.6 percent), followed by food manufacturing (21.4 percent), fishing (20.4 percent), and nonfood manufacturing (12.1 percent). The different effects on sectoral price affect import volumes, showing large increases in import volumes of food manufacturing (22.7 percent), fishing (22.3 percent), and crops (12.4 percent), as shown in Figure 10.4. The import volume of the nonfood manufacturing sector registers an increase of only 6.2 percent. However, since the nonfood manufacturing sector is the largest importer,[9] the increase in the overall import volume comes largely from this sector.

The effect on the nonfood manufacturing sector's imports, domestic production, and composite good should be of concern since this sector is a major contributor to the total output. The decline in its import prices (12.1 percent) is significantly larger than that of its domestic prices (3.3 percent). The relative price change favoring imports should lead to a reduction in domestic production of 0.8 percent.

Figure 10.4 **Percentage Change in the Volume of Imports and Exports of the Low Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

8 The Armington and the CET elasticities used in the model are based on the values of elasticities used in another CGE model of the Philippines called the Agriculture Policy Experiments, or APEX, model (Clarete and Warr 1992), which were estimated econometrically; the initial tariff rates were based on the estimates of Manasan and Querubin (1997).

9 Nonfood manufacturing accounts for 76.1 percent of total imports (see Table 10.4).

Except for livestock, exports in all sectors increase. This rise in exports could be attributed largely to the improvement in export competitiveness across sectors as a result of the local price drop (Figure 10.4). Export competitiveness increases most in nonfood manufacturing (11.6 percent) and mining (3.6 percent). Results from the mining sector, however, may be of less interest because its share of total exports is very small. But the result from the nonfood manufacturing sector is critical as it contributes greatly to total exports (48.2 percent, see Table 10.13). This result, together with the increase in domestic production, brings about an overall 0.4 percent increase in the sector's total production. Other increases are observed in other agriculture (0.1 percent) and utilities[10] (0.4 percent). Tariffs reductions under this scenario seem to mostly favor the nonfood manufacturing sector, which includes semiconductors and textiles, as the overall output of the sector increases by 4.71 percent.

Table 10.13 **Effects of Low Tariff Scenario on Prices and Volumes**

	Price Changes (%)					*Volume Changes (%)*				
Sector	*Imports*	*Domestic demand*	*Composite demand*	*Output*	*Local*	*Imports*	*Exports*	*Domestic demand*	*Composite demand*	*Outputs*
Agriculture	**-4.23**	**-2.09**	**-2.14**	**-1.93**	**-2.09**	**3.60**	**1.47**	**-1.90**	**-1.79**	**-1.65**
Crops	-8.57	-1.92	-2.06	-1.77	-1.92	12.37	0.43	-2.01	-1.74	-1.83
Livestock	0.00	-2.41	-2.35	-2.40	-2.41	-5.48	-1.24	-2.20	-2.29	-2.20
Fishing	-20.39	-2.78	-2.83	-2.19	-2.78	22.33	2.44	-1.81	-1.76	-0.91
Other Agriculture	0.00	-0.18	-0.17	-0.18	-0.18	-0.09	–	0.06	0.05	0.06
Industry	**-13.53**	**-4.98**	**-7.73**	**-3.88**	**-4.98**	**7.41**	**9.75**	**-0.72**	**1.81**	**1.57**
Mining	-25.56	-9.47	-21.63	-5.22	-9.47	10.69	3.61	-10.75	4.60	-4.39
Food Manufacturing	-21.42	-3.20	-4.86	-2.86	-3.20	22.70	1.84	-2.05	-0.20	-1.65
Nonfood Manufacturing	-12.10	-7.09	-9.61	-4.55	-7.09	6.20	11.60	0.91	3.51	4.71
Construction	–	-4.17	-4.06	-4.13	-4.17	-6.41	3.66	-1.50	-1.64	-1.46
Electricity, Gas, and Water	–	-2.69	-2.69	-2.66	-2.69	–	3.65	0.31	0.31	0.35
Services	**0.00**	**-1.68**	**-1.59**	**-1.40**	**-1.68**	**-2.76**	**1.44**	**-0.50**	**-0.17**	**-0.18**
Wholesale Trade & Retail	–	-1.19	-1.19	-0.94	-1.19	–	0.88	-0.56	-0.56	-0.26
Other Services	–	-1.91	-1.77	-1.63	-1.91	-2.76	1.86	-0.48	-0.66	-0.13
Government Services	–	–	–	-0.83	–	–	–	–	–	0.00
Total	**-12.08**	**-3.31**	**-5.02**	**-2.60**	**-3.31**	**6.36**	**6.42**	**-0.84**	**0.53**	**0.44**

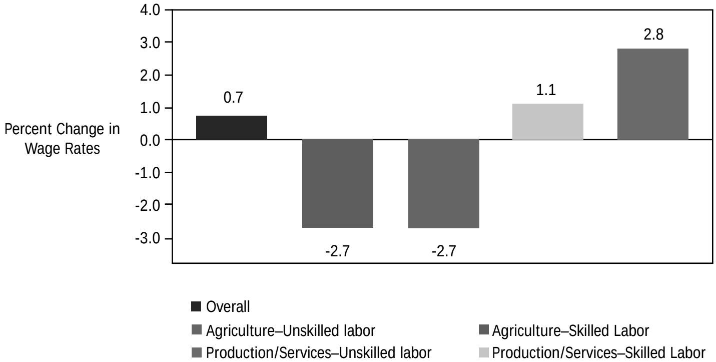
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Effects on Factor Market. Since total sectoral capital is fixed, the factor market effect pertains to labor movement across sectors as a response to changes in the factor price. Detailed effects on the factor market are presented in Table 10.14.

The tariff reduction leads to a general improvement in factor prices. Overall capital return increases by 0.6 percent, while wages increase by 0.7 percent. Capital return across sectors varies significantly. It increases in the nonfood

10 Electricity, gas, and water.

Figure 10.5 **Percentage Change in Average Wage Rates of the Low Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Table 10.14 **Effects of Low Tariff Scenario on Factor Market**

	Value Added Changes (%)				*Change in Labor Demand (%)*			
Sector	*Value added*	*Prices*	*Rate of return to capital*	*Total labor*	*Skilled agriculture*	*Unskilled agriculture*	*Skilled production*	*Unskilled production*
Agriculture	**-1.6**	**-1.0**	**-2.6**	–	–	–	–	–
Crops	-1.8	-1.1	-2.9	-3.6	-0.2	-0.2	-4.0	-5.6
Livestock	-2.2	-1.5	-3.6	-4.3	-1.0	-1.0	-4.7	-6.3
Fishing	-0.9	-0.9	-1.8	-2.5	0.8	0.8	-2.9	-4.6
Other Agriculture	0.1	0.8	0.8	0.1	3.6	3.6	-0.3	-2.0
Industry	**1.2**	**2.0**	**3.0**	–	–	–	–	–
Mining	-4.4	-4.3	-8.5	-9.2	–	–	-9.6	-11.1
Food Manufacturing	-1.7	-2.2	-3.8	-4.5	–	–	-4.9	-6.4
Non-food Manufacturing	4.7	6.6	11.6	10.8	–	–	10.4	8.5
Construction	-1.5	-1.2	-2.6	-3.3	–	–	-3.7	-5.3
Electricity, Gas, and Water	0.4	1.8	2.1	1.4	–	–	1.0	-0.7
Services	**-0.2**	**0.4**	**0.2**	–	–	–	–	–
Wholesale Trade & Retail	-0.3	0.2	-0.1	-0.8	–	–	-1.2	-2.8
Other Services	-0.1	0.5	0.4	-0.3	–	–	-0.8	-2.4
Government services	0.0	0.7	–	0.0	–	–	-0.4	0.0
Total	**0.0**	**0.6**	**0.6**	–	–	–	–	–
Change in Average Wage	–	–	–	0.7	-2.7	-2.7	1.1	2.8

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

manufacturing sector (11.6 percent), utilities (2.1 percent), other agriculture (0.8 percent), and other services (0.4 percent); and declines in other sectors.

The increase in capital return in the nonfood manufacturing sector (11.6 percent) is higher than the increase in wages for aggregate labor (1.0 percent). This results in factor substitution favoring labor.

Likewise, reallocation effects benefit the industry through the nonfood manufacturing sector, as can be seen in the effects on factors of production shown on Table 10.13. Although the value added and the price of value added in agriculture decline, overall prices increase by 0.6 percent as a result of expansion in the industry, particularly in nonfood manufacturing. Capital return in industry increases by 3.0 percent, while in the nonfood manufacturing sector it increases by 11.6 percent. The return to capital in agriculture, on the other hand, declines by 2.6 percent.

There are interesting insights that can be observed from the results across different labor types. Agricultural wages decline by 2.7 percent for both skilled and unskilled labor. Other agriculture and fishing sectors cannot absorb displaced agricultural labor from crops and livestock.

Some skilled and unskilled production workers in agriculture move to the nonfood manufacturing and utilities sectors. The same is true for some production workers in the service sector. Skilled production labor increases by 10.4 percent and unskilled labor by 8.5 percent in the nonfood manufacturing sector. In the utilities sector, only skilled production labor increases (by 1.0 percent), as unskilled labor declines by 0.7 percent.

These results suggest that tariff reduction leads to relatively higher demand for skilled labor in industry, particularly in the nonfood manufacturing sector, increasing overall employment and therefore wages of skilled and unskilled production labor. The average wage for skilled production labor increases by 1.1 percent, while the wage increase for unskilled workers is 2.8 percent.

In sum, the simulation results indicate that the nonfood manufacturing sector benefits from both production reallocation and labor movement. The shifts in output, factor price ratios, and factor substitutions tend to favor skilled production workers in the nonfood manufacturing and utilities sectors. Furthermore, the results indicate that tariff reduction leads to higher unemployment and lower wages for agricultural labor.

Effects on Income. Table 10.15 shows the effects of tariff reduction on household income from labor and capital income sources. Other income sources, such as foreign remittances, transfers, and dividends, are omitted in the table because they are all assumed in the simulation to be fixed.

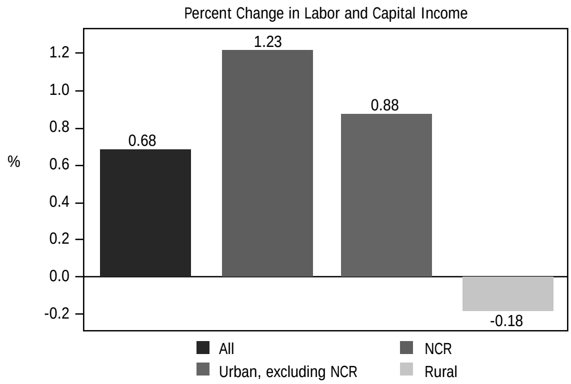
Table 10.15 **Effects of Low Tariff Scenario on Household Factor Income**
(Percentage change from base)

Household Location	*Labor & capital Income from agriculture*	*Labor & capital Income from nonagriculture*	*Total Labor & capital income*
All	-0.5	1.2	0.7
NCR	0.0	1.2	1.2
Urban, excluding NCR	-0.4	1.2	0.9
Rural	-1.1	1.0	-0.2

NCR = National Capital Region
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Labor and capital income increase by 0.7 percent, favoring households in the NCR and other urban areas (Figure 10.6). Household income from agricultural labor and capital, however, declines in both urban and rural areas to 0.4 percent and 1.1 percent, respectively. Factor income from agriculture declines by 0.5 percent because of the drop in agricultural wages of skilled and unskilled agricultural labor as observed earlier. Household income from the nonagricultural sector increases by 1.2 percent from favorable effects, especially in the nonfood manufacturing sector.

Figure 10.6 **Percentage Change in Household Factor Income of the Low Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Higher factor prices in nonagriculture results in higher income for households who depend on industry and services. Rural households, not dependent on agriculture, experience less improvement in nonagricultural factor income compared with households in the NCR and other urban areas. Households in the NCR enjoy the highest increase in income (1.2 percent); total net factor income for households in urban areas outside the NCR improves by 0.9 percent; and rural households experience a decline in total income of 0.2 percent. Overall, the average increase in total factor income is 0.7 percent.

Poverty Impacts. Generally, the level of poverty incidence drops for all groups. Lowering the tariff is predicted to lift abut 1.5 million poor people above the poverty threshold (Table 10.16). The general drop in poverty incidence is due largely to the decline in consumer prices, which lowers the nominal value of the poverty threshold for all groups in all areas. Table 10.12 shows that consumer prices decrease by 3.8 percent as a result of the tariff reduction.

The effects on poverty vary significantly across locations and household types (Figure 10.7 and 10.8), with the variation in the effects on factor income generally favoring households in the NCR. Households in the NCR enjoy the largest reduction in poverty compared with those in other urban and rural areas. Urban areas excluding the NCR also register a decline in poverty incidence The drop is significantly less than in the NCR, though relatively greater than in the rural areas.

Within the NCR, households headed by females with high education (32.8 percent) benefit the most compared with other household types. The lowest decline is in households headed by females with low education (12.3 percent). In contrast, poverty incidence among households headed by males with high education declines by a relatively lower rate (17.2 percent) than among households headed by males with low education (17.6 percent). The above results can be attributed to two factors: reallocation effects toward the nonfood manufacturing sector, which is largely located in the NCR; and nonfood manufacturing exports are dominated by the semiconductor and textile and garments industries whose workforces are mostly women with an above-average level of education.

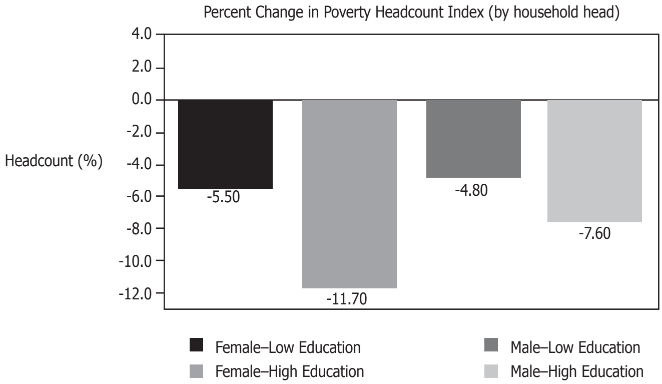
Table 10.16 **Poverty Incidence in the Low Tariff Scenario**

		Female headed households (%)			*Male headed households (%)*		
Index	*Total headed households*	*Overall*	*Low education*	*High education*	*Overall*	*Low education*	*High education*
Philippines							
Headcount	-5.3	-6.2	-5.5	-11.7	-5.2	-4.8	-7.6
Poverty gap	-6.6	-7.6	-7.1	-12.2	-6.5	-6.1	-9.3
Severity	-7.4	-8.4	-8.1	-11.8	-7.3	-7.0	-9.9
National Capital Region							
Headcount	-17.5	-18.3	-12.3	-32.8	-17.4	-17.6	-17.2
Poverty gap	-19.8	-18.3	-17.4	-21.9	-19.9	-20.2	-19.5
Severity	-21.9	-19.0	-18.7	-20.2	-22.3	-23.1	-21.3
All Urban							
Headcount	-6.5	-8.0	-7.0	-13.2	-6.3	-5.8	-8.1
Poverty gap	-7.8	-9.5	-8.6	-16.7	-7.6	-7.0	-10.3
Severity	-8.5	-10.7	-10.3	-14.8	-8.4	-7.9	-10.8
All Rural							
Headcount	-4.1	-4.4	-4.4	-5.0	-4.1	-3.9	-5.3
Poverty gap	-5.7	-6.2	-6.1	-8.2	-5.6	-5.4	-7.2
Severity	-6.6	-7.1	-6.9	-9.5	-6.6	-6.4	-8.3
Poor people lifted out of poverty (%)							-5.3
Poor people lifted out of poverty							1,453,793

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

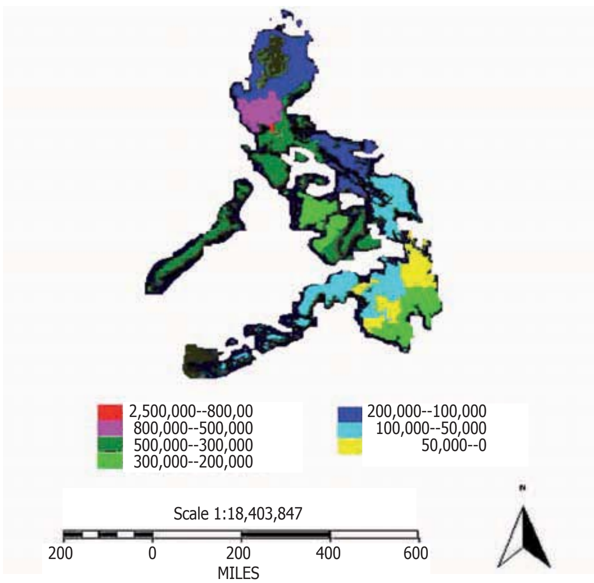
These differentiated effects across households are due largely to the effects on the sources of income of households. It was observed in Table

Figure 10.7 **Percentage Change in the Headcount Index of the Low Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Figure 10.8 **Distribution of Poverty Incidence of the Low Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

10.6 that rural households depend heavily on unskilled agricultural labor and on returns to capital in agriculture. Because agriculture contracts as a result of the reduction in tariffs, unemployment increases and wages drop in agriculture. Therefore, as shown in Table 10.13, income from agricultural labor drops. Furthermore, since agriculture contracts, the rate of return to capital in the sector also drops. This further aggravates the situation in the rural areas. Thus, the impact of the reduction in tariffs on rural households, although favorable, is marginal compared with the impact on urban areas, particularly in the NCR (Figure 10.8).

