

**Relationships between Stock Prices and Accounting Information:
A Review of the Residual Income and Ohlson Models**

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Abstract

As one of the main purposes of financial statements is to provide relevant information for investors, relationships between share prices and accounting variables have been widely researched. Early studies focus mainly on earnings, but attention has turned in recent years to valuation models that include the book value of the equity. Many of these studies cite the residual income model as their theoretical base and, with the growing emphasis on shareholder value, residual income measures are more commonly used in the business community to track financial performance. Given such trends, this paper reviews the theoretical background of the residual income model and discusses results of empirical studies that use it. The study finds that the two main accounting variables can usually explain a substantial part of the variation in share prices, and it also identifies a number of issues that remain unresolved. These findings should be of interest to other researchers, and to managers and investors who currently use or are planning to use residual income to monitor business performance.

Keywords: Valuation; residual income; Ohlson model

1. Introduction

It is generally accepted that a basic objective for most commercial organisations is to generate wealth. Firms may have different policies on the distribution of wealth but, if they fail to create it in the first place, they are likely to have difficulty raising capital to support their activities. Consequently, the creation of value is important not only for investors but also for those who manage the firm.

If a firm is publicly listed, its value to the owners can be derived from the share price. However, share prices tend to fluctuate continually in response to information on general economic conditions as well as factors specific to the firm itself. Furthermore, many firms are not publicly listed and there may be no readily available price for their shares. As a result, managers usually rely on less volatile figures from the accounting system to measure financial performance and investors have the published accounts to assist them with stock selection. Consequently, relationships between accounting information and share prices are of considerable practical interest.

Early research in this field focused mainly on earnings, but there has been a trend in recent years to include equity book value as an additional variable and to adopt the residual income model as the theoretical framework. Furthermore, with an increasing focus on value creation, residual income measures have become more widely used by the business community as indicators of financial performance. Given such trends, it is relevant to ask how well they perform. This paper addresses that question by considering the results of empirical studies that examine relationships between share prices and accounting variables in equity markets around the world.

2. Valuation Theory and Models

It is well established in the theory of finance that the economic value of an asset can be determined by discounting the expected benefits to the owner over the holding period at the opportunity cost of capital. This standard approach to valuation is covered in Williams (1938), one of the earliest texts on investment theory, and it has its roots in the net present value rule commonly used to evaluate capital projects. However, when this rule is applied to the firm as

a whole, the stream of benefits to be discounted can be defined in a number of different ways and this leads to alternative versions of the same basic model.

2.1 Dividend Discount Model

The most direct approach to valuing shares defines the benefits to the owners as the dividends paid during the holding period plus the proceeds received from selling the shares at the end of that period. However, when the shares are sold, the relevant price will be determined by discounting the cash flows the new owner expects to receive during the subsequent holding period. Consequently, if it is assumed that markets are efficient and the firm is a going concern with an indefinite life, it can be shown by successive substitution that the current price of the shares P_0 can be calculated by discounting the stream of all future dividends. This is shown in the following formula:

$$P_0 = \sum_{t=1}^{\infty} \frac{E_0[d_t]}{(1 + E_0[r_t])^t} \quad (1)$$

$E_0[.]$ is the expected value of the variable concerned, conditional on the information available at the time 0; d_t is the dividend payment; and r_t is the opportunity cost of capital applicable to the cash flows that occur at time t .

Equation (1) is a general version of the dividend discount model found in most texts on corporate finance. However, while the model is sound in theory, it can be difficult to apply because it involves estimating dividends and discount rates for an infinite period of time. As a result, empirical studies and practical applications generally assume a simplified pattern of dividend growth and a constant discount rate. For example, if dividends are constrained to grow at a constant rate g for the remaining life of the firm, the general model can be reduced to the following expression:

$$P_0 = \frac{d_0(1+g)}{r-g} \quad (2)$$

This is the known as the constant growth dividend discount model, and is usually attributed to Gordon (1962). A necessary assumption is that the constant expected growth rate g is lower

than the constant discount rate r . Otherwise, the series of cash flows will not converge to a finite solution.

