Discounted Cash Flow

The phrase "discounted cash flow" is increasingly met with in discussions of development projects as well as in regular commercial enterprises. The author explains what is involved.

George B. Baldwin

DISCOUNTED CASH FLOW stands for a modern and fast-spreading technique for the evaluation of investment proposals. The world of money and finance has understood DCF (without calling it that) for as long as compound interest has been with us, which is quite long. But a lot of businessmen and economists have discovered only within the past decade or so how useful and important this concept is.

The ordinary language of business treats the rate of profit as the ratio of (a) accounting profit in a representative year to (b) the amount of capital tied up in the enterprise, as measured by Net Fixed Assets or Net Fixed Assets plus inventories. It is a one-year figure, for some actual *or representative* year, after deducting allowances for taxes and for depreciation; both these items can be highly arbitrary. Furthermore, the ordinary one-year measure of profitability takes no account of the length of time that may separate the capital expenditures and the returns they eventually produce. The Discounted Cash Flow method can often give us a much better measure of a project's profitability, for three main reasons:

- DCF washes out year-to-year variations in profit and gives us a single valid figure for the whole life of the project.
- DCF automatically takes into account the timing of cash payments and receipts, so that no one can neglect the importance of this factor.
- DCF gets around the difficulty of interpreting what accountants mean by "profit" and gives us a simple, unambiguous definition based on project earnings over the entire life of a project.

All these points are well known to those already initiated into the mysteries of DCF. But others cannot hope to understand these claims for the method until they have gone back to "square one." First one has to understand what a Cash Flow is, why and how to discount it, and then what one can do with a DCF once he has it.

Cash Flow and the Capital Cycle

The story begins with cash—with liquid capital in search of investment opportunities. This is the time when those in control of capital have freedom of decision over how they will use it. This freedom is not something that occurs only once, at birth, in the life of a project or an enterprise. It recurs throughout a project's existence as part of the life cycle of resources as they go through the process of conversion from cash into physical resources and then back again into cash. Whenever capital reappears as cash during this cycle someone is free to redecide whether and how to put it back to work; this is the significance of the cash-flow cycle.