Actual Tariff Reduction Scenario

The actual average tariff rates are computed from different harmonized system (HS) lines within an input-output sector using the sum of domestic output and import values (Q + M) as weights (referred to as the base tariff rate). The use of weights (Q + M) tends to overcome the biases associated with using either output weights or import weights singly. Note that the use of import weights tends to result in some downward bias since low tariffs, which are usually associated with a high levels of imports, are given larger weights; high tariff rates that tend to restrict imports are assigned small weights; and prohibitive duties that give rise to zero imports are allotted zero weights.

In contrast, the use of domestic production levels as weights tends to result in some upward bias. Higher levels of domestic production tend to be associated with higher tariff rates as domestic output substitutes for imports with a rise in the rate of import duty, while the opposite is true for low tariff rates. In this paper, the actual tariff rates are derived from the weighted (Q + M) average tariff rates based on the book rates calculated for each year in 1994–2000 (Manasan and Querubin 1997). Thus, the calculated average tariff rate reduction from 1994 to 2000 is around 65 percent.

Macro Effect. The macro effects based on the actual tariff reduction between 1994 and 2000 are reported in Table 10.17. The tariff reduction leads to a drop by 10.4 percent in import prices, in local currency, of all commodities. This eventually reduces consumer prices by 2.9 percent and the local cost of production by 2.6 percent. Since the empirical procedure assumed a fixed nominal exchange rate, the decline in the local cost of production effectively results in a real exchange rate depreciation of 4.1 percent (i.e., Philippine-made products become cheaper abroad). In reaction, export volume increases by 5.4 percent.

Table 10.17 **Macro Effects in the Actual Tariff Scenario**
(Percent)

Change in prices	
Import prices in local currency	-10.40
Consumer prices	-2.87
Local cost of production	-2.59
Real exchange rate change	4.10
Change in import volume	5.28
Change in export volume	5.41
Change in domestic production for local sales	-0.66
Change in consumption (composite) goods	0.47
Change in overall output	0.40

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

The drop in import prices also translates into higher import volumes (up by 5.3 percent). The slight decline in domestic production sold on the local market (0.7 percent) indicates some crowding out of domestic production by imports. However, the net effect on domestic consumption is an increase of 0.5 percent. Despite the crowding out of domestic production for local sales, the slightly higher growth in exports over imports results in some improvement in overall output by 0.4 percent.

Sectoral Effects. Table 10.18 presents the price and volume effects of tariff reduction on the different economic sectors. It is worth noting that import prices fall much more in the industrial sector, particularly in mining and manufacturing. In agriculture, the fishing industry benefits from reduced import prices in the local market. There is also an improvement in the volume of fishing industry exports. In overall production output, Figure 10.9 shows that industry gains from the reduction in import levies, while the agriculture (-1.4 percent) and services sectors (-0.2 percent) contract.

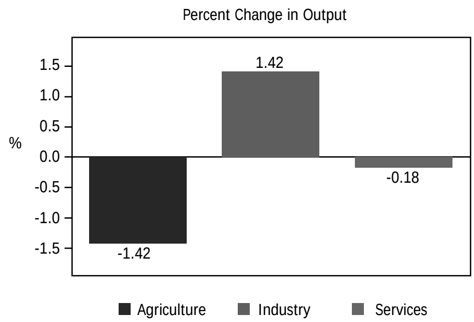
Table 10.18 **Effects of Actual Tariff Scenario on Prices and Volumes**

	Price Changes (%)					*Volume Changes (%)*				
Sector	*Imports*	*Domestic demand*	*Composite demand*	*Output*	*Local*	*Imports*	*Exports*	*Domestic demand*	*Composite demand*	*Outputs*
Agriculture	**-3.14**	**-1.43**	**-1.47**	**-1.32**	**-1.43**	**2.36**	**0.83**	**-1.60**	**-1.52**	**-1.42**
Crops	-5.90	-1.28	-1.38	-1.18	-1.28	7.97	-0.04	-1.66	-1.47	-1.54
Livestock	-0.35	-1.69	-1.66	-1.69	-1.69	-3.76	-1.26	-1.93	-1.97	-1.93
Fishing	-18.48	-2.08	-2.12	-1.64	-2.08	20.50	1.65	-1.51	-1.46	-0.84
Other Agriculture	-0.05	0.23	0.22	0.23	0.23	0.35	–	0.11	0.11	0.11
Industry	**-11.66**	**-4.13**	**-6.51**	**-3.21**	**-4.13**	**6.12**	**8.45**	**-0.53**	**1.54**	**1.42**
Mining	-25.82	-9.37	-21.81	-5.16	-9.37	10.41	2.66	-11.43	4.20	-5.19
Food Manufacturing	-13.95	-2.30	-3.32	-2.06	-2.30	12.77	1.11	-1.67	-0.55	-1.39
Nonfood Manufacturing	-10.43	-6.16	-8.30	-3.96	-6.16	5.41	10.18	0.99	3.16	4.24
Construction	–	-3.44	-3.35	-3.41	-3.44	-5.37	2.92	-1.31	-1.42	-1.28
Electricity, Gas and Water	–	-2.07	-2.07	-2.04	-2.07	–	2.84	0.30	0.30	0.33
Services	**0.00**	**-1.12**	**-1.06**	**-0.93**	**-1.12**	**-1.96**	**0.87**	**-0.40**	**-0.18**	**-0.18**
Wholesale Trade & Retail	–	-0.69	-0.69	-0.54	-0.69	–	0.39	-0.44	-0.44	-0.26
Other Services	–	-1.32	-1.22	-1.13	-1.32	-1.96	1.22	-0.38	-0.50	-0.14
Government Services	–	–	–	-0.41	–	–	–	–	–	0.00
Total	**-10.40**	**-2.59**	**-4.08**	**-2.02**	**-2.59**	**5.28**	**5.41**	**-0.66**	**0.47**	**0.40**

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

It is unsurprising that the import response is greatest for industrial imports, particularly in the nonfood manufacturing sector (which includes semiconductors and textiles and garments, among others). This sector enjoys the highest export growth (10.2 percent) as a result of a drop in local production costs. In contrast, domestic market production volume and prices decline for local sales by (0.5 percent) and (4.1 percent), respectively. Combined with lower import prices, this leads to a general decline in consumer prices (6.5 percent) in the industrial sectors. Consumers substitute a portion of their consumption from agricultural to the relatively cheaper

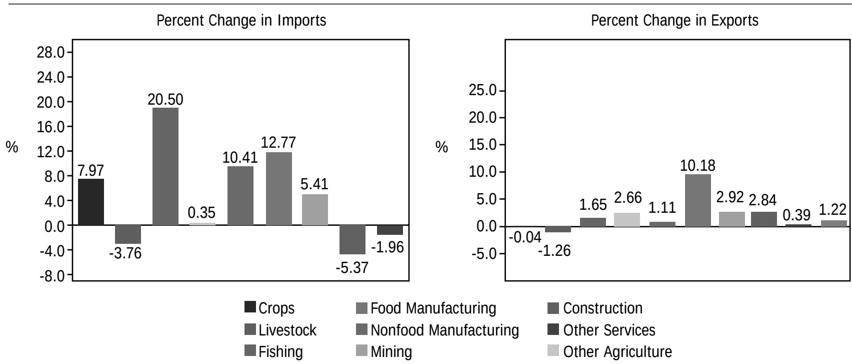
Figure 10.9 **Percentage Change in Volume of Output of the Actual Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

industrial goods. Local producers react to lower prices on the local market by increasing their exports, primarily, once again, in the industrial sector and, especially, in the nonfood manufacturing sector (Figure 10.10 and 10.11). Clearly, reallocation effects favor industry as a whole through the effects on the nonfood manufacturing sector. Overall agricultural output declines by 1.4 percent, industrial output improves by 1.4 percent, while service sector output slides marginally by 0.2 percent.

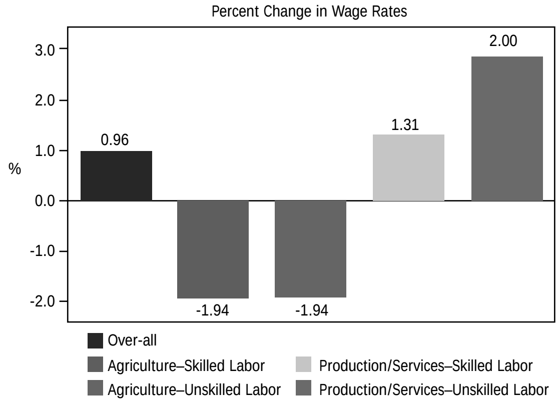
Figure 10.10 **Percentage Change of the Volume of Imports and Exports in the Actual Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Effects on Factor Market. The impact of trade liberalization is also felt in the production and labor sectors. Industry and services enjoy return-to-capital ratio rises from the reduction of import levies–with the highest increases in nonfood manufacturing and utilities. In contrast, both the value added and the price of value added decline for agriculture.

Figure 10.11 **Percentage Change in Average Wage Rates of the Actual Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

The reallocation effects benefit industry through the nonfood manufacturing sector, as can be seen in the effects on factors of production shown in Table 10.19. The rate of return to capital increases by 3.0 percent for the whole industry and by 10.8 percent for the nonfood manufacturing sector. Note that the increase in the nonfood manufacturing value-added price is largely due to a reduction in its input costs, as most of these inputs come from within this sector where consumer prices fall most. As industry is relatively more capital intensive than the other sectors, the rate of return to industrial capital increases by 3.0 percent for all industry–almost entirely from the 10.8 percent increase in the returns to capital in the nonfood manufacturing sector. In contrast, the return to capital in agriculture declines by 1.9 percent. Prices for crops and livestock become uncompetitive as the price of imports falls.

There is also an affect on labor, as skilled production and unskilled production workers move toward industry, in particular, toward the nonfood manufacturing sector (Figure 10.12). Skilled and unskilled agricultural labor is, however, employed only in the agricultural sector.

Overall, the average rate of return to capital and wages improve by 0.9 percent and 1.0 percent, respectively.

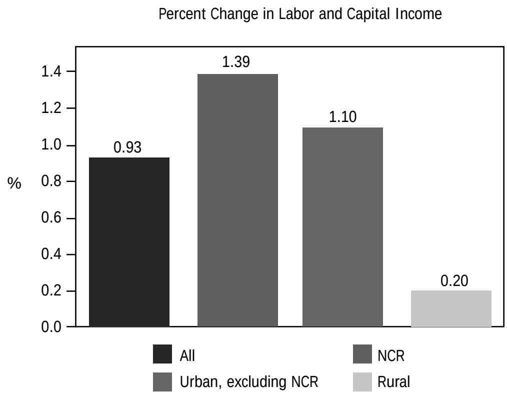
Effects on Income. The weighted average change in labor and capital income from agriculture for rural households is 0.8 percent, and for urban households, excluding the NCR, it is 0.3 percent. On the whole, factor income from agriculture declines by 0.3 percent (Table 10.20). Higher factor prices in nonagriculture results in higher income for households that depend on industry and services. Rural households, not dependent on agriculture, experience a lower improvement in nonagricultural factor income compared

Table 10.19 **Effects of Actual Tariff Scenario on the Factor Market**

	Value Added Changes (%)			*Change in Labor Demand (%)*				
Sector	*Value added*	*Prices*	*Rate of return to capital*	*Total labor*	*Skilled agriculture*	*Unskilled agriculture*	*Skilled production*	*Unskilled production*
Agriculture	**-1.4**	**-0.5**	**-1.9**	–	–	–	–	–
Crops	-1.5	-0.6	-2.1	-3.0	-0.1	-0.1	-3.4	-4.8
Livestock	-1.9	-1.0	-2.9	-3.8	-0.9	-0.9	-4.1	-5.6
Fishing	-0.8	-0.6	-1.4	-2.3	0.6	0.6	-2.7	-4.1
Other Agriculture	0.1	1.1	1.2	0.2	3.2	3.2	-0.1	-1.6
Industry	**1.0**	**2.1**	**3.0**	–	–	–	–	–
Mining	-5.2	-5.0	-10	-10.8	–	–	-11.1	-12.5
Food Manufacturing	-1.4	-1.5	-2.8	-3.8	–	–	-4.1	-5.5
Nonfood Manufacturing	4.2	6.3	10.8	9.7	–	–	9.3	7.7
Construction	-1.3	-0.7	-2.0	-2.9	–	–	-3.2	-4.7
Electricity, Gas and Water	0.3	2.0	2.3	1.3	–	–	1.0	-0.6
Services	**-0.2**	**0.6**	**0.4**	–	–	–	–	–
Wholesale Trade & Retail	-0.3	0.5	0.2	-0.8	–	–	-1.1	-2.6
Other Services	-0.1	0.7	0.6	-0.4	–	–	-0.7	-2.2
Government Services	0.0	1.0	–	0.0	–	–	-0.3	0.0
Total	**0.0**	**0.9**	**0.9**	–	–	–	–	–
Change in average wage	–	–	–	1.0	-1.9	-1.9	1.3	2.9

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Figure 10.12 **Percentage Change in Household Factor Income of the Actual Tariff Scenario**



NCR = National Capital Region
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

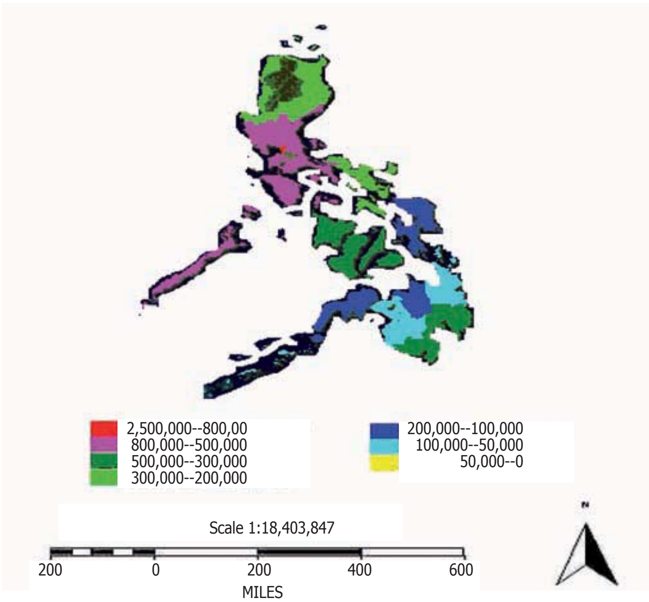
with households in the NCR and other urban areas. The total net factor income effect is 0.9 percent (Figure 10.13). Households in the NCR enjoy the highest increase (1.4 percent). Households in urban areas outside the NCR improve 1.1 percent in their total net factor income. Rural households are the least affected (0.2 percent).