Damodaran (1996) describes several alternative versions of the model that relax the constraint of constant perpetual growth by dividing the remaining life of the firm into two or more stages with different growth rates. These can accommodate more realistic patterns than constant perpetual growth, but estimating the dividend stream still remains problematic because dividends are largely discretionary. Indeed, firms with high growth opportunities may pay no dividends at all.

Furthermore, Miller and Modigliani (1961) have shown that, in a world without taxes and transaction costs, the value of a firm is unaffected by the expected pattern of dividend payments. This gives rise to what Penman (1992) calls the dividend conundrum. Share prices depend on expected dividend stream, but the pattern of dividends actually paid provides no useful information because it is largely discretionary. Moreover, dividends are not a direct measure of business performance because they reflect decisions on the distribution of wealth rather than operating decisions that affect its creation. As a result, considerable efforts have been made to link share prices to earnings and other variables that are more directly related to the process of value creation.

2.2 Residual Income Model

Several authors such as Preinreich (1938), Edwards and Bell (1961) and Peasnell (1982) have shown that the dividend discount model can be transformed to express the economic value of the equity in terms of accounting book value and abnormal earnings, rather than dividends. In this context, abnormal earnings x^a are defined as normal earnings x less a charge for the cost of the equity capital as follows:

$$x_t^a \equiv x_t - r y_{t-1} \tag{3}$$

where r is the cost of equity and y is the equity book value. Abnormal earnings are therefore similar to the residual income measure found in Solomons (1965), and other parts of the

management accounting literature. They represent earnings in excess of a normal rate of return.

A necessary condition for equivalence of the dividend and accounting versions of the general model is the clean surplus or comprehensive income relation. This requires that accounting earnings include all changes in equity book value except transactions with the owners, and it can be stated as follows:

$$y_t \equiv y_{t-1} + x_t - d_t \quad (4)$$

Here, d is dividends broadly defined to cover all transactions with the owners including new issues and repurchases of shares.

Using the definition of abnormal earnings and the clean surplus identity described in equations (3) and (4), dividends can be expressed in terms of abnormal earnings and equity book value as follows:

$$d_t = x_t^a + (1+r) y_{t-1} - y_t \quad (5)$$

Substituting this in the dividend discount model shown in equation (1), assuming markets are efficient, and that the discount rate is constant over time, the current price of a share can be expressed in terms of accounting variables as follows:

$$P_0 = \sum_{t=1}^{\infty} \frac{E_0 [x_t^a + (1+r) y_{t-1} - y_t]}{(1+r)^t} \quad (6)$$

With the further assumption that $E_0[y_t]/(1+r)^t \rightarrow 0$ as $t \rightarrow \infty$, this can be simplified to:

$$P_0 = y_0 + \sum_{t=1}^{\infty} \frac{E_0 [x_t^a]}{(1+r)^t} \quad (7)$$

This is the residual income model, and it states that the current share price or economic value of the equity is equal to the current book value of the equity plus the present value of all

future residual income or abnormal earnings. It should be noted that the model does not require current values of accounting variables to conform to the clean surplus relation. It only requires that estimated future values be calculated on this basis.

Another notable feature of the residual income model is that it holds regardless of the accounting policies used to value the assets and measure the periodic income. In fact, any set of accounting rules can be applied as long as the clean surplus relation is observed in estimating future values, and as long as the present value term covers the whole of the remaining life of the firm. Different accounting policies are likely to change the relative size of the book value and residual income components but, as long as the clean surplus relation holds and the present value term covers the remaining life of the firm, the total economic value of the equity will remain unchanged.

On the other hand, while the assumptions of the residual income model ensure that the total economic value remains the same regardless of the accounting policies adopted, the value created in individual time periods will depend on the particular measurement rules applied. Consequently, the division of total economic value between current book value and future residual income will depend on the accounting policies adopted. In particular, conservative accounting policies that understate the current book value of the assets will result in relatively higher values for future earnings and residual income.

2.3 Ohlson Model

One of the main attractions of the residual income model for researchers is that it provides a sound theoretical link between share prices and the two summary accounting variables that is consistent with the traditional dividend discount model. On the other hand, like the dividend discount model itself, the residual income model can be difficult to apply because it requires estimates for an indefinite period of time. Therefore, to make the models operational, simplifying assumptions usually have to be made about relationships between current and future values.

