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FIRM VALUATION AND ACCOUNTING NUMBERS *

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Abstract

Accounting information on earnings and book values is commonly used to help value a firm. The errors that arise from the use of these data stem from the fact that accounting depreciation is not generally equal to expected economic depreciation and that earnings are liable to random shocks. In this paper I discuss some general statements that can be made about the relative efficiency of estimates of firm value which are derived from accounting data.

We can loosely think of two types of valuation problem — what I shall call *relative* valuation and *absolute* valuation. Relative valuation is concerned with determining value at time t given both value at t-1 and any new information between the two dates. Absolute valuation is concerned with determining the present value of a security at *t* given only information at that date. Of course where a series of market prices does not exist, the only valuation problems are absolute valuation problems. Thus, if you want to value a firm that is going public or to value a division of another firm that you are proposing to buy, you need to value the business from scratch.

This paper is concerned with absolute valuation — in other words, it discusses how accounting information can help to value the firm. In practice, the notion that we should look for simple relationships between accounting numbers and value may seem restrictive and contrived. After all, investment bankers or security analysts use a much wider set of information when they value the firm. Nevertheless, if we understand what information is contained in accounting numbers, we will also know what information to look for *outside* the accounts. There are also circumstances in which we need to employ an objective estimate of value — for example, when valuing a portfolio of unquoted securities. Thus the British Venture Capital Association recommends for most cases that members value their holdings by applying a common multiple to accounting

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earnings. Since venture capital firms typically invest in a diversified portfolio of companies, we might not worry too much about errors in accounting estimates of each firm's value, as long as the errors largely cancel out. This means that the estimates need to be unbiased and the errors uncorrelated.

Accounting Models of Value

Simple accounting models of value are usually based on some measure of capitalised earnings or on the firm's book value or they may involve a combination of the two.

A distinction is often made between accounting earnings and economic earnings. Under clean surplus accounting, accounting earnings equal the cash flow plus the change in book value, while «economic earnings» can be defined as the cash flow plus the change in the firm's market value.

Regardless of what accountants should or should not do, it is clear that they do not try to estimate economic earnings. Economic earnings must be largely serially uncorrelated; but we know that accounting earnings are close to a random walk, so that the earnings level in one year is highly correlated with the previous year's level.

When they calculate earnings, accountants start with the operating cash flow, and deduct an allowance for the expected depreciation of assets in place [1]. Thus we can think of accounting earnings as reflecting partly what actually occurred (the operating cash flow) and partly what was expected to occur (the deduction for depreciation). Since most of the noise in economic earnings consists of the change in present value, we might hope that accounting earnings would approximate *expected* economic earnings. In this case we could estimate present value by dividing accounting earnings by investors' required return. Fischer Black (1980) obviously had this in mind when he suggested that accounting rules are designed to produce as far as possible a number that when multiplied by ten is equal to firm value. Of course, no set of rules can be expected to work in all circumstances. So, most of the interesting issues centre on when accounting earnings are unlikely to measure expected economic earnings.

There are three principal reasons that accounting earnings are likely to differ from expected economic earnings:

1 — *Errors in accounting depreciation.* — The first source of error is that the true path of expected depreciation differs from the simple straight-line path that is commonly used in the calculation of accounting earnings. I will have more to say about this shortly.

2 — *Earnings shocks.* — The second, and more serious, problem is that earnings are subject to a variety of shocks. If earnings follow a random walk, so that the shocks are persistent, then it would be appropriate to capitalise the

[1] To keep the exposition simple, I ignore investment in working capital.

latest earnings (possibly with the addition of a drift term) at *r*. In fact, we know that earnings tend to regress towards the mean, so that simply capitalising current earnings is likely to induce error in the estimated value. We will tend to overestimate the value of firms whose earnings have recently increased and we will underestimate the value of firms whose earnings have declined. We will, of course, obtain nonsensical estimates of the value of loss-making firms.

Rather than capitalising a forecast of earnings by a common market capitalisation rate, it is more usual to value companies by multiplying current earnings by some measure of the average price-earnings multiple (or, to be more precise, the ratio of aggregate market value to aggregate earnings). This of course does not affect the rankings of different firms, but it does ensure that the average error in the estimated values is zero [2].