Table 10.20 **Effects of Actual Tariff Scenario on Household Factor Income**
(Percentage change from base)

Household Location	*Labor and capital Income from agriculture*	*Labor & capital Income from nonagriculture*	*Total Labor and capital income*
All	-0.3	1.3	0.9
NCR	0.0	1.4	1.4
Urban, excluding NCR	-0.3	1.4	1.1
Rural	-0.8	1.0	0.2

NCR = National Capital Region
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Figure 10.13 **Distribution of Poverty Incidence of the Actual Tariff Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

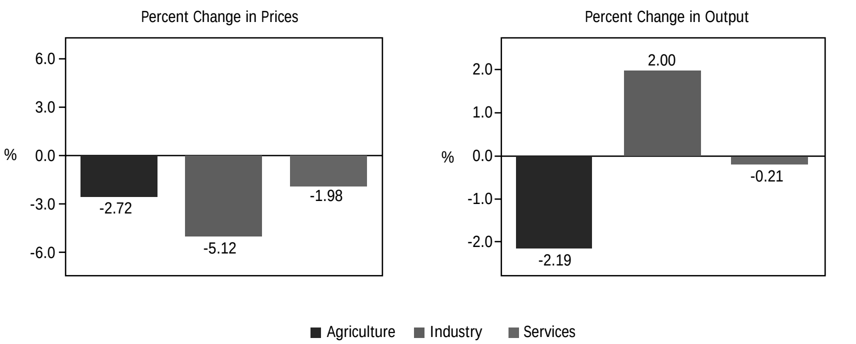
Poverty Impacts. As observed earlier, the effects on poverty vary significantly across locations and household types (Table 10.21). In this actual-tariff scenario, an estimated 1.2 million poor people are lifted out of poverty. As in the low uniform–tariff scenario, Households in the NCR enjoy the largest reduction in poverty compared with those in other urban and in rural areas. Within the NCR, households headed by females with high education, benefit the most compared with other household types (Figure 10.14). This is again largely due to the variation in the effects on factor income that generally favor households in the NCR. Better effects in the NCR are also again attributable to two factors: reallocation effects toward the nonfood manufacturing sector,

Table 10.21 **Poverty Incidences in the Actual Tariff Scenario**

Index	*Total headed households*	*Female headed households (% change)*			*Male headed households (% change)*		
		Overall	*Low education*	*High education*	*Overall*	*Low education*	*High education*
Philippines							
Headcount	-4.3	-5.4	-4.7	-10.6	-4.3	-3.8	-6.4
Poverty gap	-5.4	-6.1	-5.8	-10.0	-5.3	-4.9	-7.6
Severity	-6.0	-6.8	-6.6	-9.5	-5.9	-5.6	-8.1
National Capital Region							
Headcount	-14.9	-16.4	-9.7	-32.8	-14.7	-14.1	-15.5
Poverty gap	-16.8	-15.5	-14.7	-18.7	-17.0	-17.3	-16.6
Severity	-18.8	-16.1	-15.9	-16.3	-19.0	-19.8	-18.2
All Urban							
Headcount	-5.3	-6.3	-5.5	-10.6	-5.2	-4.8	-6.7
Poverty gap	-6.4	-7.8	-7.1	-13.8	-6.3	-5.8	-8.5
Severity	-7.0	-8.8	-8.5	-12.3	-6.9	-6.5	-8.9
All Rural							
Headcount	-3.3	-4.1	-4.0	-5.0	-3.3	-3.1	-4.3
Poverty gap	-4.5	-5.0	-4.8	-6.6	-4.5	-4.3	-5.8
Severity	-5.3	-5.7	-5.5	-7.6	-5.3	-5.1	-6.7
Poor People lifted out of poverty (%)							-4.3
Poor People lifted out of poverty							1,188,692

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Figure 10.14 **Effects in the**
Price and Volume of Output of the Full Tariff Elimination Scenario



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

which is largely located in the NCR; and exports of nonfood manufacturing being dominated by the semiconductor and textile and garments industries–whose workforce are mostly women with above-average levels of education.

Full Tariff–Elimination Scenario

Macro Effects. Table 10.22 presents the macro effects of total tariff elimination based on the assumption of a full liberalization policy.

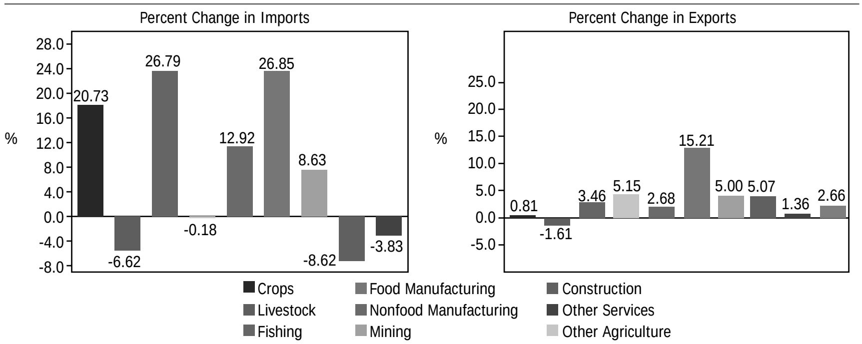
The elimination of tariffs on all commodities reduces local import prices by 15.7 percent, in which prices in all sectors decrease from 2 to 5 percent (Figure 10.15). However, in terms of output of production, the combined contraction in agriculture (2.2 percent) and services (0.2 percent) is a little higher than the expansion in industry as shown in Figure 10.15.

Table 10.22 **Macro Effects in the Full Tariff Scenario**
(Percent)

Change in Prices	
Import prices in local currency	-15.73
Consumer prices	-5.14
Local cost of production	-4.47
Real exchange rate change	6.65
Change in import volume	8.50
Change in export volume	8.54
Change in domestic production for local sales	-1.17
Change in consumption (composite) goods	0.66
Change in prices	0.55

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Figure 10.15 **Percentage Change in the Volume of Imports and Exports of the Full Tariff Elimination Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

At the same time, consumer prices decrease by 5.1 percent. In response, the local cost of production goes down by 4.5 percent because of cheaper imports. As local demand of domestically produced goods falls because of falling prices of imports, the real exchange rate depreciates by 6.7 percent.

Export volume, on the other hand, improves by 8.54 percent. The decline in import prices also translates into an increase in import volume of 8.5 percent. This result suggests that the trade index is vulnerable to changing policies that contract and expand the economy.

The increase in imports increases consumption by 0.7 percent. However, the increase in consumption does not translate into an increase in domestic production; instead, domestic production for local sales decline by 1.2 percent. This indicates that the entry of imported commodities makes it difficult for local firms to increase their selling prices, which in turn affects profit markup and local production.

Despite the crowding-out effects of domestic production for local sales, the slightly higher growth in export volume than in the import volume results in a modest improvement in overall output by 0.6 percent (Table 10.23).

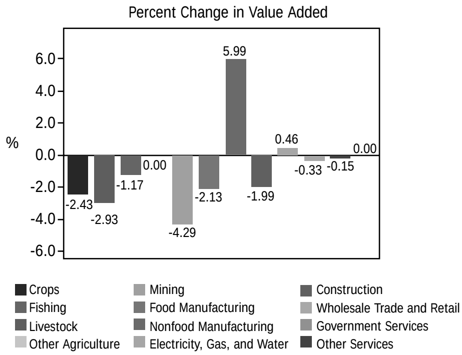
Table 10.23 **Effects of Full Tariff Scenario on Prices and Volumes**

	Price Changes (%)					*Volume Changes (%)*				
Sector	*Imports*	*Domestic demand*	*Composite demand*	*Output*	*Local*	*Imports*	*Exports*	*Domestic demand*	*Composite demand*	*Outputs*
Agriculture	**-6.56**	**-2.95**	**-3.04**	**-2.72**	**-2.95**	**6.97**	**2.17**	**-2.55**	**-2.36**	**-2.19**
Crops	-12.93	-2.75	-2.97	-2.54	-2.75	20.73	0.81	-2.70	-2.26	-2.43
Livestock	-0.61	-3.33	-3.26	-3.33	-3.33	-6.62	-1.61	-2.93	-3.03	-2.93
Fishing	-24.19	-3.82	-3.87	-3.00	-3.82	26.79	3.46	-2.41	-2.35	-1.17
Other Agriculture	-0.26	-0.47	-0.46	-0.47	-0.47	-0.18	–	0.00	-0.01	0.00
Industry	**-17.60**	**-6.60**	**-10.15**	**-5.12**	**-6.60**	**9.88**	**12.84**	**-1.05**	**2.31**	**2.00**
Mining	-29.04	-11.11	-24.72	-6.08	-11.11	12.92	5.15	-11.88	5.80	-4.29
Food Manufacturing	-25.18	-4.37	-6.30	-3.91	-4.37	26.85	2.68	-2.68	-0.51	-2.13
Nonfood Manufacturing	-16.29	-9.26	-12.82	-5.90	-9.26	8.63	15.21	0.85	4.64	5.99
Construction	–	-5.63	-5.48	-5.58	-5.63	-8.62	5.00	-2.05	-2.22	-1.99
Electricity, Gas, and Water	–	-3.71	-3.71	-3.67	-3.71	–	5.07	0.41	0.41	0.46
Services	**0.00**	**-2.38**	**-2.26**	**-1.98**	**-2.38**	**-3.83**	**2.11**	**-0.68**	**-0.20**	**-0.21**
Wholesale Trade & Retail	–	-1.75	-1.75	-1.39	-1.75	–	1.36	-0.77	-0.77	-0.33
Other Services	–	-2.68	-2.48	-2.29	-2.68	-3.83	2.66	-0.64	-0.89	-0.15
Government Services	–	–	–	-1.27	–	–	–	–	–	0.00
Total	**-15.73**	**-4.47**	**-6.67**	**-3.51**	**-4.47**	**8.50**	**8.54**	**-1.17**	**0.66**	**0.55**

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Sectoral Effects. The price and volume effects at the sectoral level show that trade policy reforms change the country's output and export structures. The manufacturing sector, for instance, has a major export component which gains from duty-free status in special economic zones. This explains the sudden shift from consumer goods such as food processing and beverages to intermediate goods such as electronics. From empirical observation, the nonfood manufacturing sector–which includes the semiconductor, textile and garments, petroleum products, and electronic industries, among others–experiences the highest export growth (15.2 percent) as a result of the drop in the local cost of production (Figure 10.16). Because of this, overall output of the sector improves by 6.0 percent while others decline.

Figure 10.16 **Percentage Change in Value Added of the Full Tariff Elimination Scenario**

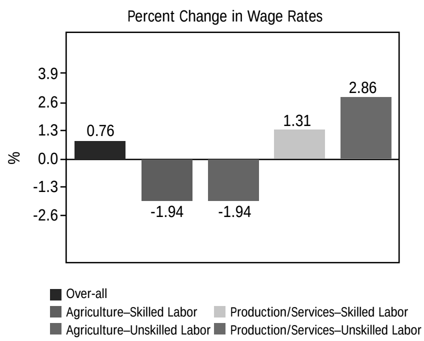


Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Clearly, the reallocation effects favor industry as a whole through the effects on the nonfood manufacturing sector. Output of all industries improves by 2.0 percent. In contrast, agricultural output declines by 3.0 percent, while the service sector slides marginally by 0.2 percent.

Effects on Factor Market. The reallocation effects on the factor market benefit industry through the nonfood manufacturing sector, as can be seen in Table 10.24. The rate of return to capital marginally increases to 3.7 percent, particularly in the nonfood manufacturing sector which increases by 14.7 percent. These increases are caused by declining prices in local production (6.6 percent) and overall composite prices (10.2 percent). Reallocation also increases export volumes by greater percentage points than import volumes. Thus, full implementation of tariff reforms induces a bias toward import substitution and provides strong support to export-oriented activities. The value added of both agriculture and services, on the other hand, is reduced (Figure 10.17). However, due to a marginal gain in prices, the services sector experiences a positive rate of return to capital.

Figure 10.17 **Percentage Change in Average Wages of the Full Tariff Elimination Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

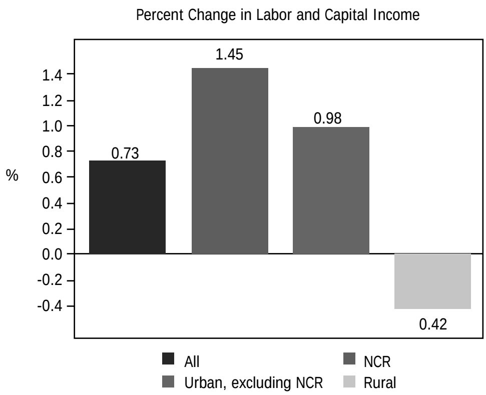
Tariffication and reforms to reduce tariffs induce agricultural labor to transfer to industrial sectors. Full tariff reduction would redirect skilled and unskilled agricultural workers toward industry, in particular toward the nonfood manufacturing sector. Thus, agricultural wages will eventually decline, while production wages will improve (Figure 10.18).

Table 10.24 **Effects of Full Tariff Scenario on Factor Market**

	Value Added Changes (%)			*Change in Labor Demand (%)*				
Sector	*Value added*	*Prices*	*Rate of return to capital*	*Total labor*	*Skilled agriculture*	*Un-skilled agriculture*	*Skilled production*	*Un-skilled production*
Agriculture	**-2.1**	**-1.5**	**-3.6**	–	–	–	–	–
Crops	-2.4	-1.6	-4.0	-4.7	-0.3	-0.3	-5.3	-7.3
Livestock	-2.9	-2.1	-5.0	-5.7	-1.3	-1.3	-6.3	-8.3
Fishing	-1.2	-1.3	-2.5	-3.2	1.3	1.3	-3.8	-5.8
Other Agriculture	0.0	0.8	0.8	0.0	4.6	4.6	-0.6	-2.7
Industry	**1.5**	**2.4**	**3.7**	–	–	–	–	–
Mining	-4.3	-4.2	-8.3	-9.0	–	–	-9.5	-11.5
Food Manufacturing	-2.1	-2.9	-5.0	-5.7	–	–	-6.2	-8.3
Nonfood Manufacturing	6.0	8.3	14.7	13.9	–	–	13.2	10.8
Construction	-2.0	-1.8	-3.8	-4.5	–	–	-5.0	-7.1
Electricity, Gas, and Water	0.5	2.1	2.6	1.8	–	–	1.3	-0.9
Services	**-0.2**	**0.4**	**0.2**	–	–	–	–	–
Wholesale Trade & Retail	-0.3	0.1	-0.2	-1.0	–	–	-1.5	-3.6
Other Services	-0.2	0.5	0.4	-0.4	–	–	-1.0	-3.1
Government Services	0.0	0.8	–	0.0	–	–	-0.6	0.0
Total								
Change in average wage	0.0	0.7	0.7	0.8	-3.7	-3.7	1.3	3.6

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Figure 10.18 **Percentage Change in Household Factor Income of the Full Tariff Elimination Scenario**



NCR = National Capital Region
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

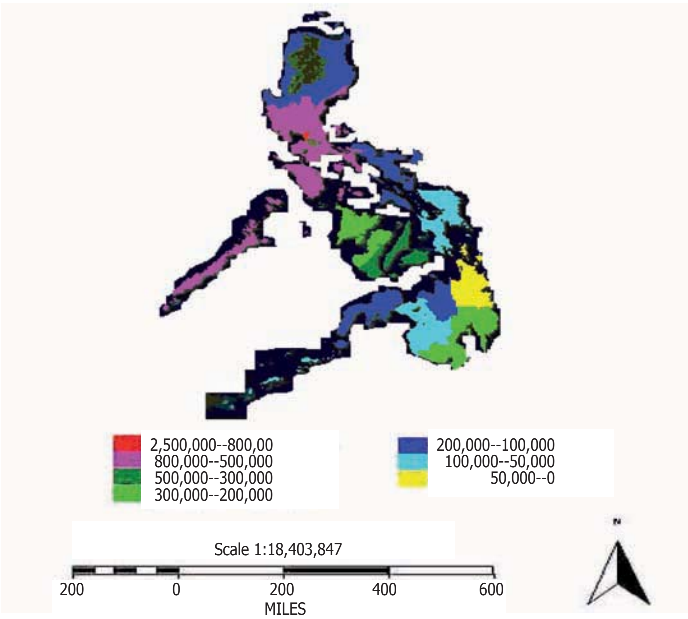
Effects on Income. The weighted average change in labor and capital income from agriculture for rural households is -1.6 percent; for urban households, excluding the NCR, it is 0.5 percent (Table 10.25). Overall, factor income from agriculture declines by 0.7 percent. Higher factor prices in nonagricultural sectors results in higher income for households who depend on industry and services. Rural households not dependent on agriculture experience less improvement in nonagricultural factor income compared with households in the NCR and other urban areas. The total net factor income effect is 0.7 percent. Households in the NCR enjoy the highest increase (1.5 percent) in factor income. Households residing in urban areas outside the NCR improve by 1.0 percent in terms of their factor income. Rural households experience a decline in factor income of 0.4 percent (Figure 10.19).

Table 10.25 **Effects of Full Tariff Scenario on Household Factor Income**
(Percentage change from base)

Household Location	*Labor and capital*	*Labor and capital*	*Total*
	Income from agriculture	*Income from nonagriculture*	*Labor and capital income*
All	-0.7	1.4	0.7
NCR	0.0	1.5	1.5
Urban, excluding NCR	-0.5	1.5	1.0
Rural	-1.6	1.2	-0.4

NCR = National Capital Region
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Figure 10.19 **Distribution of Poverty Incidence of the Full Tariff Elimination Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Poverty Impacts. The effects on poverty vary significantly across locations and household types (Table 10.26). About 2 million poor people are lifted out of poverty when all tariffs are eliminated. As in the previous scenarios involving partial and actual tariff reductions, households in the NCR enjoy the largest reduction in poverty compared with those in other urban and rural areas. Within NCR, households headed by females with high education again benefit the most compared with other household types. This is also largely due to the variation in the effects on factor income that generally favor households in the NCR (Figure 10.20). These are also attributable to the same two factors: reallocation effects toward the nonfood manufacturing sector, which is largely located in the NCR; and domination of exports of nonfood manufacturing by the semiconductor and textile and garments industries whose workforce are mostly women with above average levels of education.

