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Price to Book Ratio as a Valuation Model: An Empirical Investigation*

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ABSTRACT

This paper examines the theoretical and empirical validity of the price-to-book ratio that has received considerable attention recently. Models are developed on the basis of Gordon's constant dividend growth model. Cross-sectional and longitudinal analyses are carried out on Singapore data. It is found that models fit well, and the identified factors explain a significant portion of the variability in the ratio, with dividend being the prime value-driver. Economic regime shifts also have significant effects. Reasons for the lack of significance of other factors require further investigation.

Introduction

THE PRICE-TO-book-value (P/B) ratio has been receiving considerable attention in the literature in recent years. Wilcox (1984) has shown that P/B-ROE (return on equity) model appears to be superior to price-earnings ratio valuation model. Fama and French (1991) demonstrate that the ratio of book value to market value explains the differences in returns better than beta does, and think that size and book-to-market ratios are proxies for other fundamentals. Such observations have motivated us to examine the theoretical validity of the P/B ratio as a valuation model. The present research has the following purposes: (i) to explore the theory behind the use of the P/B ratio as a model of valuation; (ii) to identify the fundamental factors that affect this ratio; and (iii) to empirically test those relationships in the Singapore share market, which is classified by the International Finance Corporation as being among the first tier markets. The rest of this paper is organized as follows. Section II contains the development of the theory, followed by a section on research methodology. The fourth section presents the results of the study, and the last section contains the conclusions.

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Theoretical Development

When a firm is newly established, its value equals the investment made by the owners. A market value of the company's shares begins to take shape when its operations show promise of long term returns, such market value being the present value of future dividends. Under the generally accepted accounting principles based on historical costs, however, the book value remains relatively unchanged at the amount of the original investment plus the reinvestment of undistributed profits. Thus, the change in the value of a firm may be considered as a change in the ratio between the market price of its shares and their book value. This is similar to the concept of value-added. At unity, the price-to-book-value ratio indicates that the market value and book value are identical; a ratio of greater than one would mean that the firm has added value, and vice versa for a smaller-than-one ratio.

a *The Basic Price-to-Book Ratio Model*

According to the Gordon-Shapiro (1956) and Gordon (1962) constant dividend growth share valuation model, the price of shares, P, equals the present value of the future cash flows from a company, determined as follows:

$$P_0 = d_1 (k-g)^{-1} \quad (1)$$

where,

P_0 = beginning of period price per share observed in a market;
d_1 = end-of-period cash dividend per share;
k = required rate of return equal to opportunity cost in the market;and
g = constant dividend growth rate over the term of the security.

The Gordon-Shapiro model can be restated as the P/B ratio model by dividing both sides of equation (1) by the book value.[1] The following basic model may thus be derived:

$$\frac{P_0}{B_0} = (d_1/B_0)(k-g)-1 \quad (2)$$

where,

B_0 = beginning of period book value per share.

In this model, the required rate of return, k, may be considered as the risk-adjusted rate of return of the individual firm, k_i, determined in accordance with Sharpe's (1964) capital asset pricing model:

$$k_i = R_F + b_i (k_m - R_F) \quad (3)$$

where,

R_F = risk-free interest rate;
β_i = riskiness of the individual firm in relation to the market;
k_m = market rate of return.

1 The model in Equation (2) differs from that of Wilcox (1984) in that the latter is based on return on equity as the first value-driver in that valuation model. The P/B ratio can also be interpeted as Tobin's q-ratio if the book value is deemed to be the replacement cost of the net assets of the firm.

Furthermore g is the expected growth in the dividend per share of the individual firm, g_i, computed as follows:

$$g_i = \frac{d_t - d_{t-1}}{d_{t-1}} \quad (4)$$

where,

d_t = dividend per share at the end of period t;
d_{t-1} = dividend per share at the end of period t-1.

It may be observed that g arises from the growth of the company by reinvestment of undistributed profits. If a company pays all of its income as dividends, it will have no systematic increase in dividends. This can be further explained by assuming that the ROE and the pay-out ratio (POR = dividends/net income) are expected to remain constant. In such a situation,

$$d = (POR)(ROE)(B) \quad (5)$$

Therefore, the increase in dividend is:

$$g = (POR)(ROE)(B_t - B_{t-1}) \quad (6)$$

b *Extended Models*

A study of the basic model presented above shows that it takes into consideration the following factors, which may be referred to as value-drivers:

i Expected earnings and dividend payments by the company,
ii Expected growth in dividends because of the expansion of the company from internal resources, that is, reinvestment of undistributed earnings,
iii Riskiness of the company, and
iv Risk-free interest rate and market rate of return.