As mentioned earlier, the general dividend discount model is often simplified by assuming dividends will continue to grow at a constant rate for the remaining life of the firm. A similar assumption could be made for residual income as well, but it seems an unlikely

scenario as firms with abnormally high earnings usually attract competition that reduces returns over time to a more normal level. It is more likely that abnormally high earnings will be a temporary phenomenon and, with this in mind, Ohlson (1995) proposes a model in which they evolve according to the following auto-regressive process:

$$x_{t+1}^a = \omega x_t^a + v_t + \varepsilon_{1t+1} \quad (8)$$

$$v_{t+1} = \gamma v_t + \varepsilon_{2t+1} \quad (9)$$

Here ω and γ are constant persistence parameters; v is information, other than current abnormal earnings, that is useful in predicting future abnormal earnings; ε_1 and ε_2 are random disturbance terms with constant variance and zero mean.

It is also assumed that the persistence parameters ω and γ remain constant within a range between zero and one so that the process defined by equations (8) and (9) will typically result in abnormal earnings that decline over time.

Ohlson goes on to show that, given the dynamics specified above, the residual income model can be reduced to a linear combination of current book value, current abnormal earnings and other value relevant information as follows:

$$P_t = y_t + \alpha_1 x_t^a + \alpha_2 v_t \quad (10)$$

In this case, the coefficient on abnormal earnings $\alpha_1 = \omega / (R_f - \omega)$ and the coefficient on other information $\alpha_2 = R_f / (R_f - \omega)(R_f - \gamma)$ where R_f is one plus the risk free rate, as risk neutrality is assumed.

Substituting from the definition of abnormal earnings and the clean surplus identity shown in equations (3) and (4), Ohlson obtains a further expression for the price or market value of the equity in terms of current book value, current earnings, current dividends and other value relevant information, as follows:

$$P_t = (1 - k)y_t + k(\varphi x_t - d_t) + \alpha_2 v_t \quad (11)$$

In this case, the coefficient $k = (R_f - 1)\alpha_1 = (R_f - 1)\omega / (R_f - \omega)$, and the coefficient $\varphi = R_f / (R_f - 1)$. Expressed in this form, the Ohlson model can be viewed as a weighted average of a book value and an earnings model, with appropriate adjustments for dividends and other value relevant information that is not yet reflected in the accounts. As before, the dividends variable d is broadly defined to include other transactions with shareholders, such as share issues and repurchases.

A particular attraction of the Ohlson model for empirical researchers is that, unlike the basic residual income model that requires estimates of future abnormal earnings, the linear dynamics incorporated in the Ohlson framework allows price to be expressed in terms of current variables. Furthermore, the model goes beyond a general functional relationship to predict the sign and range of values for the respective coefficients.

On the other hand, like any other model, the Ohlson framework has limitations. First of all, the model refers to the individual firm and does not predict that the parameters are the same for all firms (although this is often implied in cross-sectional studies). Secondly, the variable that represents other value relevant information is not specifically defined and therefore difficult to test. In fact, empirical studies often omit it with the implicit assumption that it can be absorbed entirely in the intercept and random error terms. Thirdly, while the dynamics incorporated in the Ohlson framework are plausible, they are only one of many possible ways in which residual income could evolve over time.

Nevertheless, while it has limitations, the model has made a significant contribution to empirical research as it provides a sound theoretical link between share prices and accounting information that was previously missing.

3. Empirical Studies

The term *market based accounting research* has been used by several authors, including Lev and Ohlson (1982) and Walker (1997), to describe the body of literature that deals with relationships between market prices and accounting information.

Most of the early empirical studies in this field focus on earnings and are usually concerned with the response coefficient that relates earnings to returns rather than the explanatory power of accounting information for shares prices or value. However, in a review of earnings research, Lev (1989) notes that earnings are generally found to have very low explanatory power, and he suggests that this casts doubt on the practical value of reported earnings. While there is evidence that earnings convey information that helps form opinions about security prices, the earnings figures themselves have limited value because their relationship to prices is generally weak and unstable over time. Lev suggests this could be due to bias introduced by accounting rules, and he advocates a shift in research focus away from the information content of accounting variables towards the rules that determine them.