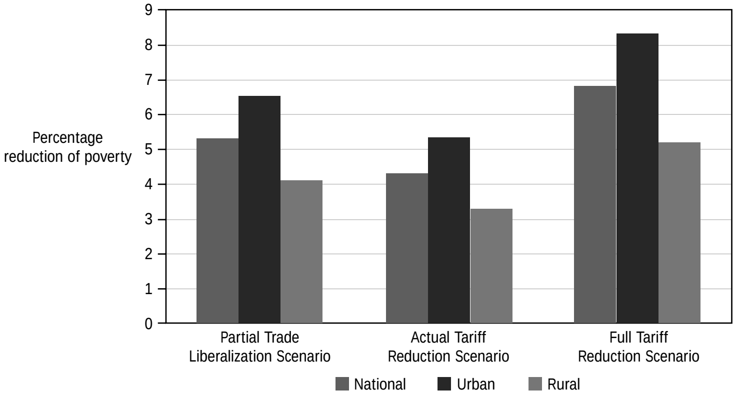
Table 10.26 **Percentage Change of Poverty Incidence in the Full Tariff Scenario**

Index	*Total headed households*	*Female headed households (%)*			*Male headed households (%)*		
		Overall	*Low education*	*High education*	*Overall*	*Low education*	*High education*
Philippines							
Headcount	-6.8	-8.1	-6.9	-16.5	-6.7	-6.0	-10.3
Poverty gap	-8.5	-9.8	-9.2	-15.6	-8.3	-7.8	-11.9
Severity	-9.5	-10.9	-10.5	-15.1	-9.4	-8.9	-12.7
National Capital Region							
Headcount	-22.8	-23.6	-14.5	-45.9	-22.7	-20.9	-24.8
Poverty gap	-25.2	-23.6	-22.7	-27.0	-25.4	-25.8	-24.7
Severity	-27.9	-24.2	-23.8	-25.7	-28.3	-29.2	-27.1
All Urban							
Headcount	-8.3	-10.2	-8.3	-20.9	-8.1	-7.3	-10.9
Poverty gap	-10.0	-12.3	-11.2	-21.3	-9.8	-9.0	-13.4
Severity	-11.0	-13.8	-13.3	-18.9	-10.8	-10.1	-13.9
All Rural							
Headcount	-5.2	-5.8	-5.8	-5.0	-5.2	-4.9	-6.9
Poverty gap	-7.3	-8.0	-7.8	-10.8	-7.2	-6.9	-9.3
Severity	-8.4	-9.2	-8.9	-12.3	-8.4	-8.1	-10.6
Poor People lifted out of poverty (%)							-6.8
Poor People lifted out of poverty							1,857,608

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

In summary, all three simulations show that each trade reform results in a slight improvement in the plight of the poor. Results of applying a low uniform–tariff scheme is not very different from implementing full tariff elimination. Moving from low tariffs to free trade, would result in only a 1.7 percent reduction in poverty or roughly just an additional 500,000 people lifted out of poverty.

Figure 10.20 **Poverty Reduction of the Full Tariff Elimination Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

The marginal reduction in poverty can be attributed to the fact that only the nonfood manufacturing sector benefits greatly from the reduction or elimination of tariffs. The agricultural and services sectors contract as their output, value added, and labor reallocate to the industrial sector. These effects lead to a higher unemployment rate, lower wages, and lower rates of return to capital in agriculture and services. In addition, tariff reduction in agricultural imports depresses domestic agricultural prices. Since a large portion of households belong to rural areas, where agriculture is the major economic activity, these tariff reduction or elimination effects counteract with the benefits gained, resulting in only marginal improvements in household income and poverty incidence.

Summary and Conclusion

The importance of trade liberalization, in the form of tariff reduction, in reducing poverty has received considerable attention from policy makers. Tariff reduction alters relative prices of domestically produced goods and import prices, leading to a reallocation of resources. The effects on the poor can be traced through three transmission mechanisms of household income, consumption, and unemployment.

Tariff reduction has been a major part of the trade liberalization program implemented by the Philippine government since the 1980s. As a result, significant changes have already taken place such as overall reduced tariff, simplified tariff structure, and tariffication of quantitative restrictions. This study examined the tariff reduction effects on the economy and on poverty in the Philippines in 1994–2000.

The study uses PRISM, which is basically a user-friendly CGE-microsimulation model linked to a GIS poverty-mapping application. Detailed individual household data are integrated in the PRISM to capture the interaction between the trade reforms and individual household responses, and their feedback to the general economy.

Three scenarios are examined, namely low uniform–tariff reduction, actual tariff reduction, and full trade liberalization. A number of interesting findings can be summarized as follows:

Tariff reduction reduces both domestic prices of imported and locally produced goods. The decline in import prices results in higher imports, while the drop in local prices increases export competitiveness, which in turn translates into higher exports. Although higher imports put pressure on local production, the export-push effect coming from improved competitiveness offsets the negative effect on output. Thus, overall output increases and the supply of goods available in the market expands, benefiting consumers.

The nonfood manufacturing sector benefits from both output reallocation and labor movement. Furthermore, there are some indications that changes in the output and factor price ratios, as well as factor substitution, favor skilled production workers in nonfood manufacturing, utilities, and other agricultural sectors.

Agricultural wages decline as a result of a drop in agricultural output. The contraction leads to higher unemployment for both skilled and unskilled agricultural labor. Furthermore, the drop results in lower capital return in agriculture that lowers rural households' income. In contrast, the resource reallocation effects favoring industry, particularly the nonfood manufacturing sector, increase the wages of production workers and capital returns in industry. Resource reallocation also reduces unemployment of both skilled and unskilled production labor.

The overall effects improve urban household income in the different regions, including the NCR. There is an apparent bias favoring households in urban areas, due to the production and resource reallocation toward the nonfood manufacturing sector. As poor people mostly live in rural areas, the tariff reductions worsen the income inequality problem. The Gini coefficient deteriorates from 0.4644 before the tariff reduction, to 0.4672 after the tariff cut.

The poverty effects calculated using the FGT indices of poverty incidence, poverty gap, and poverty severity, show some interesting findings. The poverty effects can be examined from two transmission channels of income and consumption. The income channel comes from factor incomes allocation, while the consumption channel emerges from the effects on the households' consumption basket and the poverty threshold.

The decline in composite prices as a result of tariff reduction leads to a lower poverty threshold for a given commodity basket. As a result, all poverty indices computed show favorable effects. The poverty effects, however, vary considerably across household groups. As urban households, particularly in the NCR, receive the most benefits, the poverty reduction in the NCR is the most apparent. Poverty incidence, poverty gap, and poverty severity in the NCR improve significantly. Poverty incidence in other urban areas outside the NCR also show a sizeable reduction, but still less than in the NCR.

The urban-rural poverty impact is ironic: poverty is reduced the least in rural areas–where most of the poor live. This effect is due to the contraction of rural agriculture and the expansion in urban industry. It is important to note that the goods driving the expansion of nonfood manufacturing exports are semiconductors and garments. These industries are located mainly in export processing zones with a workforce dominated by females with at least a high school diploma or vocational training, or both. It is interesting to relate this with the results that the largest improvement in poverty is observed among households headed by females with high education.

Appendix 10.1

Poverty Reduction Integrated Simulation Model

Guntur Sugiyarto, Caesar Cororaton, Erwin Corong, Joakim Rylander, and Eric B. Suan

Introduction

The Poverty Reduction Integrated Simulation Model, or PRISM, is a user-friendly, online modeling tool that combines a computable general equilibrium (CGE) model with microsimulation at the household level and a geographical information system (GIS) application of poverty mapping for spatial analysis. All complexities of the modeling aspects have been interfaced in a user-friendly way so that users can run simulations and conduct some analyses online with ease. The development of PRISM is under the auspices of the Economics and Research Department of the Asian Development Bank (ADB).

PRISM is a completely new and unique system. It is designed to provide an integrated economic framework for evaluating wide-ranging policy changes, economic shocks to the economy, sectoral effects, factor market effects, household income and consumption effects, and poverty effects. The results are presented in graphs and tables that can be copied to other Window-based applications. Moreover, the poverty impact is also presented in as dynamic and interactive GIS maps to allow spatial analysis to be done intuitively.

The tool allows users to do scenario analysis by changing some policy parameters in the model, running the simulation, and getting the results online. The economy-wide effects of any changes as a result of the simulation are presented in graphs and tables, which can then be copied to other computer applications. In line with ADB's overarching goal of poverty reduction, as well as the Millennium Development Goal No.1 of halving poverty incidence by 2015, the tool provides a framework for poverty impact analysis.

There are similar computer applications that can be used by policy makers to design pro-poor policies such as the one developed by the United Nation University's World Institute for Development Economics Research (UNU-

WIDER).[1] In the UNU-WIDER application, simulations of "what if" on tax policy scenarios can be conducted. PRISM, however, not only simulates "what if" scenarios of important issues and gives a detailed analysis of how many people might be lifted out of poverty, but also displays the geographical location of the poverty impact.

PRISM is easy to understand. It allows users to run their own scenarios or to examine the economy-wide effects of preset scenarios carefully selected for their relevance in each particular country incorporated in the system. Simulations can produce results on, as mentioned above, the overall economy, sectoral outputs, factor market, and household incomes, and, more importantly, on poverty reduction.[2] Furthermore, the poverty impact of any changes introduced in a simulation is interfaced with advanced GIS mapping techniques so that the poverty impact indicators such as the headcount ratio and poverty gap for selected regions, provinces, and districts in each country can be presented interactively on GIS maps. A comparison of poverty impact indicators of two different scenarios is also possible through a dual-window map-viewing facility.

PRISM was developed by using the Philippines' CGE-microsimulation model based on the 1994 Social Accounting Matrix (SAM) and the 1994 Family Income and Expenditure Survey. Incorporation of other countries in the system is possible, especially for those countries which already have CGE models developed such as Bangladesh, the People's Republic of China, Indonesia, Nepal, Pakistan, and Viet Nam.[3] To incorporate other countries in the system, further refinement of the models, including the integration of household data and interfacing of the modeling mechanisms may be necessary, especially given each model is specific to the underlying economy.

---

1 The simulation models were developed for five African countries and Russia. African models provide poverty, distribution, and budgetary impacts at specific changes in policy and compare the results with the current state or base scenario (http://www.wider.unu.edu/). The Russian model can track the effects of taxes on the Russian people, i.e., who pays the taxes, who gets the benefits, and who gains and loses.

2 The model is hosted on a production server that maintains the Web and GIS server. The infrastructures that support the production server are Windows 200x, Microsoft SQL Server 2000, GAMS for simulating CGE, Minifold 6 Web GIS, and ESRI ArcView Desktop, ChartFX Graph Generator, Autodesk Map, and MapGuide 6.5 Advanced GIS Analysis.

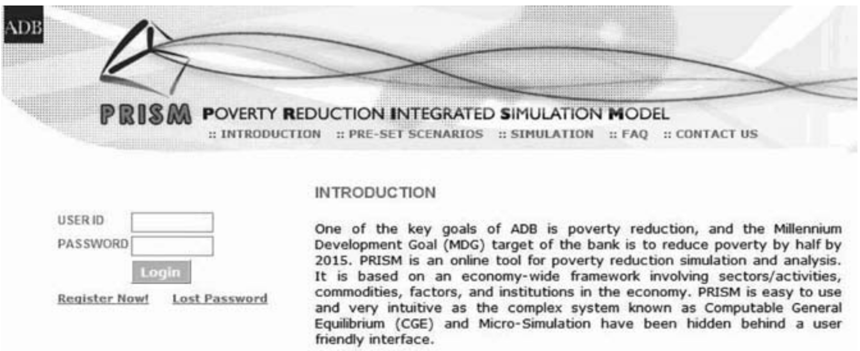
3 Malaysia, Singapore, and Thailand also have CGE models. In general, all countries can be included in the PRISM provided there is a representative CGE model for the country's economy or that CGE model can be developed based on available data.

How to Use PRISM

Setting up User Name and Password

To be able to use the functionality of PRISM in full, users have to register in the system by entering their user identification and password (which are not case sensitive) and clicking the REGISTER NOW menu. The registration is needed to enable the users to receive a confirmation e-mail message when their simulations are done so that they can view the results. Registration also allows the site administrator and ADB to verify the user's identity and to note the frequency and duration of each visit to provide better services. Registration is also important as the system will not allow users to move to the next page until they have finished registering. Figure 10.1.1 shows the registration screen, with the introduction to PRISM.

Appendix Figure 10.1.1 **Registration and Introduction Page**



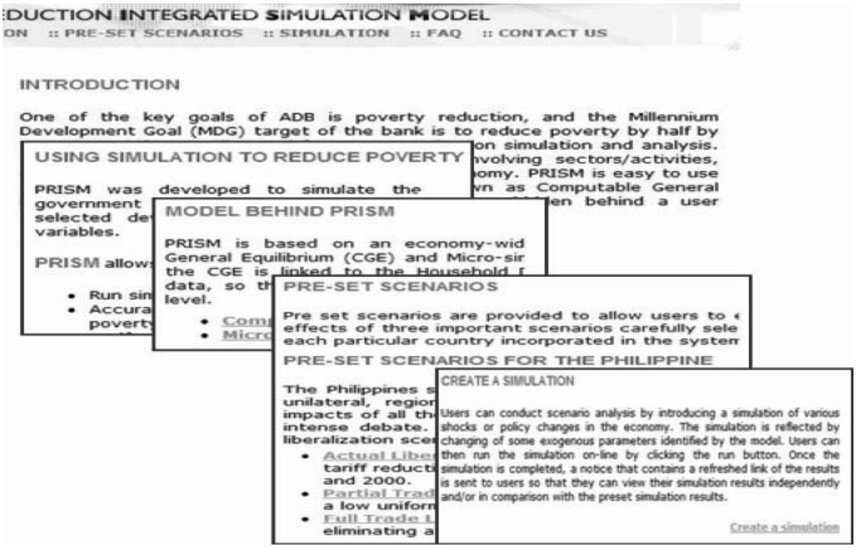
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

In case users lose or forget their password, they can click on LOST PASSWORD and enter their e-mail address. The lost or forgotten password will then be forwarded by PRISM to the registered e-mail address. Alternatively, users can also use PRISM by typing *adb* in both the USER ID and PASSWORD boxes. If they then decide to run simulations, their results can still be reviewed by logging out and then logging into the system after about 5–10 minutes using the same *adb* user name and password. The simulation results are stored in the *previous simulations file.*

Viewing Preset Scenarios and Exploring

Once the users log in, they can go to the second page of PRISM (Figure 10.1.2) that provides more information about the system including the model behind PRISM, how to create a simulation, and how to view the preset scenarios. For example, clicking the *actual liberalization scenario* of the preset scenarios will display the effects of the actual reduction in nominal tariff rates on poverty. This is the default scenario.

Appendix Figure 10.1.2 **Example of the Content of Introductory Page**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

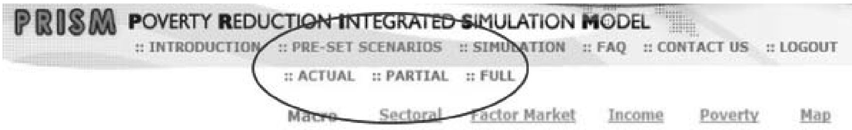
Users can also customize their own scenarios by simply clicking the *create simulation* menu bar and then setting up the scenario. Alternatively, users can click the *simulation* icon on the page heading to bring up the simulation page.

Preset Scenarios

To introduce to the underlying economy concerned, PRISM runs preset scenarios of particular issues relevant to the underlying country. The preset scenarios are designed to be relevant to the country concerned such as trade liberalization in the Philippines. Trade reforms have been ongoing in the Philippines since 1980s, partly as a result of its unilateral, regional, and multilateral trade agenda with other countries. In this context, PRISM provides a tool to systematically examine the economy and poverty impacts of the trade policies.

Figure 10.1.3 shows three different preset scenarios introduced in the model, namely: *Actual Liberalization* that mimics the actual tariff reduction that occurred in the Philippine economy between 1994 and 2000; *Partial Trade Liberalization* that illustrates the impact of a low uniform tariff rate across sectors; and, *Full Trade Liberalization* that depicts the impact of eliminating all tariffs.

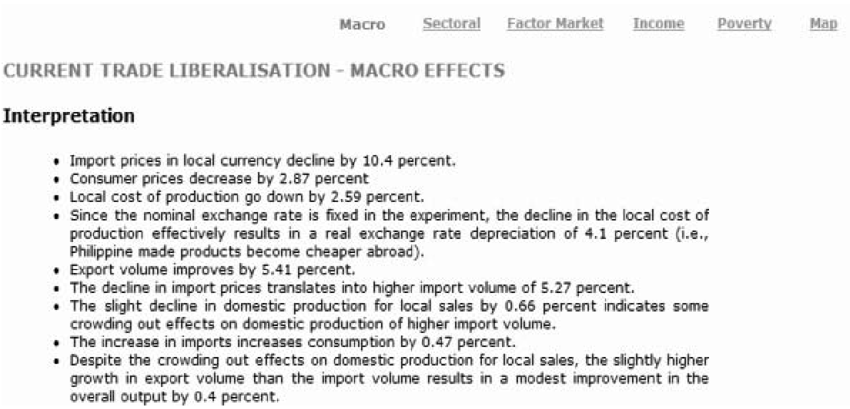
Appendix Figure 10.1.3 **Intro Page to Preset Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Figure 10.1.4 presents the schematic representation of adjustment mechanisms in the underlying model of PRISM. Notice that the impact evaluation of any policy changes introduced in the model is conducted at macro, factor, and household level, which are reflected in macro, sectoral, factor market, income, and poverty effects.