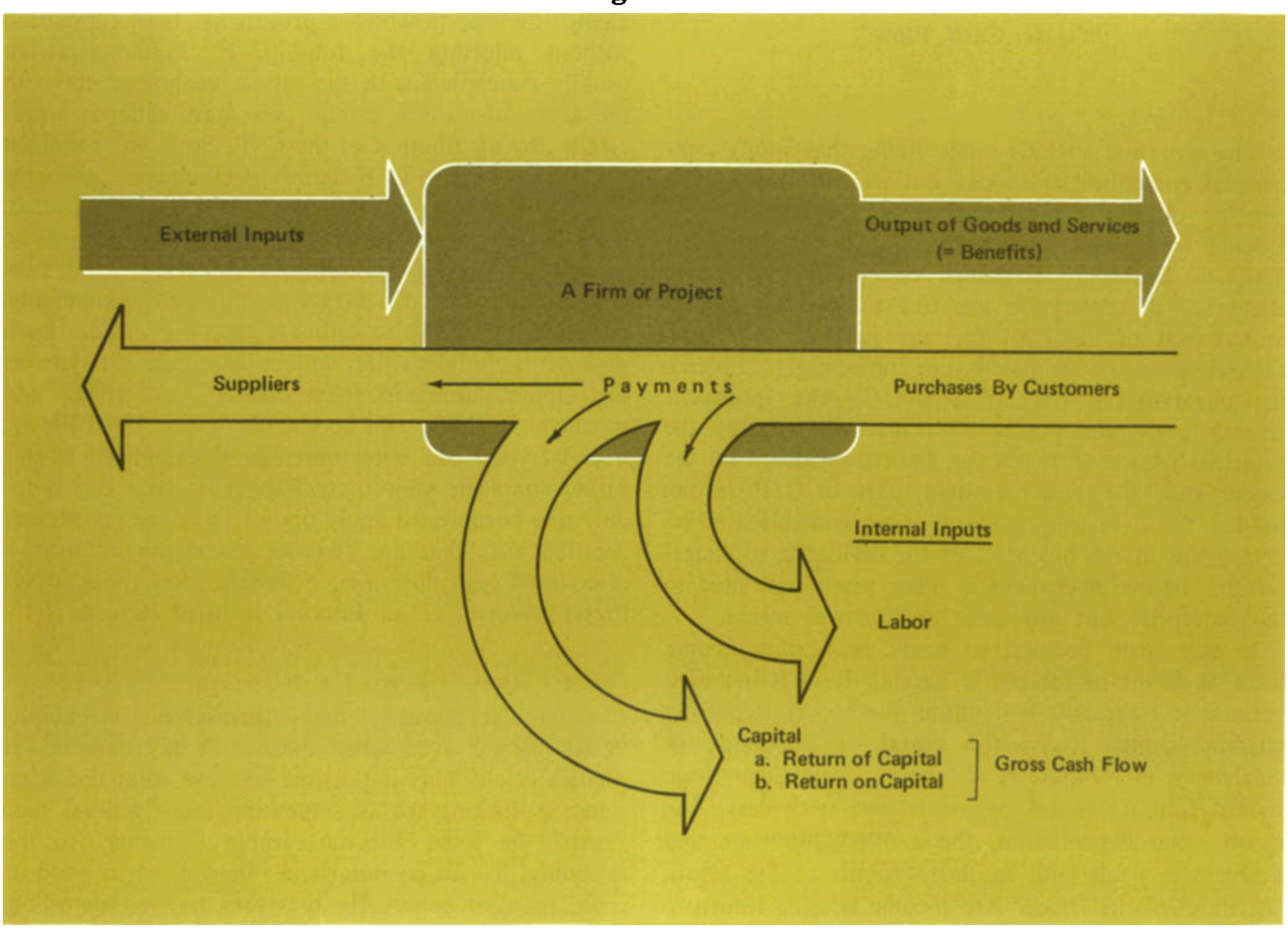
Schematic Construction of a "Cash Flow"

Every project has cash flowing into and out of its accounts, both during construction and after operations begin. These flows include capital funds for construction; the cash receipts (total cash income) after operations start; outflows of funds to suppliers for raw materials, fuel, electricity, and for transport, banking, and advertising services; regular weekly or monthly payments to labor; interest and debt amortization payments to bankers or bondholders; dividend payments to shareholders; and tax payments to government. Which of these flows of cash is *the* "cash flow"? None of them. The "cash flow" (C/F) refers to one specific stream of cash, one that can be derived from those named but one we have not yet separated out.

The central idea in identifying the C/F is easy: it consists of inflows of funds that "belong to capital" i.e., that represents the remuneration of capital in whatever forms it may take. The derivation of C/F is represented schematically in Figure 1, where the solid lines represent physical flows and the dotted lines represent the flows of cash which correspond to them but move in the opposite direction.

The remuneration of capital takes many specific forms, and depends on the legal and institutional arrangements under which the project's capital has been assembled. For example, a revenue-producing project financed 100 per cent by owners' capital obviously

Figure 1



will not pay any interest on borrowed capital nor any rent for rented capital. The same project might conceivably have been financed 100 per cent by debt, with no equity and no rented assets. Calculations of C/F, when made for purposes of *economic* analysis, take no notice of these distinctions. For purposes of *financial* analysis, however, they can be important.

As noted, there are two broad categories under the general heading "remuneration of capital": "return of capital" and "return on capital." The principal accounting items that would be included under each of these categories are shown in this Table:

I. Return of Capital

1. Allowance for depreciation
2. Write-off of preproduction expenses
3. Allowance for depletion

II. Return on Capital

1. Interest on borrowed capital
2. Rental payments for assets that have been rented instead of purchased
3. Income taxes
4. Profits after income tax, including
   (a) dividends
   (b) reinvested earnings.