In another review of the relevant literature, Penman (1992) claims that much of the empirical work in market based accounting research has been misdirected in taking an informational perspective that assumes accounting variables only affect share prices if they provide new information. He advocates that there should be a return to fundamentals and a switch to a measurement perspective that views accounting numbers as useful determinants of asset values. Penman also maintains that traditional fundamental analysis and accounting practices have lacked the theoretical foundations required for rigorous economic analysis. However, he adds that the work of Ohlson has been a significant breakthrough in this respect.

The question arises, however, of how well residual income models can explain variations in share prices. Several researchers have addressed this point, and some of the more significant studies are discussed in the following sections. The first group explores the explanatory power of the models under different sets of accounting rules. The second focuses on identifying variables other than earnings and book value that may form part of the other information in the theoretical framework. Finally, a number of studies are discussed that do not fall neatly into either of the previous two categories.

3.1 Effect of Different Accounting Rules

With a view to examining the effects of international differences in accounting rules, Frankel and Lee (1998) explore relationships between share prices and accounting variables using data from 20 countries that include Australia, Japan, South Korea and Thailand. They use the general residual income model shown in equation (7) together with reported book

values and consensus earnings forecasts to calculate an estimated value of the shares in individual companies. This value estimate is then included as an explanatory variable together with current book value and current earnings in a model that follows the version of the Ohlson model shown in equation (11). The explanatory power of the model is high, 88% for the US and 72% for the other countries combined. The study also finds that the value estimate based on consensus earnings forecasts is highly significant in all 20 countries, and that it consistently dominates current earnings and book value in explaining variations in share prices. Furthermore, the coefficients on the value estimates are relatively stable over time ranging from 0.67 in Norway to 2.56 in Italy suggesting some consistency in relationships between share prices and the value estimates under different accounting regimes. The authors use country-specific discount rates to calculate their value estimates, but conclude that most of the explanatory power of the estimate can be attributed to the use of consensus earnings forecasts rather than varying discount rates. They go on to suggest that the discounted residual income model could be an integral part of a broad solution to problems of international accounting diversity that goes beyond the harmonisation of standards. Their reasoning is that, in theory at least, value estimates based on this model do not depend on the particular accounting rules adopted in published financial statements.

King and Langli (1998) examine relationships between share prices and the two main accounting variables with data from Germany, Norway and the United Kingdom. They select these three countries because the accounting systems are considered quite different, particularly in their degree of conservatism and the extent to which the accounting rules deviate from the clean surplus relation. The authors estimate a model that links share prices to equity book value and current earnings in accordance with equation (11), and also estimate two restricted models that express share prices as a function of either equity book value or earnings alone. They find that book value and earnings are both significantly related to share prices in all three countries, and that the two variables combined have explanatory power of about 70% in the United Kingdom, 60% in Norway and 40% in Germany. The authors conclude that these findings are consistent with the differences in the accounting systems of the three countries. They also find that the incremental and relative explanatory power of the two variables differ over time and between countries, with book value explaining more than earnings in Germany and Norway but less than earnings in the United Kingdom. The authors note however that, in this case, the results are not consistent with differences in conservatism and violations of the clean surplus relation embedded in the accounting rules. Finally, results

with an extended model that includes realised earnings for the following four years as proxies for expected earnings show that these additional variables explain little of the variation in market prices not already explained by current book value and earnings.

In another study of international accounting differences, Graham and King (2000) examine relationships between share prices and accounting variables in Indonesia, South Korea, Malaysia, the Philippines, Taiwan and Thailand. Their regression model relates share prices to current book value and current residual income in accordance with equation (10) and they find that the coefficients on both these variables are statistically significant in all six countries. They also find that the explanatory power of the model varies significantly between countries, ranging from a low of 24% in Taiwan to 55% in Thailand and 90% in the Philippines although, in this case, the sample size is relatively small. Their evidence supports the view that more strongly conservative accounting information is less value relevant. They also find that the incremental explanatory power of book value is higher than that of residual earnings in all six countries. Violations of the clean surplus relation such as revaluation of assets and immediate write-offs of goodwill have the expected effect on the value relevance of book value but the effect on the value relevance of residual earnings is less clear.