The model does not take into account the effects of inflation, nor does it consider growth of the company from external sources. Therefore, variations of the model are developed below to include these factors as additional value-drivers.

Inflation affects a company in numerous ways. Some of these are accounted for in preparing the historical cost based financial statements, such as changes in purchasing and selling prices, wage rates, etc. Many other effects are not accounted for, for example, changes in the values of the assets held by the company, depreciation on such assets, and so on. Furthermore, inflation may have varying effects on different companies, depending upon the age and composition of their assets, extent of their influence upon contracts with outside parties, such as in fixing prices, wage rates, etc., and other factors. Accounting theorists generally think that during an inflationary period traditional statements overstate income but understate asset values.[2] It is also thought that the market sees through the unaccounted effects, and the share prices take into consideration the undervaluation of the company's assets.[3] Investment in shares is often regarded as a hedge against inflation.[4] Thus inflation may be treated as a value-driver. The principal effect may be to increase the price by the rate of inflation (INF) applied to the book value of the equity of the company, that is: (1+INF)(B).[5] When divided by B for use in the P/B ratio model, this factor would be reduced to INF. A variation of the basic model would thus be:

$$\frac{P_0}{B_0} = \frac{d_1}{B_0}\,(k\text{-}g)^{-1} + (1+INF) \tag{7}$$

where,

INF = the rate of inflation during the period.

External sources may be either in the form of additional equity or debt. If equity shares are issued, and ROE remains unchanged, it will have no effect on P/B, though the price of shares might increase. Thus, the price-to-book ratio model will provide useful information beyond that provided by the traditional model. In view of this fact, however, it is not necessary to include the issue of new equity as a factor in the price-to-book ratio model.

A company normally borrows money only if the expected return on investment is greater than the interest on the debt. This will result in an increase in earnings but not in equity, thus raising its ROE. However, debt also leads to larger k_i because of higher risk. The effect on share prices and on P/B will depend on the relative change in these two factors. It has been shown (Scott and Martin 1975 and Ariff and Lau 1992) that every company has an optimal debt to assets ratio; above this optimum, the additional debt will cause a fall in the share prices, while below the optimum, it will cause a rise. In either case, the debt to assets ratio is a value-driver. Another variation of the basic model using debt to asset ratio as an additional value-driver may be written as follows:

$$\frac{P_0}{B_0} = \frac{d_1}{B_0}\,(k\text{-}g)^{-1}+DAR \tag{8}$$

where,

DAR = the average debt-to-assets ratio of a firm.

A fully extended model covering both inflation and debt to equity ratio as additional value drivers may now be written as follows:

$$\frac{P_0}{B_0} = \frac{d_1}{B_0}\,(k\text{-}g)^{-1} + DAR + INF \tag{9}$$

2 A large body of literature has developed on this subject over the past several decades. A good discussion of the various aspects of inflation accountng may be found in the now-superseded SFAS 33. The other aspects of the effects of inflation on decision making, see Van Horne (1971) and Agrawal et. al. (1980).

3 Because of this, the disclosure of additional information about the effects of inflation has not been found to have significant information content (for example, see Bernard and Ruland 1987; Beaver, Griffin and Landsman 1982; Lev and Ohlson 1982; and others).

4 For example, Pindyck (1984).

5 This is similar to a capital maintenance adjustment advocated, or permitted, by many theorists. For example, see Agrawal (1977), SSAP 16 and Agrawal and Rosenzweig (1983).

c *Theoretical Limitations of the Models*

There is an inherent limitation in all the models discussed above, including the Gordon-Shapiro model as well as the basic and extended P/B ratio models. All of these can be applied only to companies that have positive dividends and (k_i-g_i). If a company pays no dividends, that is $d_1 = 0$, the models can not be used. Similarly, if a company has a high ROE but pays no or very small dividends, its g_i may be more than k_i, making $(k_i-g_i)<0$. In this situation also, the models can not be applied. Thus, none of these models can be used in the context of non-profitable companies or highly profitable growth companies.

The value-drivers identified here comprise the fundamental factors affecting share prices. They can not be used to explain temporary, day-to-day fluctuations in the market. Therefore, when testing these models, it is necessary to eliminate the impact of such fluctuations. This can be done by taking averages over long-term windows. However, it is not clear as to what is a long term for this purpose. It can only be surmised that longer the window, the better the results should be.