Appendix Figure 10.1.4 **Macro Effects of the Preset Scenario**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

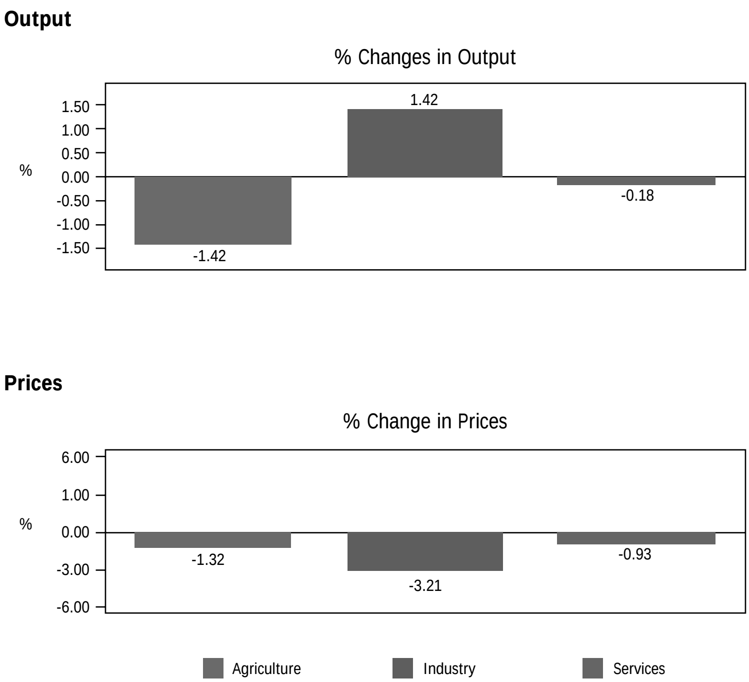
The results of each preset scenario are presented in graphs, tables, and maps. Some highlights of the findings are also included to make them more informative. Clicking on the *macro* option, for instance, will reveal the preset scenario results on overall changes in prices, production, and consumption (See Figure 10.1.4).

To examine the sectoral effect, one simply clicks on *sectoral* for a graphical presentation and tabular result of the changes in outputs, prices, imports, and exports of the selected scenario. The preset scenarios give complete results of changes in tariff rates on the economy such as production, consumption, income (in nominal terms), capital and labor, and poverty (Figures 10.1.5a – 10.1.5f). For the poverty impact, the user can use the dual-window viewing system for comparing two simulations.

Appendix Figure 10.1.5a **Sectoral Effects of the Preset Scenario**

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

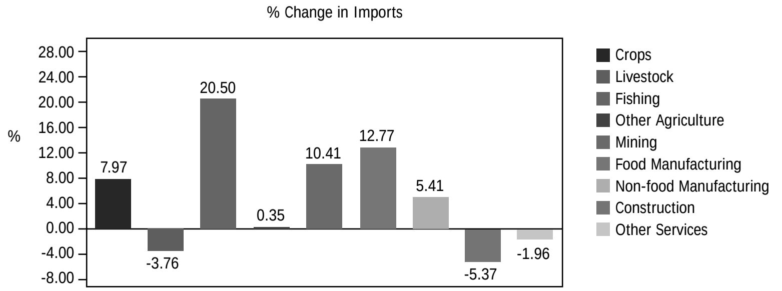
Appendix Figure 10.1.5b **Effects of the Preset Scenario on Output and Prices**



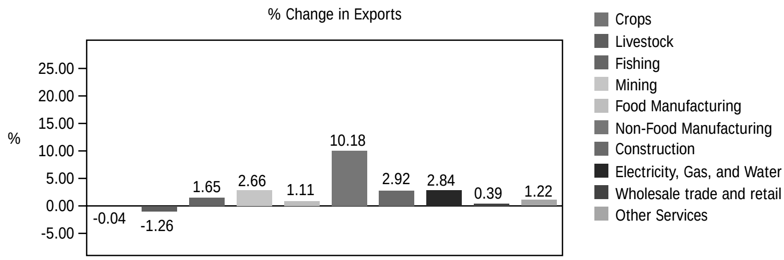
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Appendix Figure 10.1.5c **Effects of the Preset Scenario on Imports and Exports**

Imports



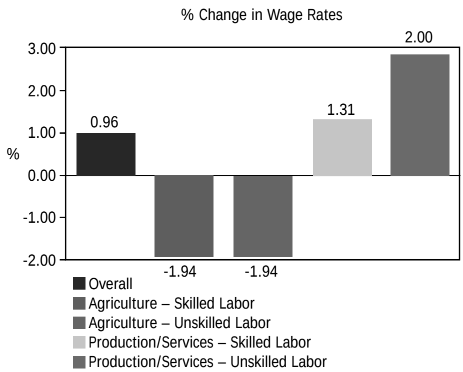
Exports



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Appendix Figure 10.1.5d **Effects of the Preset Scenario on Factor Market**

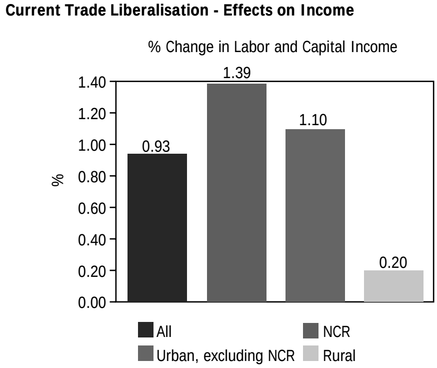
Current Trade Liberalisation - Factor Market



- The reallocation effects benefit the industry through the nonfood manufacturing sector, as can be seen in the effects on factors of production shown in Table 3.
- Both the value added and the price of value added decline for agriculture and increase for industry, particularly for the nonfood manufacturing sector.
- The rate of return to capital increases by 3.0 percent for the whole industry and 10.8 percent for the non-food manufacturing sector.
- The return to capital in agriculture declines by 1.9 percent.
- There is labor movement of skilled production and unskilled production toward industry, in particular toward the nonfood manufacturing sector.
- Agriculture wages decline, while production wages improve.

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

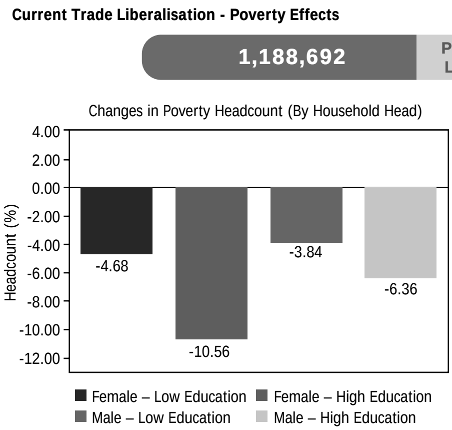
Appendix Figure 10.1.5e **Effects of the Preset Scenario on Income**



- The weighted average change in labor and capital income from agriculture for rural households is -0.8 percent, and for urban households, excluding the NCR, is -0.3 percent.
- On the whole, factor income from agriculture declines by 0.3 percent.
- Higher factor prices in nonagriculture results to higher-income for households who depend on industry and services.
- Rural households, not dependent on agriculture experience a lower improvement in nonagriculture factor income compared to households in the NCR and other urban areas.
- The total net factor income effect is 0.9 percent.
    - Households in the NCR enjoy the highest increase of 1.5 percent.
    - Households residing in urban areas outside the NCR have 1 percent improvement in their total net factor income.

NCR = National Capital Region
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

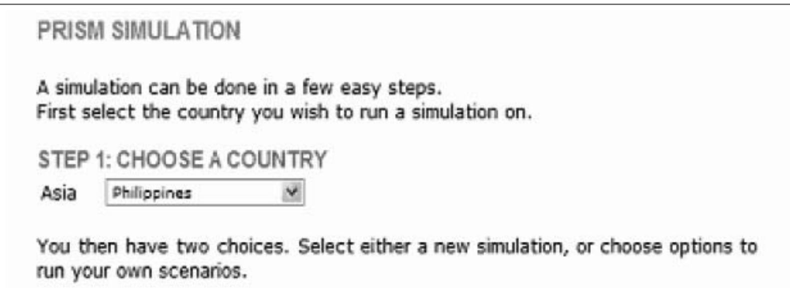
Appendix Figure 10.1.5f **Effects of the Preset Scenario on Poverty**



- The effects on poverty vary significantly across locations and household types.
- Households in the NCR enjoy the largets reduction in poverty compared with those in other urban and rural areas.
- Within NCR, female-headed households with high education benefit the most compared with the other household types.
- This is largely due to the variation in the effects on factor income that generally favor households in the NCR.
- These are the attributable to two factors.
    - The reallocation effects towards the nonfood manufacturing sector which is largely located in the NCR.
    - The export of nonfood manufacturing is dominated by semi-conductor, and textile and garments — whose workforce are majority women with above average level.

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Appendix Figure 10.1.6 **Selecting a Country of Interest**



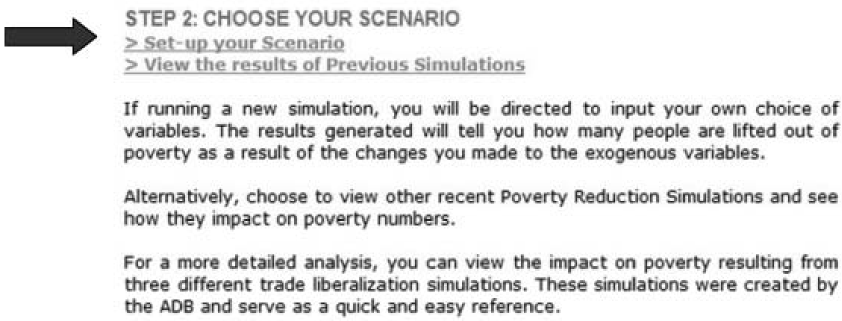
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Getting Started with the PRISM Simulation

PRISM is designed to subsequently incorporate all developing member countries. Therefore, the guideline below is written for a general case, i.e., applicable to other countries selected from the system.

Step 1: Choose a Country. Users can select the country of interest from the drop-down menu as outlined in the Figure 10.1.7. At the moment, however, the system has only one country, the Philippines, with which users can conduct a simulation analysis.

Appendix Figure 10.1.7 **Starting a Simulation**



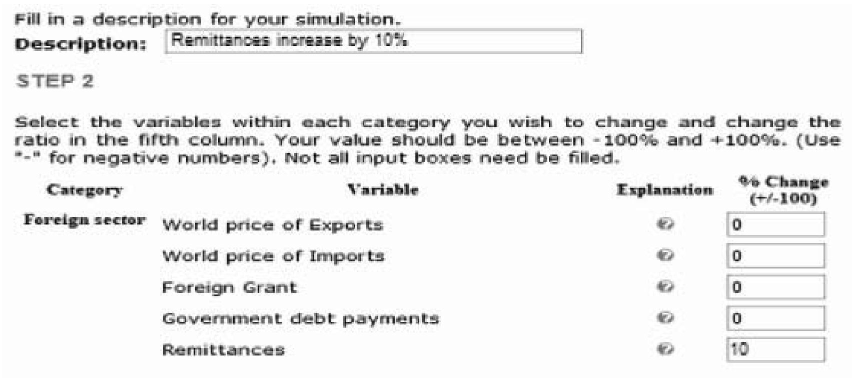
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Step 2: Set Up Your Scenario. After selecting the country (for now, the Philippines), the user can either start setting up a scenario by clicking on *Set up your scenario* or customize different scenarios by following Step 4.

Another option would be to retrieve the previous simulation results conducted by previous users by simply clicking on *View the results of previous simulations.* The previous simulation results are arranged according to dates of completion. The list also includes simulation names and descriptions (or references) to make them easy to identify.

Step 3: Name a Scenario. Each simulation must be given a distinct name and a description, consisting of up to 35 alphanumeric characters, that includes key actions taken in the simulation. The unique name and description will distinguish a specific simulation from previous ones or from others run by the same user and will make it easy for the simulation to be referred to when needed. For example, if John is running a simulation of a 10 percent reduction in indirect tax rates, the name and description such as "John, 10% cut in indirect taxes" can be used. This allows other users with the same interest to view results without running their own simulation. Figure 10.1.8 shows the simulation description box in PRISM.

Appendix Figure 10.1.8 **Describing Simulation**



Fill in a description for your simulation.

Description: Remittances increase by 10%

STEP 2

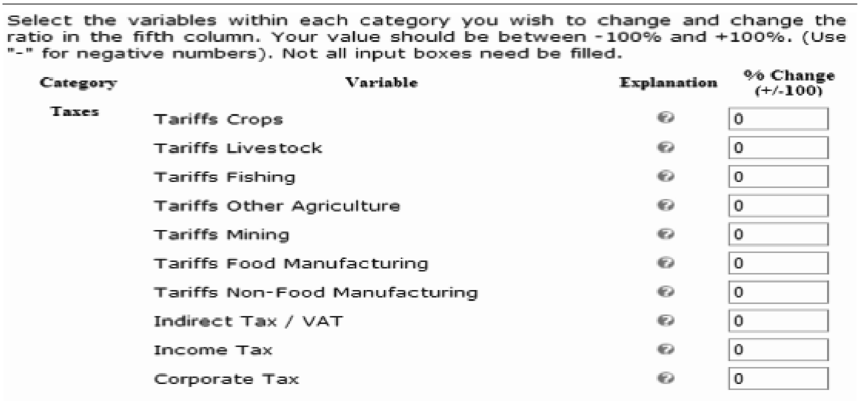
Select the variables within each category you wish to change and change the ratio in the fifth column. Your value should be between -100% and +100%. (Use "-" for negative numbers). Not all input boxes need be filled.

Category	Variable	Explanation	% Change (+/-100)
Foreign sector	World price of Exports		0
	World price of Imports		0
	Foreign Grant		0
	Government debt payments		0
	Remittances		10

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Step 4: Customize a Scenario. To customize a scenario, users can select the policy variables within each category and indicate the changes by entering the percent rate of change in the box provided in Step 2 (see Figures 10.1.9 –10.1.11). The value should be between -100 percent and +100 percent. The negative sign (-) means reducing, while the positive sign (+) indicates increasing any of the variables under review. For instance, to analyze the impact of tariffs on crops to the overall economy by reducing the tariff by 10 percent, the user must enter -10 in the *% change* box beside the *Tariffs Crops* variable. Not all input boxes have to be filled up with an assigned value, as shown in Figure 10.1.9. However, at least one value should be inputted in the box to represent a policy change introduced in the model.

Appendix Figure 10.1.9 **Introducing Policy or Economic Changes**

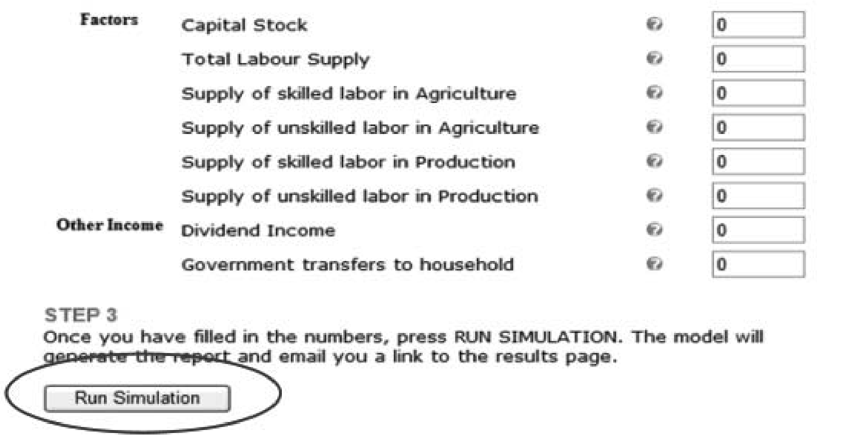


Select the variables within each category you wish to change and change the ratio in the fifth column. Your value should be between -100% and +100%. (Use "-" for negative numbers). Not all input boxes need be filled.

Category	Variable	Explanation	% Change (+/-100)
Taxes	Tariffs Crops		0
	Tariffs Livestock		0
	Tariffs Fishing		0
	Tariffs Other Agriculture		0
	Tariffs Mining		0
	Tariffs Food Manufacturing		0
	Tariffs Non-Food Manufacturing		0
	Indirect Tax / VAT		0
	Income Tax		0
	Corporate Tax		0

Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Appendix Figure 10.1.10 **Running a Simulation**



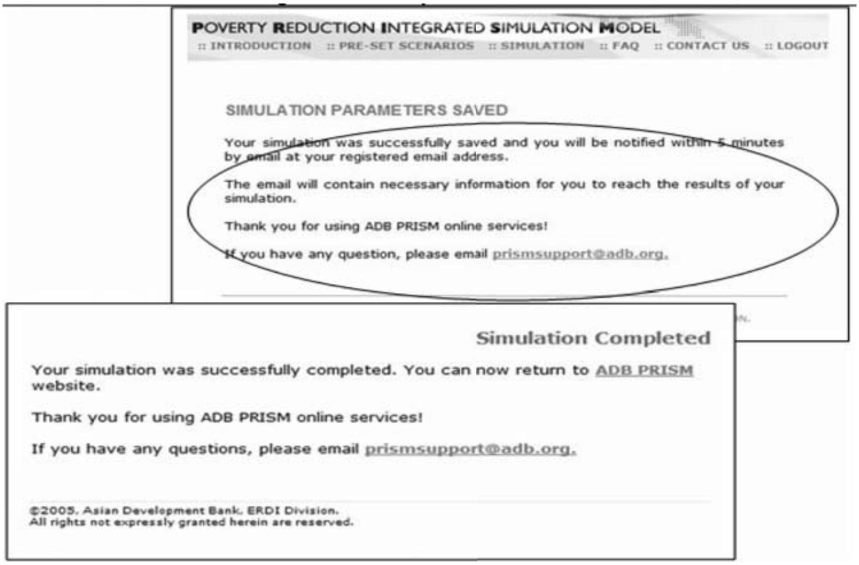
Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

The policy variables or parameter changes are divided into four different categories–*Foreign Sector*, *Taxes*, *Factors*, and *Other Income*–to reflect all the important aspects of a fully functioning economy.