The sum of I and II constitutes a project's "Gross Cash Flow."

Some Explanations

The two lists include some items that imply contractual commitments to pay out part of the C/F to persons outside the enterprise (i.e., interest, rents, income taxes, and sometimes dividends). But other items do not carry any such commitment; those in charge of the enterprise are free to use the uncommitted part of the C/F for any purpose they wish (shareholders or ministers not objecting!). Indeed, the unearmarked part of the C/F—the return-of-capital items plus profits after taxes—is usually the principal source of funds for amortizing debt. To the extent that the noncommitted part of C/F is not needed for debt amortization, it is available for reinvestment in the business, or for dividends to shareholders, or for investment in other assets unrelated to the enterprise but attractive as financial assets.

It may seem peculiar to count rents and income taxes as forms of returns to capital. Rent is included because it represents a common method of acquiring physical capital (e.g., the rental of buildings, of machinery, of computers, of lorries). Analytically, one should split up rental payments into two parts, one representing depreciation, the other profit—but that problem is dealt with in the accounts of the lessor, not those of the lessee. Are income taxes a return to capital? They are not a return to anyone else, so they are treated as if they belonged to capital, augmenting the "profit" item. If income taxes were a specific payment for government services then we could treat them just like payments to any other supplier—but they are not: income taxes are based on profits, not on government service rendered.

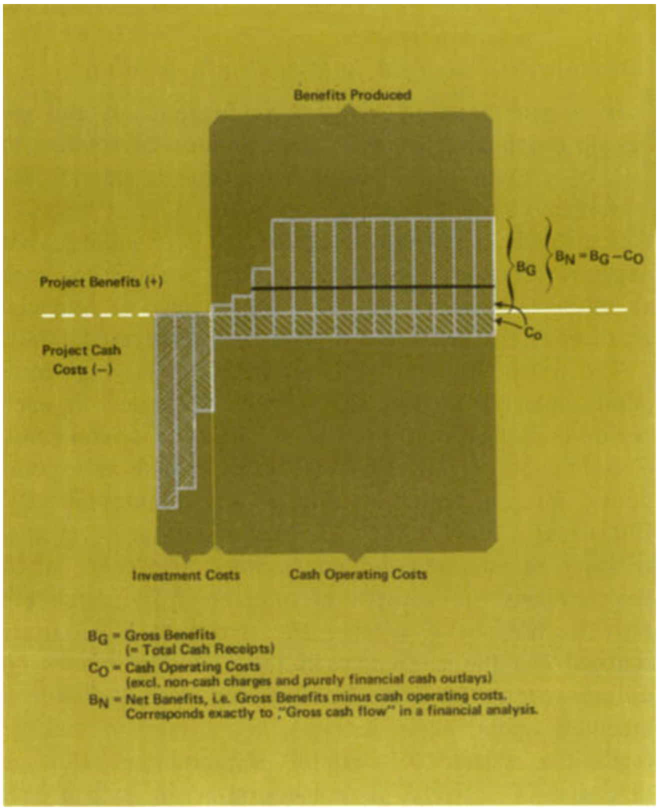
We have already noted that the "cash flow" can be defined in slightly different ways depending on the point of view, or purpose, of the analyst. For example, the managers and shareholders of an enterprise will not want to consider rental payments or income taxes as part of the firm's C/F, since these payments are not available for purposes in which they have a direct interest. Bankers would probably deduct rents and income taxes in order to measure the C/F available to cover debt-service requirements. Shareholders would show most interest in C/F after deduction of taxes, rents, and debt-service obligations in order to get a measure of the discretionary C/F that remains available for payment of dividends.