Research Methodology

a *Test Models*

The basic and extended models discussed in the last Section have been tested with respect to a selected sample of firms with continuous trading on the Singapore Stock Exchange for at least fourteen years, 1975 to 1988. This period has been used in two ways: (i) as a single long window, using annual average numbers for the years 1975-88; and (ii) subdivided into four short windows with respect to the years 1975-76, 1977-81, 1982-86 and 1987-88. There are two reasons for choosing the period of the short windows. Rates of inflation in Singapore were significantly different during these periods (i.e. -1.50%, 6.70%, 0.40% and 1.50% respectively). Furthermore, Singapore suffered unexpected deep economic depressions during the years 1975-76 and 1982-86. Thus, the four short windows represent economic regime shifts.

Multiple regression and pooled regression have been used for analysis. Test models developed for this purpose are described below.

As the independent variables in the basic model (Equation (2)) are in a multiplicative form, a log-linear model has been utilized:

$$\log \frac{P_0}{B_0} = a + b_1 \log \frac{d_1}{B_0} + b_2 \log(k-g) + e \qquad (10)$$

where,

a = intercept term;
b_1 = coefficient for the value-driver (d_1/B_0) of firms;
b_2 = coefficient for the value-driver (k_i-g_i) of firms i=1,..n; and
e = independently and identically distributed residuals.

Cross-sectional analysis has been carried out to test the above model over the long window as well as the short windows. It is expected that the price-to-book ratio of a firm is affected significantly by the identified value-drivers, (d_1/B_0) and $(k_i\text{-}g_i)$ of the i-th firms in the sample taken from the market, and that there is a difference between the long window and short windows in their explanatory power.

The effect of inflation can not be judged in a cross-sectional analysis because it will have the same value for all the companies (with only a slight variation due to differences in the fiscal years of various companies). Therefore, in order to test the model in Equation (7) with inflation as another variable, a pooled regression has been used with respect to the four windows, adding three dummy variables.

$$\log \frac{P_0}{B_0} = a + b_1 \log \frac{d_1}{B_0} + b_2 \log(k\text{-}g) + b_3 \log(1+INF) + b_4(DY_1) + b_5(DY_2) + b_6(DY_3) + e \quad (11)$$

where,

b_3 = coefficient for the value-driver INF specified as the mean rate;
b_4 = coefficient for the Dummy 1 (=DY_1) for the period 1975-76 (1,0);
b_5 = coefficient for the Dummy 2 (=DY_2) for the period 1977-81 (1,0);
b_6 = coefficient for the Dummy 3 (=DY_3) for the period 1982-86 (1,0).

When applying this model, deviations from the means will be used for the values of the variables. This would permit the estimation of the significance of the effect of the last short window, 1987-88, from the intercept term. It is expected that the addition of the inflation variable and dummies for time periods will significantly increase the explanatory power of the model.

The test model for Equation (8) is as follows:

$$\log \frac{P_0}{B_0} = a + b_1 \log \frac{d_1}{B_0} + b_2 \log(k\text{-}g) + b_3 \log(DAR) + e \quad (12)$$

where,

b_3 = coefficient for the value driver (DAR) measured for each firm.

It is expected that the addition of the debt to asset ratio variable will significantly increase the explanatory power of the model.

The test model for Equation (9) is:

$$\log \frac{P_0}{B_0} = a + b_1 \log \frac{d_1}{B_0} + b_2 \log(k\text{-}g) + b_3 \log(DAR) + b_4 \log(INF) + b_5(DY_1) + b_6(DY_2) + b_7(DY_3) + e \quad (13)$$

It is expected that the addition of the inflation and debt to asset ratio variables and time period dummies will significantly increase the explanatory power of the model.

b *Test Statistics*

The following statistics obtained for the test models will be used to accept or reject various hypotheses:

F-ratio: model's goodness of fit,
Adjusted R^2: overall explanatory power of the models, and

t-statistics: significance of the individual independent variables. Confidence levels of 1%, 5% or 10% are used to draw conclusions.

c *Variable Definitions*

Different variables used in the test models have been defined as follows:

P : Three-months average price per share, with one-quarter delay after the end of the fiscal year. The delay has been used to permit the market to absorb the information contained in the financial statements of a company that are presented approximately three months after the end of the fiscal year.[6] The three-month average for each firm in the cross section has been used to eliminate any temporary fluctuations that might have taken place after the financial statements were published, and to capture the long-term, continuing effect of such information.

B : Book value of the equity. Sum of the total shareholders' equity and minority interest, minus the face value of preference shares.

d : Cash dividend per share of common stock.

k_i : Average of the annual k_i of each company for the years in each window computed in the manner described earlier. For this purpose, k_m has been assumed to be 16% , which is the long term average market rate of return in Singapore; R_F is annualized yield on three-month treasury bills during the period; and beta is the long-term beta of each company.[7]

g_i : Average of the annual growth rates of dividend per share of each firm during the period computed as described earlier, that is, $(d_t - d_{t-1})/d_{t-1}$.