Step 5: Run the Simulation. After a scenario is set up, users can run the simulation by simply clicking on *Run Simulation* (Figure 10.1.11). The PRISM system will then confirm that the parameters of change have been saved and immediately start processing the simulation. Detailed descriptions of policy variables that can be changed in the PRISM are presented in Table 1.

PRISM, when made available to the public, can help policy makers demystify some of the model runs. They can use it to carry out sensitivity analyses of their choice (e.g., a 10 percent rather than a 20 percent change in a selected variable). However, it is important to note that there is no single CGE model suitable for all policy simulation options. Many argue that a CGE model should even be developed specifically for each policy concern.. For example, if we change tariffs, taxes, or government debt payments, we cannot get sensible results unless we maintain income-expenditure balance by changing other items in the government's budget. Similarly, increasing skilled labor supply in one sector would affect labor supply in other sectors. The policy options selected in Table 10.1.1 were chosen for their sensible results–i.e., "sensible" in so far as there are no changes in the modeling specifications of the underlying CGE, including in the changing of closure rules. There are in fact more policy simulations that can be conducted using the underlying CGE model used in the PRISM than are listed in the table.

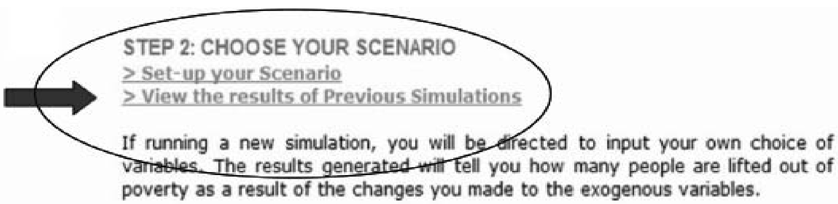
Appendix Figure 10.1.11 **Example of a Notice for Completed Simulation**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Step 6: Complete Simulation. As shown in Figure 10.1.12, a confirmation that the simulation parameters have been saved successfully will be displayed on screen and the system will immediately start processing the data. Normally, processing time is between 3 to 10 minutes, depending on many factors– such as the complexity of the inputted parameters and the number of users accessing the system at the same time. This is of course in addition to general factors such as the number of algorithms needed to find the solution.

Appendix Figure 10.1.12 **Viewing Results of Previous Simulations**

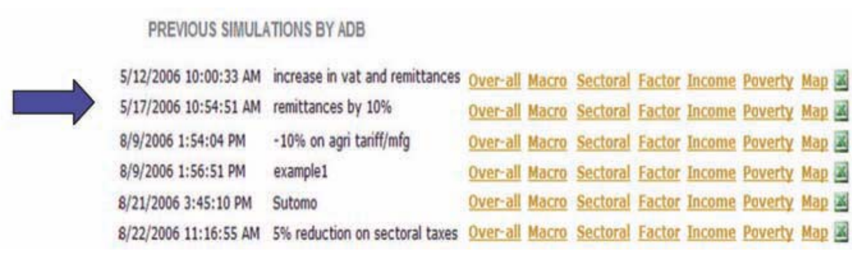


Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

An e-mail message with the subject SIMULATION COMPLETED is sent to the registered e-mail address of the user once the simulation has been completed. This e-mail notification contains a fresh link to the ADB PRISM site, so that users can view all their results by simply clicking on the link.

Past simulations are stored in the system and can be retrieved. Figure 10.1.13 shows how to view simulation results which are stored in previous simulations pages. The description, date, and time of each simulation are logged. Clicking on *View the Results of Previous Simulations* will open the customized simulation results pages. The reference name of each simulation is provided in the list with the latest completed simulation listed at the bottom.

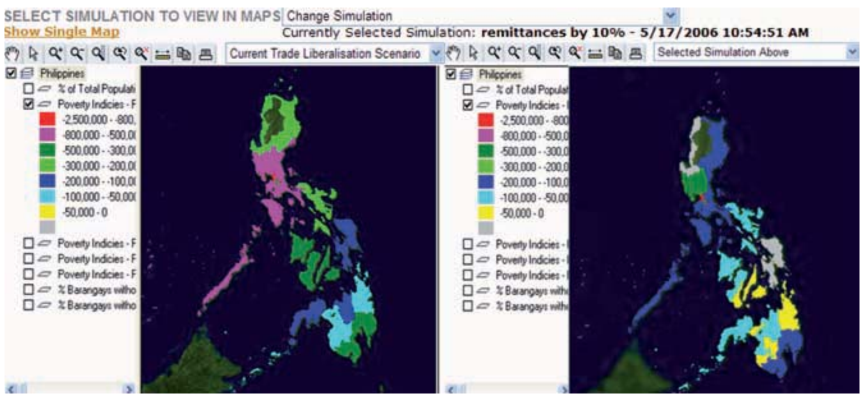
Appendix Figure 10.1.13 **List of Results of Previous Simulations**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

The simulation results are grouped according to categories outlined earlier, i.e., *Overall*, *Macro*, *Sectoral*, *Factor*, *Income*, *Poverty*, and *Map*. Users can view the results as graphs and tables in Microsoft Excel. The results can be downloaded and copied to other Windows-based applications (Figure 10.1.14).

Appendix Figure 10.1.14 **Comparing of Poverty Impacts of Two Simulations**

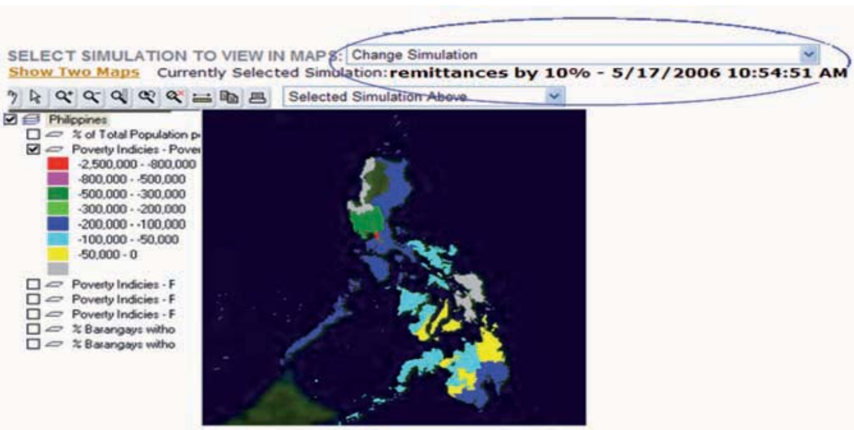


Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

Step 8: View Poverty Maps. As mentioned before, in addition to graphs and tables, the poverty impact of policy changes is also presented in a map. To view the impact as a map, Mapguide ActiveX Control must first be downloaded. This software is legitimate and free, and can be accessed through a download link in the *Help* section of PRISM.

When viewing the maps, the three preset scenarios can be examined, or alternatively, browsed through from the list of previous simulations. By default, PRISM displays two GIS maps side by side for comparing two simulation results, as shown in Figure 10.1.15. Alternatively, PRISM also allows users to view a single map for greater clarity and ease of use, as illustrated in Figure 16. To select a single map view, users click on the *Show Single Map* icon. To go back to double-window viewing, users select *Show Two Maps*. This icon toggles between these viewing options.

Appendix Figure 10.1.15 **Viewing and Customizing a Map on Poverty Impact**

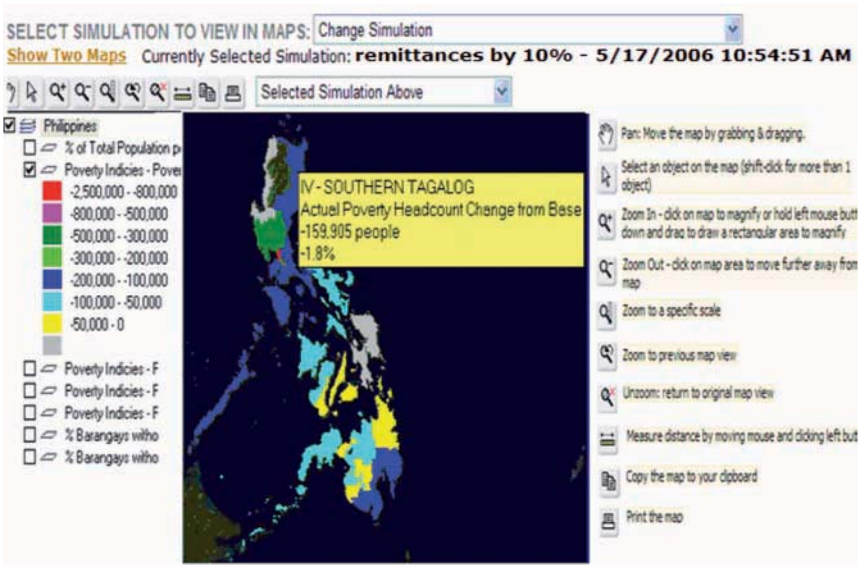


Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

The first drop-down menu lists all results of previous simulations. The next drop-down menu provides the option to map either the customized results or the preset scenarios. Users can choose *Selected Scenario* to map their own scenarios. Figure 10.1.15 shows the selection of a previous simulation of a 30 percent reduction in world prices for mapping. The poverty map results shows that the reduction will benefit 100,000 to 200,000 households in the Luzon area of the Philippines, while 50,000 to 100,000 households were lifted out of poverty in Mindanao and the Visayas.

Step 9: Magnifying the Map. Another feature of the poverty map is to ability to change the viewing scale of the map. Figure 10.1.16 shows how GIS application icons can help to enhance the usability of the mapping function, e.g., by zooming in and out, printing, and measuring the distance from one region to another. A description of each GIS function and how to use them, are available in the *Help* section of the *Mapping* folder.

Appendix Figure 10.1.16 **Magnifying a Map on Poverty Impact**



Source: Poverty Reduction Integrated Simulation Model (PRISM) (Available at http://prism/adb_prism).

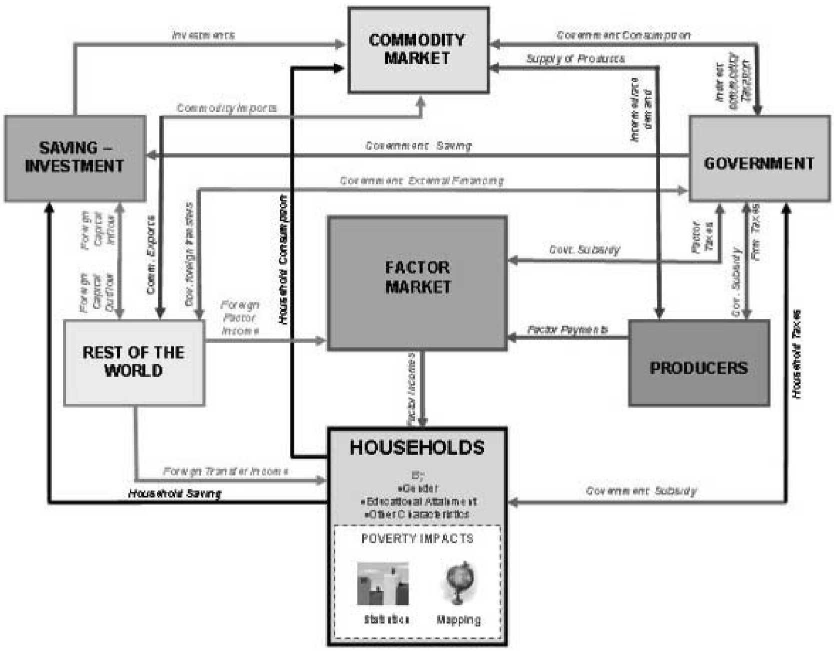
Appendix 10.2

Computable General Equilibrium Model

The Model

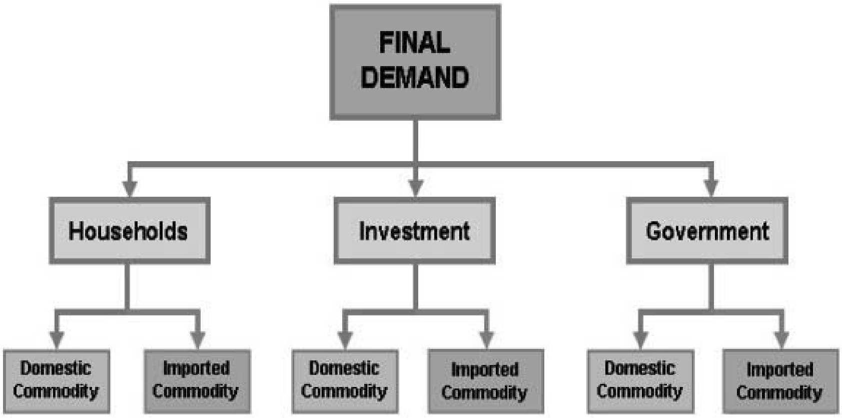
A computable general equilibrium (CGE) model captures the complex relationships of agents and sectors in an economy–as depicted in the schematic diagram below. In this modeling framework, households maximize their utility functions subject to their budget constraints. The household utility function was derived from the consumption of domestically produced and imported commodities, while household income was generated from the accumulation of factor income and transfer payments.

Appendix 10.2.1 **The Interlinked Nature of the Economy**



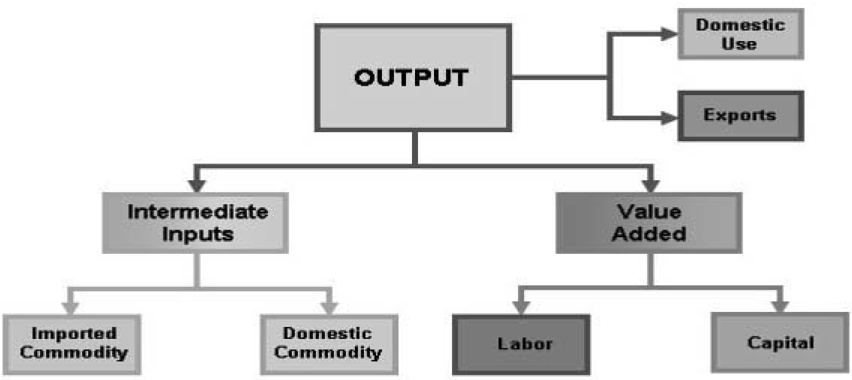
On the final demand side, total demand in the domestic economy consists of demands for consumption and for investment purposes–both of which are derived from composite commodities. Total consumption is an aggregation of household and government consumptions, while investment is generated by the savings-investment account. Aggregate investment is fixed in quantity, reflecting the investment-driven nature of the economy. Finally, a small-country assumption is adopted for the import side, making the domestic economy a price taker of imported products.

Appendix 10.2.2 **Final Demand in Domestic Economy**



On the supply side, outputs were specified as a multilevel nesting of constant elasticity of substitution (CES) functions. At the top level, the domestic output was specified as an input-output (Leontief) function of intermediate inputs and value added. The intermediate input consumption was set as a CES aggregation of domestically produced and imported commodities, allowing for imperfect substitution between the two commodities (with different degrees of substitution reflected in the values of substitution elasticity). The value added is a CES function of different labor categories and types of capital. Total production is then allocated to domestic demand and exports through a constant elasticity of transformation.

Appendix 10.2.3 **Total Production Function**



Appendix 10.3

Implementation of the CES Function

The Armington (1969) assumption of imperfect substitutability between two products of different origins implies that total domestic demand *Qi* is a constant elasticity of substitution (CES) function of domestically produced and imported commodities:

$$Q_i = A_i\left[\alpha_i M_i^{-\upsilon} + (1-\alpha_i)D_i^{-\rho}\right]^{-\frac{1}{\rho}} \tag{1}$$

with *Di* as demand for the locally manufactured good, *Mi* as the demand for the imported imperfect substitute, *Ai* a scale parameter and the elasticity of substitution given by: $\varepsilon_s = \dfrac{1}{1+\rho}$. The maximization problem is to minimize cost: *PQiQi* = *PDiDi* + *PMiMi* subject to the Armington function. We obtain the relative demand for imported versus local goods as a function of their relative prices:

$$\frac{M_i}{D_i} = \left[\frac{PD_i}{PM_i}\frac{\alpha_i}{1-\alpha_i}\right]^{\varepsilon_s} \tag{2}$$

Given price normalization, the volumes of demand for both domestic and imported products are directly provided by the social accounting matrix. The only parameters to be calibrated therefore are the share and scale parameters. For a given external estimate of the elasticity of substitution, the share parameter is easily computed by inverting the above import demand equation. The scale parameter is then obtained by inverting the Armington function.