An economist has the simplest view of all: he sees C/F as a single undifferentiated stream of cash whose allocation is essentially unimportant, since allocations reflect the accident of how projects are financed and how profits are defined and taxed. So far as making an economic analysis is concerned one could radically change the way in which a project has been capitalized without affecting the total C/F. Economists are usually concerned with the whole economy, not with the needs of specific groups who have different interests in the distribution of the C/F. So if an economist has to build up a C/F figure from separate accounts he lumps together all forms of capital remuneration; if he is working on the appraisal of a new project he looks for the total C/F without bothering to ask how it may have to be divided up among various claimants. All he has to do is to estimate cash receipts for each year of the project's life, deduct estimates of payments for inputs purchased from outside the project and payments to labor, and he has his "Gross Cash Flow," year by year. The economist can limit himself to this rather simplistic view of C/F because he wants it for only one purpose, to apply one of the three investment decision tests that are commonly constructed from a discounted cash flow, i.e., a Benefit/Cost ratio, a Net Present Worth, or an Internal Rate of Return.

Cash Flows Without Cash

Often economists find themselves calculating "Cash Flows" even when there isn't any cash in the picture at all! This is possible because what the economist is looking for is something more general than "cash"; he looks for measurable "benefits" to the economy. To an economist, a "benefit" is as good as cash, or even better. He therefore treats "benefits to

Figure 2



the economy" *as if* they were cash. He uses them to construct a "Benefit Flow" which is conceptually identical to a financial Cash Flow. When he does so he comes up with a picture of a project like Figure 2. Gross Benefits correspond to the Total Cash Receipts in financial accounting. The cost of the current inputs (external purchases plus labor) needed to produce these Gross Benefits have to be deducted to arrive at each year's Net Benefits. These Net Benefits are exactly equivalent to what we called *Gross* Cash Flow in Table 1. Regardless of which label we use, this is the key "returns-to-capital" stream from which the *discounted* cash flow is easily derived.

Why Bother Discounting

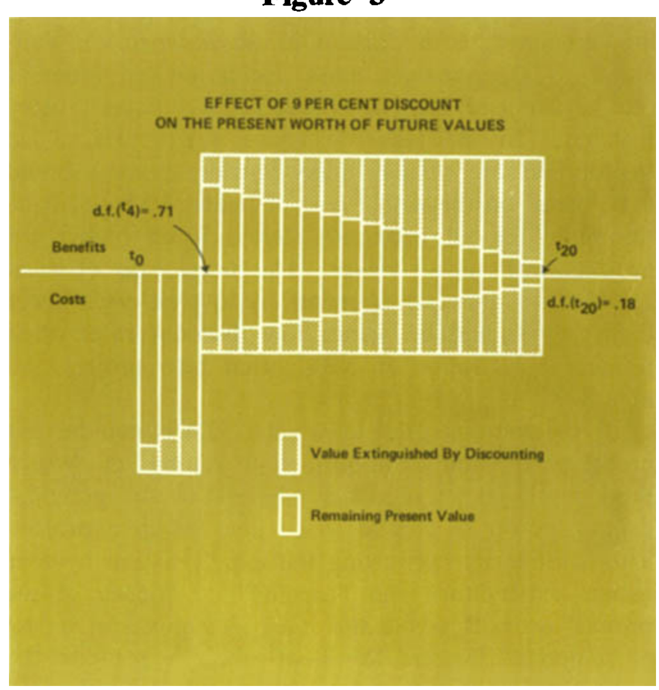
Some people find discounting an arcane and mysterious operation. It is nothing of the sort. It is a process of adjusting future values in order to give them an appropriate weight in our present decisions. That is all discounting is—a weighting system to cut future values down to their present worth. The amount of this reduction depends on two things, the rate of interest and how far in the future a value lies.

It helps to realize that discounting is simply the reciprocal of compound interest.[1] Everyone accepts the fact that the compound interest formula shows us what present values will become in the future, given a particular rate of interest. Discounting just reverses the process; it reduces future values to their present worth. The two processes look through the same telescope from different ends; their arithmetic is the mirror image of each other. Take a simple example: if you lend out $1,000,000 at 6 per cent for 7 years it will grow from its original value to $1,503,630 (i.e., from 1.0 at t_0 to 1.503630 at t_7 in a compound interest table). The ratio of these two numbers (1.0/1.503630) gives a value of 0.665057. If we multiply $1,503,630 by 0.665057 we obviously knock off some of its value—indeed we reduce it right back to 1.0. The number 0.665057 is the "discount factor" for the seventh year, at an interest rate of 6 per cent, that will reduce any seventh-year figure back to its present worth.