DAR : average ratio of interest bearing debt to (total assets minus non-interest bearing debt) of each firm in the cross section. Debt in each category may be either long term or short term. The substraction of non-interest-bearing debt from total assets makes it the sum of long-term assets and working capital.

INF : Rate of inflation during the fiscal year of each company based on the quarterly consumer price index numbers (I). INF is computed as $(I_q - I_{q-4})/ I_{q-4}$, where q is the last quarter of the company's fiscal year (or the nearest quarter for which the index is available). The index values were disaggregated and recomputed with a common base year of 1980.

d *Data*

The sample of firms selected for this study is taken from the OCBC Index which consists of 54 companies representing 58% of the market capitalization on the Singapore Stock Exchange. Banks and Finance Companies were excluded from the sample, as were those companies that did not have

6 There is evidence of this delayed realisation of price changes in Singapore for profit announcements (Ariff and Finn 1989).

7 For further details of these terms and their values, see Ariff and Johnson (1990) from which this information has been taken.

continuous listing from 1975 to 1988. After further excluding companies with missing data, the sample size came down to 44. All of these companies have been used for the long window. For the short windows some companies had to be excluded further because the average (k_i-g_i) was less than 0. This reduced the sample for individual short windows.

Data were collected from the following sources: (i) Financial statement data were gathered from SES Companies Handbook and NUS Financial Database at the Faculty of Business Administration; (ii) Stock price data were collected from SES Monthly Journal; (iii) RF, beta, and k_m were taken from Ariff and Johnson (1990).

Results of the study

Results of the regression analysis are presented in tables 1 to 4. These tables show the necessary statistics, including F-ratio, Adjusted R^2, and t-statistics. Further tests using the residual plots and heteroscedasticity (Breusch-Pagan test) have shown that the residuals are normally distributed and that the constant variance assumption is valid in the cross-sectional regressions.

Table 1 contains the results for the basic model (Equation (2) operationalized in Equation (10)) with respect to both the long window and the four short windows.

Table 1

Results of the Basic Model: Separate Regression for Each Window Over 1975-88

Window	Constant	Value of b_1	Value of b_2	Adj R^2	F-ratio
Long Window: 75-88	0.905	0.395	0.151	0.242	6.252
t-value	4.782	3.483	1.681		
Short Window 1:	0.599	0.513	-0.170	0.402	8.728
t-value	3.006	4.079	-1.131		
Short Window 2:	0.941	0.520	0.043	0.303	8.161
t-value	4.328	3.988	0.562		
Short Window 3:	0.363	0.146	-0.003	0.008	1.158
t-value	1.565	1.522	-0.210		
Short Window 4:	0.937	0.405	0.160	0.089	2.215
t-value	2.753	2.006	1.023		

$$\text{Basic Model: } \log P_0/B_0 = b_0 + b_1[\log d_1/B_0] + b_2[\log k_i - g_i] + e$$

For the long window, the model appears to fit well as suggested by the significant F-ratio. Adjusted R-squared indicates 24.3% of the variability in the dependent variable, P/B ratio, is explained by the independent variables; (d/B) and (k_i-g_i). The signs of both independent variables are also as predicted by theory. The coefficient of the first variable, (d/B), has a significant t-value of 3.483. However, the second variable, (k_i-g_i), does not seem to be significant as its t-value of 1.681 is outside the 0.10 confidence level.

Results for the four short windows are quite interesting. F-ratios are significant in the first two and the last window. Furthermore, adjusted R-squared for the first two windows are higher than that of the long window, while for the last two these are smaller. The first variable, (d/B), has a significant t-value and correct sign in all the windows. But the second variable, (k-g), is not significant in any of the windows, and has the wrong signs in the first and third windows. A probable reason for the incorrect signs is that during these periods the actually required market return, k_m, was much lower than the number used in the test models because of the economic downturn. It would thus seem that the first variable, (d/B), is the prime value-driver.

Results of the extended model (Equation (8) operationalized in Equation (12)) are given in Table 2 for both the long window and the four short windows.