Similarly, export supply may be represented, depending on the destination, by a constant elasticity of transformation function that takes a form similar to that of the CES:

$$X_i = \beta_i\left[\alpha_i \mathrm{E}_i^{-\varphi} + (1-\alpha_i)D_i^{-\varphi}\right]^{-\frac{1}{\varphi}} \tag{3}$$

with $\varepsilon_t = \dfrac{1}{\varphi+1}$ as the elasticity of transformation, $-\infty \prec \varphi \prec -1$ and $-\infty \prec \varepsilon_t \prec 0$.

Export supply resulting from the maximization of profits to the producers reads as follows:

$$\frac{D_i}{E_i} = \left[\frac{PE_i}{PD_i}\frac{1-\alpha_i}{\alpha_i}\right]^{\varepsilon_t} \tag{4}$$

Findings and Conclusions

Main Findings

Poverty refers to deprivation of certain essential goods and services. It is a multidimensional concept, covering not only income but also other equally important non-income aspects, since two households having the same per capita income might have different welfare levels because of their differences in the non-income aspects. The overarching goal of the Asian Development Bank (ADB) is poverty reduction. Given the current poverty situation in Asia and the Pacific, the challenge ahead is daunting. The latest indicators, for instance, show that developing member countries (DMCs) of the ADB seem to be moving toward achieving MDG No. 1 of halving poverty by 2015. This, however, means that the poverty incidence rate would still be around 17 percent in 2015 as the starting point of the rate in 1990 was about 34 percent. Fortunately, serious concern over poverty reduction among various stakeholders outside ADB is also evident. This is reflected, among other ways, in the Millennium Development Goals (MDGs) and in the increasing number of pro-poor programs by various institutions. In this context, poverty impact analysis (PIA), in addition to other impact assessments, is very important in ensuring that programs reach the right beneficiaries.

This book deals with impact assessment issues, particularly on developing tools and providing examples of their applications. The main contributions of the book are in the areas of identifying the poor, mapping poverty, and performing impact analysis using CGE modeling frameworks.

Poverty Impact Analysis

PIA aims at bringing about better allocation of resources–a goal that has become increasingly important for developing countries, where resources are scarce. PIA essentially examines a project or program to see whether it has generated its intended effects on the targeted group. Findings from a PIA provide critical feedback for officers and policy makers to help them better design and implement ongoing as well as future programs. PIA results can help project officers be more accountable to the donor community and general public, especially regarding the relevance and management of the project.

Each PIA design is unique–it depends on many factors such as the project's main purpose, data availability, local capacity, budget constraints, and time frame. Two important aspects of PIA include: identifying the poor and measuring the project impact on the poor. The latter can be conducted by developing the right counterfactual such as in the computable general equilibrium (CGE) modeling framework.

Development and Application of the PIA Tools

The Economics and Research Department of ADB has conducted a series of research studies to develop tools for a PIA that maximizes the use of available information and techniques for the different stages in PIA. There are five different tools discussed in this book:

- poverty predictor modeling (PPM) for identifying the poor at the household level;
- poverty mapping for identifying the poor over geographical areas;
- CGE modeling for assessing the economy-wide effects and distributional implications of wide-ranging issues on the economy with representative household groups (RHGs);
- CGE-microsimulation modeling for conducting assessments such as in CGE modeling but with a complete household data set; and
- poverty reduction integrated simulation model (PRISM), which is essentially an integration of CGE-microsimulation modeling and poverty mapping using a geographic information system (GIS) application in a dynamic, interactive, and user-friendly way.

The identification of the poor is very important since they are the main beneficiaries of pro-poor programs. At the household or individual level, this can be conducted through PPM by relying on household attributes or poverty determinant variables.

PPM provides a practical alternative to the time-consuming and expensive way of collecting data on income and expenditure for assessing poverty at the local levels. With PPM, the poverty predictor variables can be transformed into a short questionnaire for a quick survey to replace the long questionnaire of household income and expenditure surveys. The quick survey was pilot tested in the People's Republic of China (PRC), Indonesia, and Viet Nam.

In addition, there are other ways of assessing the poor such as by using independent assessments from respondents, enumerators, neighbors, and village chiefs to determine the poverty status of respondents. The use of these assessments was also explored in the pilot surveys to provide alternative and more participative ways of classifying the poor that can complement the result based on the household income and expenditure survey.

Identifying the poor over specific regions or areas was conducted through poverty mapping. The technique basically maximized the rich information of surveys and the wider coverage area of censuses to estimate reliable poverty indicators for more disaggregated geographical areas. The estimation was based on the modeling relationship between poverty indicators and some common variables available in both surveys and censuses. The results were then "mapped" on census data to get estimates of poverty indicators for a wider coverage area.

The next aspect of PIA, identification and measurement of the impact, can be conducted by using quantitative or qualitative methods, or both, including developing a counterfactual to minimize selection and other biases. On the measurement issue, PIA measures could include a broader concept of poverty measures beyond the general poverty measures, such as headcount ratio, poverty gap, and poverty severity. In some cases, other poverty or well-being indicators might be more relevant since many pro-poor programs do not necessarily directly target the poor household, instead they work through increasing employment or improving access to various services such as education, health, and sanitation.

In the economy-wide context, a CGE modeling framework can provide "with" and "without" scenarios, and therefore provide a solid counterfactual. This approach also provides information about the impact transmission mechanism, detailing how the intervention affects different workers, households, and markets in the economy. The poverty impact in the CGE context, however, can only be examined at the RHG level. To examine poverty impact at the household level, the CGE modeling is linked to a household data set in the CGE-microsimulation modeling. Furthermore, in the PRISM, the CGE-microsimulation model is linked to a GIS application in a user-friendly way to make the spatial dimensions of the PIA interactive and easy to use.

Identifying Poor Households

Household income or consumption data for a particular area are not easy to gather. Household surveys to collect such data are costly and based on samples, which may not be representative of the particular area concerned. Hence, there is a need for identifying poor households in the area targeted for policy intervention or impact analysis. The methods used for predicting the household poverty status based on easily collected and verifiable household attributes are the consumption correlate model, logit/probit model, and principle components analysis. All three methods were implemented for Indonesia, the first two for the PRC, and the first for Viet Nam.

The first method predicts per capita consumption expenditure using predictor variables that are highly correlated with it; such as possession of land and other durable assets, household demographics, education level, occupation, house type and size, and access to services. The predicted consumption expenditure can then be used for determining household poverty status. The second method also uses similar predictors, but the dependent variable has binary values of *1* and *0* representing poor or not. In the third method, an asset index is constructed following Filmer and Pritchett (1998a) by pulling out a few linear combinations that best capture the common information from a large number of variables. Even though they referred to the bottom 40 percent of households in the asset index as poor, they did not intend to use the asset index for a poverty measure. However, given that household assets are closely correlated with income or consumption, it is natural to use this variable as a proxy indicator for arranging households on a poverty scale. For classifying poor and nonpoor, the authors use a cutoff point below which the proportion of the poor would be the same as that obtained directly from consumption survey data.[1]

The survey-based evidence shows that the predictors do serve the purpose, for they are able to identify most of the poor. The studies also included perceptions of respondents, local officials, and enumerators that tally predominantly with the poverty ratio. Perception analysis is based on direct questions on whether a household could be regarded as poor or not and the answer would normally be in reference to a local standard that is not necessarily the same across all respondents. Therefore, the results could be more a measure of relative poverty than absolute poverty since subjective judgments are involved.

On the similarity of perception results of respondents, local officials, and enumerators, the enumerators might have played a key role in explaining the poverty concept. Notwithstanding the possibility of subjectivity, the fact that results tally closely with those based on consumption criteria implies that properly trained enumerators could by and large identify poor households. This obviously serves a verification purpose. Perception of the poor is important for both identifying the poor and for impact assessment.

1 A simple but similar alternative is to assign scores for various household assets and identify poor households if they get a total score below a critical level. This approach is adopted in India for identifying below–poverty line households for several government interventions. A similar procedure is also applied in Indonesia to classify poor people based on 14 predictor variables in the latest census of poor people targeted for the fuel subsidy program.

It is important to know what the poor conceive as poverty, their ability to overcome it, and the opportunities and risks they foresee.[2]

Indonesia. The three methods to predict poverty were implemented by using the National Socioeconomic Survey (Susenas) data set. The results show that the consumption correlates model is the best approach, predicting poverty correctly for more than 60 percent of respondents in urban and rural areas. Prediction for rural areas is 52.7 percent accurate, while prediction for urban areas is 49.6 percent accurate.

The rough guide to predicting poverty in Indonesia would be based on information about asset ownership, education level, and consumption pattern. Variables that correlate with poverty, either negatively or positively, are: ownership of car and refrigerator, education level, household size, and consumption of milk and beef. The roles of household characteristics such as employment status of household members and access to facilities in explaining poverty are relatively small but significant.

Results from the validation survey show that the effectiveness of poverty predictors for rural, urban, and total, are 83.4 percent, 86.6 percent, and 77.3 percent, respectively. The numbers demonstrate a high accuracy of predicting the poor. The shares of nonpoor households predicted as poor in rural and urban areas, are only 9.9 percent and 7.4 percent, respectively, while poor households predicted as nonpoor in both areas are 6.7 percent and 6.1 percent, respectively.

If the results of applying different methods of independent assessment or perception are also used, i.e., by concentrating only on the group of respondents having consistent poverty status based on expenditure survey and independent assessment, the effectiveness of prediction increases to 93.1 percent, 82.2 percent, and 91.0 percent, respectively, for rural, urban, and total.

The People's Republic of China. Poverty predictors based on easy-to-collect individual, household, and community variables in the PRC were estimated using multiple regression and logit models. The estimation used data from the PRC's Rural Poverty Monitoring Survey. The results show that both models can accurately predict the poor by over 50 percent. The significant predictor variables include household characteristics such as productive age (15–60 years old) of family members, household composition, and number

2 A poverty reduction policy involving credit, for instance, must consider willingness of the poor to take risks in building new small enterprises by borrowing to improve their conditions. Such participatory methods could be extended to impact assessment through focus group discussions.

of school age children. Also important are the characteristics of household head, such as gender, age, and education level. Other important predictors are household possession of a telephone, truck, TV set, livestock, or large grain storage. Land resources, difficulty in collecting fuels, participation in insurance programs, use of gas or coal for cooking, a big event taking place within the year, and participation in community activities are also important variables in predicting poverty. From the community variables, households living in villages designated as poor villages or encountering natural disasters and having less access to roads, tend to have low per capita consumption.

The validation survey results show that the poor are correctly predicted by more than 80 percent. The prediction uses a logit model and CNY1,500 as the poverty threshold. In general, households having low income or facing limited access to income sources tend to be poor. As the predictors were initially derived by correlating the household's per capita consumption expenditure and the household's characteristics, these predictors reflect the relevance of purchasing power as a factor in defining poverty. In addition, because the predictors were also derived using local perceptions of poverty, they likewise could, in principle, encompass the multidimensional aspects of poverty that include not only the level of income but also other "local" factors that make a household socially and economically disadvantaged.

Viet Nam. The development of PPM in Viet Nam was conducted in four stages:

- examining the relationship between poverty and household characteristics using a multiple regression model and data from the 2002 living standards survey;
- testing the significant predictors using 1998 data to examine the consistency and stability of the models across time;
- implementing the same modeling procedure in two provinces of the North Central Coast to further test the methodology and to examine whether poverty predictors may be different at a more disaggregated level; and
- generating poverty predictors and a short questionnaire for high-frequency implementation of data collection at the local level.

Overall, PPM in Viet Nam performs well across different data sets. The predictor variables include ownership of assets (such as TVs and motorbikes), demographic characteristics (number of dependents and working family members, education status), and housing conditions.

Poverty Mapping

Poverty estimates at national or provincial levels are commonly available from household income or expenditure surveys. Sample size and distribution normally do not permit estimates at a smaller administrative or geographical level with adequate precision. This makes the poverty indicators less useful for poverty reduction programs with a small coverage area. Following the small-area estimation technique developed by Rao (1993), Elbers, Lanjouw, and Lanjouw (2003a) developed and applied a poverty mapping method to estimate poverty indicators for small areas. This method has now been applied in many countries. The technique maximizes the rich information of surveys and the wider coverage area of censuses by developing a regression model to estimate income or consumption based on common independent variables available in the household survey and census, and predicting poverty indicators for smaller areas based on applying the regression to census data. This census-survey matching method is to fill the gap in dealing with small-area poverty estimates such as for districts or even smaller administrative areas.

Poverty mapping has shown to produce reliable poverty estimates for areas consisting of as few as 15,000 households. Such estimates are obviously very helpful for resource allocation in poverty reduction programs, for impact analysis of welfare programs, and for monitoring. The technique's use could be broadened to other areas such as access to education or health service. [3]

The poverty mapping in Indonesia used data sets of the 1999 SUSENAS, 2000 Population Census, and 2000 Village Census. The results show that reliable poverty indicators can be generated at the subdistrict level with standard errors of estimates at less then 10 percent. At the village level, however, the standard errors increase to nearly 14 percent, making the estimates less reliable.

An interactive and dynamic GIS application of the poverty mapping results is then developed to enhance the spatial aspects of poverty analysis. The GIS application is to display spatial poverty characteristics as well as to visualize meaningful relationships between poverty indicators and other poverty-related data. The tool for doing this is called Poverty Related Information System for Monitoring and Analysis or, simply, PRISMA.

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3 A 2006 World Bank research evaluation has, however, questioned the accuracy of poverty mapping estimates since these estimates may be biased due to the presence of spatial correlations. Thus, it would be prudent to use poverty mapping results as a broad indicator that supplements other available welfare indicators.

PRISMA provides meaningful information useful for poverty monitoring and analysis. In presenting the poverty indicators, the system adopts a "traffic-light" classification system of red, yellow, and green to represent high, average, and low poverty incidences. Thematic maps are generated to show spatial distribution of one or more specific data themes for a particular geographic area. Menus of geographic disaggregation, population, household, and poverty characteristics are available and can be combined with other features. Users can accordingly overlay poverty indicators with other poverty characteristics in bar charts, alter the flexible traffic-light classification of the thematic map, present detailed information about a province or district, export of maps for use in other software applications, and print outputs.

CGE Modeling Frameworks

The CGE economy-wide modeling frameworks consider optimal behavior of economic agents like consumers and producers and are built using a social accounting matrix that considers economic transactions among various sectors and agents in the economy in a consistent manner. These frameworks are suitable for policy simulations with economy-wide repercussions, such as trade liberalization discussed in this book. The model's benchmark reproduces the functioning economy in the base year when there was no policy change. Trade liberalization is then introduced by reducing tariff or nontariff barriers, or both, that will change imports, exports, and domestic prices. Prices in protected sectors fall following the trade barriers' removal and, hence, trade liberalization leads to resource allocation across sectors. Changes in commodity prices, demand, supply, employment, wages, and profit levels corresponding to a new equilibrium lead to changes in national income and its distribution across income groups. These effects are examined by comparing two equilibrium scenarios of *with* and *without* trade liberalization.

Many DMCs have adopted a two-pronged strategy for poverty reduction: economic growth enhancement and direct poverty reduction programs. A CGE modeling framework could be developed for ex ante PIA under both types of programs. It is important to note, however, that there is no single model that fits all programs. Sectors, agents, and linkages in a trade-driven growth strategy would, for example, be different from those in an infrastructure-led growth strategy. Similarly, impact analysis of direct poverty reduction programs on a fair-price scheme for the poor would require a model with different layers of commodity price structures, while an analysis of an employment-generation scheme would detail labor market features.

CGE modeling framework results have provided analytical support for carrying out economic reforms in many developed and developing countries by indicating the quantitative magnitude of welfare increase from reforms. With appropriate household grouping, the major gainers and losers from policy changes could be identified from a model's simulations. Compensation mechanisms could be devised to make all major stakeholders improve their welfare. This process provides insights on how a broad consensus for certain reform packages can be attained (See Parikh et al. 1997 and Panda and Quizon 2000 for similar exercises).

While these frameworks are not commonly used for impact analysis of a specific project, a combination of projects in a particular sector might amount to a kind of policy change with macroeconomic impact. Large-scale poverty reduction programs have an impact on the entire economic system as well as other policy reforms. To capture their impacts, the underlying CGE model must reflect country-specific structural features and generate the right counterfactual, providing the "before-and-after" approach in impact analysis.