The farther off in the future a value lies the less weight it carries in our present decisions. Similarly, the higher the interest rate, the higher the premium on having cash in hand, today, so that one can take advantage of the high earning opportunities for money. This explains why projects with long payouts must show future benefits that are very large if their discounted present worth is to count for anything in decisionmaking. Failure to grasp this point is one of the most persistent causes of misdirected investment. One of the principal virtues of the DCF method is that it automatically takes into account this problem of the timing of both costs and benefits.

Figure 3 shows what happens to the undiscounted values of a 20-year project when the discount factors for 9 per cent are applied to them. If you look closely

Figure 3



[1] The compound interest formula is $(1.0+r)^n$; the discount-factor formula is $\frac{1}{(1.0+r)^n}$ where r stands for the rate of interest and *n* the number of periods over which compounding is to take place.

at the diagram you will notice that we have discounted not only the C/F of the benefit-stream but also the much shorter stream of capital expenditures that were required to generate them, as well as the stream of operating costs. The capital costs must be discounted as part of the process of reducing *all* future values to their proper weight at a common point in time. The particular "common point in time" we choose can be any date we like, e.g., the time when investment decisions are being made, the start of construction, the end of construction and begining of operations, etc. It is typical of the clarity of economic language that we call this comparison-date "the present" even if it is not! That is why the neutral symbol "t_0" is better. All values that occur before this date must be increased by compounding, just as all subsequent values must be reduced by discounting.

Choice of Discount Rate

The selection of an appropriate discount rate depends primarily on the purpose for which the DCF is to be used. In the common case where analysts are trying to measure the earning power of capital in a proposed project the appropriate discount rate is a *derived* value, something to be found through a process of trial and error until the analyst finds the discount rate that makes the present value of the net benefit stream just equal to the present value of the investment costs that generate those benefits. There are calculating tricks that make this quite easy in most projects. (Too many people assume you need a computer. That's rare; usually all one needs are financial tables and a slide rule or a desk calculator.) When different investment criteria using DCF are being applied (such as one of the several Benefit/Cost [B/C] ratios or a Net Present Value [NPV] test) the discount rate is treated as an *independent* variable—i.e., the analyst must decide on a particular rate to use and then carry out his calculations using that rate. In the latter instances, the choice of an appropriate rate involves many considerations. (Should it be based on the actual cost of finance? Should it be the same for all projects? Should it be higher for projects with higher risks?) The usual bias of most agencies, in most governments, is to pick rates lower than they should be—since low discount rates often produce B/C ratios or NPV's that help projects get approved!

Of the various uses to which a DCF can be put probably the most important—certainly in World Bank work—is to derive a measure of the potential earning power of capital to be invested in a project. This is done by converting the expected year-by-year capital expenditure and "earning" experience of the project, over its whole life, into an equivalent model of compound interest. We shall presently see how the discounting process does this; but first a few comments about compound interest.

Compound Interest as a Growth Model

In a general way everyone understands it and relies on compound interest tables to provide answers to rate of growth problems. Indeed, this is one of the important characteristics of compound interest tables—they provide a growth model for understanding what happens to capital funds when they are put to work at interest, whether in the paper assets of financial markets or the brick and mortar assets of the economy.

The most important assumption underlying compound interest is that the surplus generated in each period is completely plowed back into the capital fund. Certain types of financial instruments, such as a compound interest bond, assure this result automatically. But usually some of the annual "surplus" gets distributed as interest, dividends, rent, taxes, etc.; when this happens the compound interest effect is realized only if those who receive the distribution promptly reinvest the funds (where in the economy makes no difference) at the same interest rate. But, if dividend receivers spend their receipts, there is then leakage from the system of capital accumulation through diversion of "profits" to consumption. In such a case it would be wrong to say that the earning power of capital was any less than if it had been successfully reinvested. It would be more accurate to say that those concerned had not chosen to take full advantage of the capital building opportunity which the investment had presented.