Table 2

Results of Extended Model: Separate Regression for Each Window Over 1975-88

Window		Constant	Value of b_1	Value of b_2	Value of b_3	Adj R^2	F-ratio
Long Window:75-88		0.947	0.411	0.151	0.017	0.217	4.049
	t-value	4.920	2.729	1.653	0.169		
Short Window 1:		0.561	0.532	-0.162	-0.054	0.364	4.619
	t-value	2.660	3.443	-0.897	-0.711		
Short Window 2		1.111	0.575	0.385	0.085	0.235	4.173
	t-value	5.189	3.513	0.501	1.150		
Short Window 3:		0.439	0.169	-0.003	0.036	0.009	0.885
	t-value	1.874	1.619	-0.023	0.619		
Short Window 4:		1.091	0.422	0.157	0.067	0.087	1.728
	t-value	3.141	2.087	0.919	0.857		

$$\text{Extended Model: } \log P_0/B_0 = b_0 + b_1[\log d/B] + b_2[\log k\text{-}g] + b_3[\log DAR] + e$$

The model includes the additional variable for debt-to-asset ratio, DAR, to incorporate the effect of external financing. However, its inclusion does not improve the explanatory power of the model: in fact, the adjusted R-squared values are smaller as compared to the basic model. Furthermore, the coefficient values are not significant in any of the windows. However, the first two variables, (d/B) and (k_i-g_i), continue to behave in the same manner as before. The first variable, (d/B), is still the prime value-driver with all the coefficients being significant at or below the 0.05 confidence level. The second variable, (k_i-g_i), is not significant except at about 0.10 confidence level only in the long window. Furthermore, results for the first and third short windows continue to show incorrect sign for this variable.

Table 3 shows the results of longitudinal analysis, including the effects of inflation, (1+INF), and using dummy variables for different time periods (Equation (7) operationalized in Equation (11)).

Table 3

Results of Basic Model: Pooled Regression Using Mean Deviation from Mean*

Panel A	Coefficient Values	t-values
Value of Constant	0.273	0.973
Value of b_1	0.639	5.139
Value of b_2	0.132	1.072
Value of b_3	0.024	0.002
Value of Dummy 1	-0.487	-3.458
Value of Dummy 2	-0.301	-1.524
Value of Dummy 3	-0.303	-2.623
Panel B		
Adjusted R^2		0.413
F-Ratio		8.745

Basic Model: $\log P_0/B_0 = b_0 + b_1[\log D/B] + b_2[\log k\text{-}g] + b_3[\log(1+INF)] + b_4(DY_1) + b_5(DY_2) + b_6(DY_3) + e$

*Specifying the vaiables in mean deviation form helps to identify the effect of left-out dummy of the fourth period in the intercept term.

Inclusion of the inflation variable improves the explanatory power of the model with adjusted R-squared of 41.3%. The F-ratio has also improved to 8.745, which is significant at 0.01 level. The sign of the three variables is as predicted by theory. The inflation variable, though not significant by itself, does seem to make a difference. Coefficient values for the dummies are significant for all periods[8] except the third (1977-81), indicating that regime shifts do affect price-to-book ratio.

Table 4 shows the results of the most extensive model (Equation (9) operationalized in Equation (13)) which includes variables for both inflation and debt-to-assets ratio as well as dummies for time periods.

Inclusion of the debt-to-assets ratio does not improve the explanatory power of the model; in fact, the adjusted R-squared value is smaller at 36% as compared to the previous model. However, the F-ratio is significant at 0.01 level. t-values are significant for the first variables, (d/B), and for the four time periods. Thus, (d/B) continues to be the prime value-driver during significant economic regime shifts.

Table 4

Results of Extended Model: Pooled Regression with Dummy for Time Periods

Panel A	Coefficient Values	t-values
Value of constant	1.585	5.620
Value of b_1	0.696	4.489
Value of b_2	0.126	1.009
Value of b_3	0.012	0.620
Value of b_4	-1.045	-0.119
Value of Dummy 1	-0.504	-3.489
Value of Dummy 2	-0.311	-1.559
Value of Dummy 3	-0.328	-2.665
Panel B		
Adjusted R2		0.360
F-Ratio		5.032

Extended Model: $\log P_0/B_0 = b_0 + b_1[\log D/B] + b_2[\log k\text{-}g] + b_3[\log(1+INF)] + b_4[\log(DAR)] + b_5(DY_1) + b_6(DY_2) + b_7[DY_3] + e$

Conclusion

The foregoing analysis of results indicates that the identified fundamental variables which are supposed to determine the value of a firm also explain a significant portion of the variability in its price-to-book ratio. Therefore, the price-to-book ratio may be considered to be a valid valuation model. As far as the individual factors are concerned, only (d/B) has been found to be significant. However, economic regime shifts are observed to make a significant impact on the ratio also. The reasons for the lack of significance of other individual factors, (k-g), inflation and debt-to-asset ratio, require further investigation.

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