3.2 Value Relevance of Other Variables

In a study to explore the market valuation of research and development expenditure in the United Kingdom, Green, Stark and Thomas (1996) adopt a regression model based on the version of the Ohlson model shown in equation (10). However, they formulate it with the market-to-book premium (share price less equity book value) as the dependent variable, and current residual income as the main explanatory variable. The authors then add current expenditure on research and development as a second explanatory variable that can be considered as a part of other value relevant information variable in the theoretical model. They go on to include a number of control variables such as current advertising expenditure, market share, capital structure, and the variance of market returns as a measure of risk that can also be considered as part of other value relevant information. The authors find that residual income has significant explanatory power for the market-to-book premium but the evidence on research and development expenditure is mixed. The other control variables have almost no effect on the explanatory power of the model and have little effect on the inference tests.

Rees (1997) adopts the version of the residual income model shown in equation (11) as his theoretical framework in a study that examines the impact of dividends, debt and investment expenditure on the market value of a large sample of industrial and commercial firms in the United Kingdom. He finds that the two summary accounting variables are highly significant in both the pooled and annual regressions, although the coefficients themselves vary over time. Rees then goes on to explore the effect of dividends, debt and capital investment. He does this by decomposing earnings into dividends and retained earnings, by re-stating book value as total capital less total debt, and by including the annual expenditure on fixed assets as an additional explanatory variable. The results of the study show that earnings distributed as dividends have a larger impact on value than earnings retained within the firm and that, when dividends are included, the overall explanatory power of the model increases from 54% to 60%. There is also evidence that capital expenditure is positively related to market value, but there is inconsistent evidence on the value relevance of debt.

Many studies citing Ohlson (1995) as their theoretical framework include book value and earnings as explanatory variables in line with equation (11), but relatively few include dividends or the variable that represents other value relevant information. However, in a study with United States data, Hand and Landsman (1998) include both dividends and net capital contributions in addition to the two main accounting variables and use this model to test different predictions that arise from two common assumptions about other value relevant information. Their model with industry fixed effects explains about 80% of the variation in share prices. They also find that, if other value relevant information is set to zero as implied by empirical models that omit it, the sign of the coefficient on dividends is reliably positive when the theory predicts it should be negative. Alternatively, if realised earnings for the following year are included as a proxy for expected earnings on the assumption that the other information impacts future residual income through the linear information dynamics proposed by Ohlson, the sign of earnings coefficient is opposite to the theory. Hand and Landsman conclude that neither of these assumptions cleanly fits the data and they suggest that an explanation for the positive relationship with dividends could be that, contrary to assumptions in the theoretical model, dividends provide information that is useful for predicting future residual income. Consistent with this explanation, they find that larger dividends are associated with higher future residual income, especially for firms that are currently making losses.

3.3 Other Studies

Motivated by claims that changes in the economy have caused historical-cost financial statements to lose relevance over time, Collins, Maydew and Weiss (1997) investigate changes in the value relevance of earnings and book value in the United States over a period of forty years. Citing the residual income model as their theoretical base, the authors estimate a regression model that links share prices to equity book value and earnings in accordance with equation (11). They find that, contrary to claims in the professional literature, the value relevance of earnings and book value combined has actually increased slightly in the past forty years. The authors go on to estimate two restricted versions of the model with book value and earnings respectively as the sole explanatory variable, and use the results to calculate the incremental explanatory power of each. They find that, while the incremental explanatory power of earnings has declined over time, it has been replaced by an increase in the incremental explanatory power of equity book value. The authors suggest a number of explanations for this shift including an increase in transitory components of earnings, an increased frequency of negative earnings, an increased proportion of smaller firms, and an increase in the proportion of firms with a high intensity of intangible assets. The evidence suggests that these factors can explain much of the shift.