A second point about compound interest concerns the investors' firm expectation that they will get back their original investment as well as earn interest. In financial investments this presents no analytical problem, because "money does not wear out." But in economics the problem is more complicated because the capital is always invested in physical assets, which either wear out or become obsolete and must be scrapped. So investors (or projects which use their money) either have to make provision for reconverting the original assets back into cash or for maintaining the original value through replacement. Analytically this problem is taken care of through allowances for depreciation or, more broadly, for "capital recovery." These serve the purpose of maintaining the original capital at its initial value of 1.0. A compound interest table assumes that the capital recovery allowances (plus all the surplus) are also plowed back and kept at work at the same rate that was earned by the original capital.

But the business world does not keep its books this way. Depreciation accounting ("capital recovery") is governed by a mixture of legal requirements, by tax strategy, by what management wishes to show in financial reports, and by accounting tradition. As a result, all methods of accounting for depreciation on an annual basis are rather crude estimates, often determined arbitrarily by considerations of accounting tactics. To the extent that depreciation charges are arbitrary, so too are calculations of "profit." As already noted, one of the great virtues of DCF is that it sweeps away this problem while still making sure that investors get their money back at the end of the project's life. This is accomplished by focusing on the total cash flow without regard to its arbitrary or conventional composition.

In the extensive literature on DCF one often encounters confusion as to whether the DCF method does or does not assume full reinvestment of the cash flow "at the same interest rate." A project's promoters, if interested only in the size to which their capital would have grown at the end of the project's life (i.e., in its earning power over its useful life) would be indifferent between the up-and-down realities of a project practicing partial reinvestment of cash flows at varying interest rates and the alternative of buying a financial asset that earned compound interest on a totally reinvested cash flow at a constant interest rate. In both cases the investor comes out at the same place, although he would have traveled by different routes. So the correct answer is that DCF does not assume that reality will see full reinvestment of the C/F at a constant interest rate. All that is required is that someone specify what they think will actually happen—i.e., how much of the total cash flow will be reinvested each year and how much that reinvested portion will earn. But once reality has been specified it will then be converted, through the discounting process, into an equivalent compound interest model carrying a specific interest rate (growth rate). Whether people realize it or not, when they talk about a project's "earning power" they are talking about the model, not the reality—and the model *does* assume full reinvestment of the cash flow at a uniform rate of compound interest. Change the description of reality and you change the model that will correspond to it (e.g., instead of having a 9 per cent model you change to a 7.5 per cent or a 9.3 per cent model). In the project appraisal work of the Bank the normal practice is to assume that the total cash flow (= the full Net Benefits) is reinvested, i.e., that there is no "leakage" from the stream of earnings that belong to capital. This assumption is not based on naïve expectations of what project analysts hope will happen; it is merely a simplifying assumption to measure the rate at which a capital stock *would* grow if its estimated earning power were realized.

A Cautionary Ending

I have tried to explain DCF and to make clear why it is often a better measure of the earning power of capital than other tests. But it is possible to believe in something too much and to lean on it too hard. While it is important to understand the techniques and philosophy of DCF, it is equally important to realize that the final figure which emerges from a DCF calculation reflects how the boundaries of a project have been drawn, how the benefits and costs attributable to the project have been defined and measured, and similar conceptual or institutional or methodological factors that underlie the arithmetic and determine its outcome. In deciding how much to let one's judgment about a project be influenced by a figure thrown up by DCF calculations, the economic analyst should give as much attention to these questions as to the "payoff" figure, which can easily claim too much of everyone's attention. This comment applies, of course, to most types of investment criteria, not just to the DCF method.

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