Note that PIA carried out through the CGE model might be interpreted as ex-ante impact assessment that could be useful for designing better programs and policies. It allows judging of alternative programs using optimal criteria such as maximizing poverty reduction at a given cost. High-cost projects could thus be avoided. In some cases, trade offs between growth and poverty reduction could be better understood. Similarly, there is a scope for improving a program's effectiveness by reducing leakages. Impact analysis under alternative leakage parameters could help in examining the benefits of controlling the leakages (see Narayana, Parikh, and Srinivasan 1990). Ex-post program monitoring could help in verifying whether the anticipated assumptions on exogenous variables and parameter changes materialized or not. Incorporating the new parameter values consistent with ex-post realization could turn the ex-ante evaluation into an ex-post one.

Anticipated parameter changes corresponding to a simulation run must be clearly spelt out while assessing the policy impact. For example, policy analysis aimed at providing better access for poor groups in employment-generation programs might change the distribution parameter for the poor from such programs. The models might be very sensitive to changes in some key parameters and their values must be chosen after careful scrutiny of the database and the relevant literature.

In CGE models, representative households consist of large groups and might not be homogenous enough for certain programs or policies. Given the differences in income sources and consumption patterns, some households within the group might benefit while others might lose, and average values are not very helpful in such cases. Extending the CGE model to microsimulation is an attempt to extend economic effects analysis, such as prices and wages, to individual household–level data in a survey and is useful to capture intra-group heterogeneity which is an important consideration in PIA. Integration of CGE microsimulation with GIS, such as in the PRISM, adds further value to the spatial dimension of PIA.

Overall, CGE models provide a method of analyzing economy-wide effects of macroeconomic policies. With extensions to new techniques, like microsimulation and poverty mapping, it is possible to examine the poverty impact of macro policies at the micro level. Such approaches would be more satisfactory in the future when micro foundations of macroeconomic analysis are developed. Despite the caveats, CGE-modeling frameworks do help enhance our knowledge of PIA for different types of economic policies.

CGE Modeling Application

Can the Poor in Indonesia Benefit from Trade Liberalization? Agricultural trade barriers remain prevalent among developing countries, raising important questions on whether there is justifiable reason for agricultural protection and what effects might result from farm trade liberalization. Furthermore, as most farm producers are poor farmers, there is also an issue on whether the poor would benefit from trade liberalization.

The CGE model is employed to address these issues by simulating what the likely effects of the Doha Development Agenda would be for a developing country such as Indonesia. The assessment is conducted at the economy-wide level, including welfare and distributional implications for different household groups. Moreover, to view agricultural protection in a broader context, the assessment includes the welfare costs of existing sectoral taxes.

Three scenarios are simulated: a complete removal of tariffs on agricultural products, the first scenario combined with a complete removal of domestic taxes on agricultural products, and full tariff liberalization. The overall results suggest that a removal of agricultural tariffs alone will generate adverse effects, while its combination with the removal of agricultural taxes will create benefits for the economy, households, and the poor. Single sector trade liberalization does not seem a good strategy but more comprehensive trade reform is desirable. In addition, the results of the last simulation provide further evidence of the inefficiency of raising revenue through commodity taxation.

Moreover, the results of near marginal tax incidence indicate that nearly all sectors have already been overtaxed, except for utilities. The existing tax system has distorted the economy so that a unit of revenue collected increases welfare loss. A further elaboration of the welfare costs of the existing commodity taxation reveals that some sectors are relatively much more distorted than others. This applies to both tariffs and domestic indirect taxes, even though the welfare costs of tariffs are relatively less than those of domestic taxes.

Contrasting the first two simulation results further confirms that existing taxation on domestic agricultural commodities is an expensive way of collecting revenue as shown by its associated welfare costs and the potential benefits from its removal. The first simulation results indicate that increasing market access alone will generate more adverse effects for the domestic economy, since all other distortions remain. This policy does not stimulate domestic production, increase employment, or improve welfare. Perhaps, most importantly, the result is not pro-poor. The results of the second scenario, however, are very promising. The removal of both agricultural tariffs and domestic taxes boosts domestic production, which have positive ramifications on the economy. Welfare is improved and the poor benefit.

The detailed results also show that full benefits of trade liberalization cannot be obtained by piecemeal trade liberalization. Liberalizing one sector alone will generate misleading signals for resource allocation. The full tariff liberalization scenario yields the greatest benefits for the poor and for the economy as a whole. This calls for more comprehensive trade liberalization, aligned with domestic industrial and other policies. The government could expand the benefits by further liberalizing both international and domestic markets. This, however, requires strong commitments as well as collaboration with other trading partner countries. The latter is essential since unilateral trade liberalization is not a desirable a course of action, reflecting a key role for the World Trade Organization.

Infrastructure Development and Poverty Alleviation in the PRC. This study assesses the contribution of infrastructure development to poverty reduction in the PRC using a CGE model with disaggregated households, segmented urban and rural labor markets, and endogenous labor supply. The short and long-run implications of improved infrastructure on poverty alleviation are analyzed.

The simulation results show that in the short term, the increase in infrastructure investment promotes outputs of related sectors and creates more employment opportunities for rural migrants, which benefits rural households. From a long-term perspective, the development of infrastructure reduces migration costs and promotes urban employment of rural migrants. But under the background of full employment and restriction of labor mobility, the urban households share more benefits from economic growth and improvement of agriculture labor productivity. However, if the policy loosens the restriction on labor migration from rural to urban areas and makes more rural migrants employed in urban areas, then the welfare of those poor rural households will improve. Reducing transfer costs and promoting employment in urban areas for rural labor are, therefore, the key approaches through which infrastructure makes contributions to poverty reduction.

Higher infrastructure investments promote economic growth and improve all rural households' welfare by creating more off-farm and urban job opportunities. However, as more rural migrants try to work in urban areas, the competition in the urban labor market becomes more intense, bringing adverse effects on the income and well-being of urban households.

The most direct benefit brought by infrastructure improvements to the poor is the reduction of migration costs, which stimulates labor productivity growth in the long run. The lower the migration costs, the more the rural households benefit. Lower migration costs alone, however, have limited effects on economic growth and rural poverty reduction. The improvement of agricultural labor productivity strongly promotes economic growth, but the distribution of the benefits is determined by the scale of labor migration.

CGE-Microsimulation Modeling Application

Economic and Poverty Impacts of Trade Liberalization in Indonesia. The rapid pace of Indonesia's unilateral trade liberalization and the imminent agricultural liberalization arising from the DDA, have been the subject of policy debates. To address this issue, CGE linked to a microsimulation model of the Indonesian economy was developed.

Three policy experiments in line with DDA were undertaken in the study. These are: full elimination of tariffs on agricultural imports, full eliminations of tariffs and indirect taxes on agricultural imports and products, and full elimination of all tariffs on imported products.

The results indicate that removing agricultural tariffs alone generates adverse effects, while the removal of agricultural tariffs coupled with the abolition of agricultural taxes benefits the economy, households, and the poor. An alternative strategy of more comprehensive liberalization involving all sectors, seems the best scenario as the degree of poverty reduction also intensifies. Hence, the general results seem to indicate that the existing tariffs are not only distorting to the economy but are also not pro-poor.

The prevalence of agricultural protection may not be beneficial to the Indonesian economy in the long run, as can be seen from the simulation results of only eliminating agricultural tariff. The presence of cheap agricultural imports as a result of the policy will induce consumers to substitute toward them, resulting in agricultural output contraction and a reduction in the income of farm workers. National poverty headcount, poverty gap, and poverty severity increase. This implies that the already poor, especially agriculture dependent households, become poorer.

In contrast, a more proactive stance of adopting complete farm trade liberalization in which tariffs and indirect taxes on agricultural products were also removed, appears more promising. The policy is consistent with the DDA and seems beneficial to the economy and the poor. Agriculture, industry, and services outputs expand, resulting in an increase in factor returns. In particular, wages of agricultural laborers increase substantially, suggesting that they benefit from the resource reallocation effects. They benefit most especially when compared with other workers. To a large extent, the abolition of domestic agricultural taxes allows domestic agricultural producers to compete with agricultural imports. Disposable incomes of all households increase, while the cost of the commodity basket falls, leading to poverty reduction. As a result, headcount ratio, poverty gap, and poverty severity fall, indicating an improvement in the overall poverty condition.

The last alternative of full tariff elimination appears the best poverty reducing policy. Industrial and services outputs expand, while agricultural output contracts. Industrial exports and imports increase, while agricultural and service imports fall, thereby sustaining the trade surplus. Resources are reallocated away from agriculture toward industry and services. The adjustment impact is a decline in wages and, consequently, income for almost all households. However, this fall is outweighed by the reduction in consumer prices as a result of tariff elimination. Hence, poverty decreases substantially. Nonetheless, the decline in poverty is higher among nonagriculture dependent households, especially those residing in urban areas, where poverty incidence is already the lowest. This benefit may stem from the ability of nonfarm workers to take advantage of additional opportunities as a result of the expansions of the industrial and services sectors. Accordingly, the main challenge for the government is to implement complementary policies especially targeted to farm workers and the poor. Through improved access to the labor market, they would then be able to take advantage of the opportunities being offered by trade liberalization and the DDA.

PRISM—Poverty Reduction Integrated Simulation Model

A CGE-Microsimulation Model linked to a GIS Application. PRISM is an online modeling tool that combines a CGE-microsimulation model and a GIS application for poverty mapping for spatial analysis. All complexities of the modeling aspects are interfaced in a user-friendly way so that users can run simulations and conduct some analyses online with ease.

The modeling tool allows users to conduct scenario analysis by changing some policy parameters in the model, running the simulation, and getting the results online. The economy-wide effects of any changes as a result of the simulation are presented in graphs and tables, which can then be copied to other computer applications. Moreover, the poverty impact for selected regions, provinces, and districts in a country is also presented in dynamic and interactive GIS map to allow spatial analysis to be conducted in an intuitive way. A comparison of poverty impact indicators of two different scenarios has also been made possible with a dual-window, map-viewing facility.

PRISM was developed using the Philippines' CGE-microsimulation model based on the 1994 Social Accounting Matrix and 1994 Family Income and Expenditure Survey. Incorporation of other countries in the system is possible, especially for those countries which already have CGE models developed such as Bangladesh, PRC, Indonesia, Nepal, Pakistan, and Viet Nam.

Trade Liberalization in the Philippines: The Need for Further Reform. The importance of trade liberalization in reducing poverty has received considerable attention from policy makers. Tariff reduction alters relative prices of domestically produced and import goods, leading to the reallocation of resources. The effects on the poor can be traced through several transmission mechanisms such as household income, consumption, unemployment, wages, and relative prices. This study examines the tariff reduction effects on the economy and poverty in the Philippines in 1994–2000 by employing PRISM. Detailed individual household data are integrated in the model to capture the interaction between policy reforms and individual household responses, and their feedback to the general economy. Three scenarios are examined in the paper, namely, low uniform tariff reduction, actual tariff reduction, and full trade liberalization.

Results reveal that, among other effects, tariff reduction reduces domestic prices of imported and locally produced goods. The decline in import prices results in higher imports, while the drop in local prices increases export competitiveness, which in turn promotes higher exports. The nonfood manufacturing sector benefits from both capital reallocation and labor movement. Agricultural wages decline as a result of a drop in agricultural output. The contraction leads to higher unemployment in agriculture. Furthermore, the contraction results in lower capital return in agriculture, lowering rural household income. On the other hand, with the resource reallocation effects favoring industry, particularly nonfood manufacturing, the wages of production workers and capital return in industry increase. Finally, the decline in composite prices as a result of tariff reduction leads to a lower poverty threshold for a given commodity basket leading to favorable effects on all poverty indices. Poverty reductions, however, vary considerably across different household groups.

Limitations of the Studies

The five modeling frameworks discussed in this book are essentially diagnostic tools that can all contribute to the implementation of a comprehensive PIA. Each tool can be used alone or in combination with others at different stages of PIA.

Due to time and resource constraints, however, the tools developed in this book did not cover the whole spectrum of PIA techniques available to policy makers and researchers. The book focuses only on the tools developed by ADB's Economics and Research Department.

Another obvious limitation is that this volume lacks actual examples of projects in which the tools were used. Even though applications of the modeling tools tried to emulate actual policies or policies that could have been adopted by the government or other stakeholders, the selected scenarios may not fully capture the way actual projects, programs, or policies are implemented.

Key Challenges

Conducting a comprehensive PIA for a general project or for a project specifically designed to assist the poor remains a challenge. The difficulties start with getting the key stakeholders to agree to do it. Should they agree, technically complex and difficult issues have to be addressed such as identifying the project's beneficiaries and measuring actual project impact that should be attributed only to the project and free from selection bias.

Many attempts to conduct PIA mostly suffer from insufficient analytical rigor, wrong questions being addressed, and inappropriate timeframes. As a result, there is no single comprehensive PIA that serves as a prototype. This fact is made worse by the requirement that each PIA should be unique, i.e., specifically designed for a particular purpose and for characteristics peculiar to the project being assessed. Therefore, it is not surprising to find that we still know very little about the actual impact of projects on the poor. Moreover, available data are often not useful for conducting a comprehensive PIA and using the data leads to misattributions in terms of timing, topical relevance, and geographical coverage.

On the other hand, people are increasingly aware that good PIA will be very helpful in improving resource allocation. Information from good PIA can be used to help weed out defective pro-poor programs or projects and identify the most effective ones.

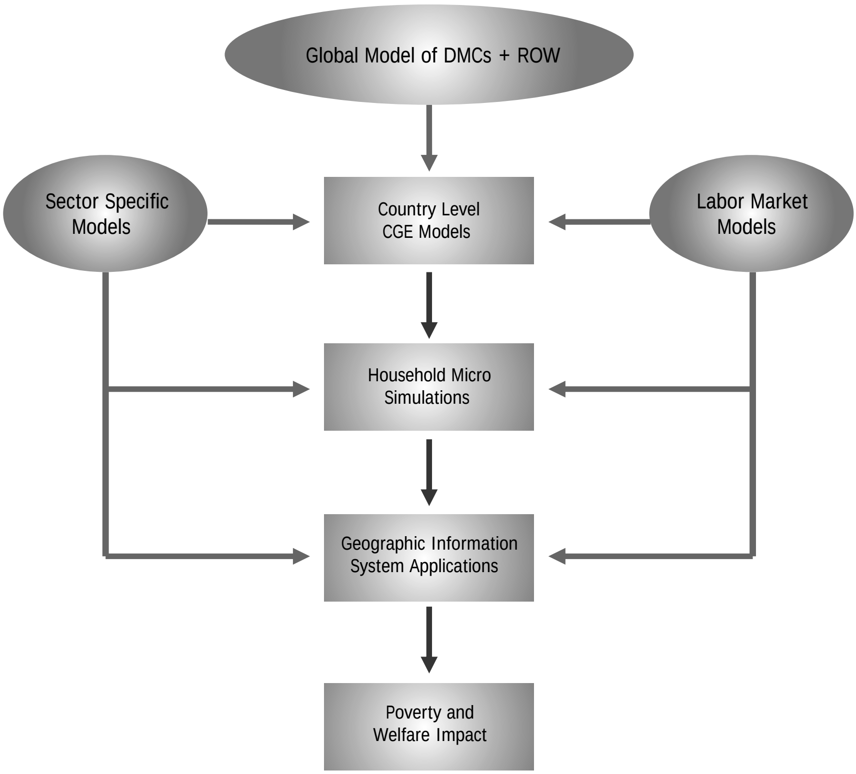
The challenge remains to find ways to conduct a comprehensive PIA which adopts an analytically rigorous approach, answers the right questions, and uses the right timeframe. Specifically, other key challenges include:

- providing more comprehensive and rigorous macro-micro linkages in the modeling tools used;
- focusing on the dynamism of policy interventions and how they affect the overall economy as well as groups targeted by the interventions;
- integrating long-term growth considerations in modeling aspects;
- combining available techniques or approaches in a meaningful and integrative way;
- maximizing all available information from secondary and primary sources starting from general to more specific issues, hence, addressing the issues concerned in a systematic and comprehensive way;
- providing some scenario and sensitivity analyses in the modeling tools developed to provide better and more complete information about all likely impacts; and
- making PIA modeling tools as user-friendly as possible such as by automating some PIA activities to make them easily replicable across topic, sector, or even country.

In terms of modeling aspects, a complete link to the various modeling approaches at global, national, local, and household or individual levels can be provided in a user-friendly way, as partly demonstrated in the PRISM. The schematic representation below illustrates the proposed user-friendly and comprehensive modeling system. At the top level is a global CGE model representing some important DMCs and the rest of the world that link to the individual CGE-microsimulation models and GIS applications. The last two have been integrated in the PRISM.

Moreover, different kinds of modeling tools related to the labor market and for some specific and relevant sectors such as education, health, agriculture, manufacturing, and service sectors can also be incorporated to further enhance the performance of the individual CGE-microsimulation models. In addition, the individual labor market and sectoral models can also be linked to a GIS application to produce separate spatial analysis of the labor market and other sectoral issues. With a complete modeling framework, PIA on wide-ranging issues could be comprehensively conducted and the impact of programs and projects to reduce poverty could thus be traced at global, national, and individual levels.

A Blueprint for PIA Modeling Development and Applications



Source: Authors' blueprint.

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