Barth, Beaver and Landsman (1998) examine the prediction that the relative roles of book value and earnings depend on the financial health of the firm. Using bond ratings as a measure of financial health and two samples of data from the United States, they estimate regression models linking market value with book value and earnings in accordance with equation (11). The first sample consists of firms that subsequently file bankruptcy, and the second includes firms in various states of financial health. The results confirm the prediction that, as the health of the firm declines, the relative explanatory power of book value increases and the explanatory power of earnings declines. The authors also examine a further prediction that the explanatory power of the earnings and book value variables varies systematically across industries, according to the relative importance of intangible assets. Once again, the results support their prediction. In industries such as pharmaceuticals where intangible assets are more important, earnings have more explanatory power. In industries such as financial services where intangible assets are less important, book values have more explanatory power. Their findings are robust to the inclusion of several control variables such as industry

sector, firm size, return on equity, negative rather than positive earnings, and volatility of market returns.

In a broad empirical assessment of the Ohlson model, Dechow, Hutton and Sloan (1999) note that its distinguishing feature is the linear information dynamics linking expected residual income with currently available information. They develop a number of regression models based on equation (10) and (11) with alternative values of the persistence parameters, and they estimate these models with data from the United States. Their study finds that models based on the Ohlson framework are a reasonable fit for the empirical data, with explanatory power in the range of 40% to 60%. However, they also find that they show only a minor improvement over a model that capitalises in perpetuity earnings estimates for the following year. The authors suggest that a possible explanation for this could be that investors overweight information in earnings estimates, and underweight information in the current accounting variables. Nevertheless, they conclude that the Ohlson model has a useful role to play in empirical research, because it provides a unifying framework for valuation studies that have previously used accounting information to explain share prices without a sound theoretical base. Furthermore, the model highlights assumptions that other models implicitly make about relationships between accounting variables and future residual income. Finally, it provides a solid platform on which subsequent research can build.

4. Summary and Conclusion

It is well established in the theory of finance that the value of an asset can be determined by discounting the expected benefits to the owner over the holding period at the opportunity cost of capital. Applying this concept to shares in a going concern leads to the dividend discount model, which has become a standard method of valuing shares. However, while this model is sound in theory, it can be difficult to apply in practice because it involves estimating future dividends for the remaining life of the firm. It is also difficult to apply the model to fast-growing firms that retain most of their earnings and distribute little or nothing in the form of dividends for substantial periods of time.

For reasons like these, considerable efforts have been made to develop valuation models that link share prices to variables other than dividends that are more directly related to the operations of the firm. One possible approach is to discount the free cash flow rather than the

dividend stream to estimate the total value of the firm. The value of the debt can then be deducted to determine the value of the equity. An alternative approach is to focus on accounting variables, as they are readily available and traditionally used to measure financial performance. Early developments focused mainly on earnings but attention has turned in recent years towards models that also include the equity book value. These are usually based on the concept of residual income or abnormal earnings but, while they link value with accounting variables rather than dividends, they still require estimates of variables for the remaining life of the firm. To tackle this problem, Ohlson (1995) assumes that residual income evolves according to an auto-regressive process and this enables him to develop a model that can be expressed entirely in terms of currently available data.

The Ohlson model has been adopted as the theoretical framework for a number of studies that explore the value relevance of accounting variables under different circumstances. These generally find that earnings and book value together have considerably more explanatory power than either variable alone, and that the explanatory power varies in different accounting regimes. However, in many cases, a significant part of the variance remains to be explained and may be attributed in part to the variable in the theoretical model that represents other value relevant information. With this in mind, several studies have tested the value relevance of variables other than book value and earnings with mixed results. There is also evidence that residual income does not necessarily evolve according to the linear dynamic process assumed by Ohlson.

These findings suggest that the residual income model, and the Ohlson version in particular, form a useful framework for exploring empirical relationships between share prices and accounting figures. They also suggest that accounting-based measures used by investors or business managers to estimate value or value creation are likely to be more effective if they focus on both earnings and book value rather than on one or other of the main variables alone.

Finally, there are opportunities for further research to identify variables other than earnings and book value that have significant explanatory power, and to explore the empirical fit of alternative time-series processes linking future residual income with data that is currently available. In this context, the residual income and Ohlson models can provide a sound theoretical base for such further research.

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