3 — *The value of growth opportunities.* — A third problem with capitalising earnings is that the value of the firm may reflect perceived opportunities for the firm to make new profitable investments in the future. Thus we can write the value of the firm as $PV = EPS/r + PVGO$, where *EPS* is the expected level of earnings from assets in place and *PVGO* is the present value of growth opportunities. It is doubtful whether accounting earnings can ever provide much information on the extent of growth opportunities, and therefore value estimates based on capitalised earnings are likely to understate true value by the amount of any growth opportunities.

By using a common earnings multiple to capitalise earnings, we may also adjust for the fact that the mean value of growth opportunities is not zero. Unfortunately, if different firms have different growth opportunities, they will not be correctly valued by multiplying current earnings by a representative earnings multiple. Thus the use of a representative earnings multiple may ensure that the average valuation error is zero but, since it will undervalue firms with high growth opportunities and overvalue the remainder, it does not, for example, necessarily reduce the mean square error for individual firms.

I mentioned earlier that instead of using earnings-based estimates of value, an alternative would be to use book value to estimate market value. If accounting depreciation equals the expected change in present value and there is no noise in the cash flow series, then the book value of the firm's assets cannot contain any extra information on firm value that is not already contained in the earnings. However, as I have noted, one of the problems with the use of accounting numbers is that accountants rely on simple rules of thumb to estimate depreciation. If accounting depreciation does *not* correctly measure the path of expected true depreciation or if there are shocks to the cash flows, then book value could be either a better or worse measure of true value than capitalised earnings.

Rather than just using book value as an estimate of market value, it might make sense to multiply book value by some measure of the average price to book ratio. This takes account of common biases in depreciation and of the

[2] Of course, if the market capitalisation rate is not the same for each stock, then the use of a common multiple could induce additional error.

failure to enter growth opportunities in the balance sheet. It, therefore, ensures that the mean error is zero, but it does not necessarily reduce the mean square error for individual firms.

Errors in Accounting Measures of Value

I turn now to look at how errors in accounting estimates of value are related to errors in accounting depreciation and the growth rate of the firm. I do so within the context of a simple steady-state model of the firm.

A number of papers [3] have commented on the relationship between accounting and economic rates of return. In particular they have modeled a world in which (*a*) returns are as expected, (*b*) projects have zero net present values, (*c*) a firm undertakes 1 project in Year 0, $(1 + g)$ identical projects in Year 1 and so on, and (*d*) the firm has reached steady state so that its cash flows are growing at rate g. An important result is that, regardless of the accounting depreciation method, the accounting rate of return is then equal to the economic rate of return only if the firm is in steady state growing at a rate of $g = r$.

In a similar spirit we can look at whether estimates of value based on book value can add to estimates based on earnings [4]. It is easiest to illustrate the relationship between present value, capitalized earnings and book value with a simple example. Suppose a firm initially invests \$1000 in a ten-period project, which has a zero NPV at the 10% cost of capital. For accounting purposes it depreciates the investment straight-line over the ten periods. In the second period the firm invests $\$1000(1 + g)$ in an identical project, and so on. By period 9 the company is in a steady state with expected cash flows and accounting earnings growing at a rate of g per period. I will assume for the moment that there are no shocks to cash flows, so that they turn out to be exactly as expected. Notice that g is the steady-state growth rate in *total* cash flows, rather than in per share earnings or dividends. The latter depends on the firm's payout ratio. For example, if the firm distributes all its earnings, then regardless of the growth in total cash flows, per share earnings and dividends will not grow at all, given my assumption that the projects have zero-NPV [5].

The accuracy of accounting-based measures of value depends in part on whether the economic depreciation is more or less accelerated than the accounting depreciation. I will therefore consider the three depreciation patterns illustrated in figure 1. The lower line is an example of accelerated economic depreciation, in which the value of the asset declines most rapidly in the early years. In figure 1 the decline in asset value *reduces* geometrically by 15 percent

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[3] See, for example, Solomon and Laya (1967), Fisher and McGowan (1983), Kay (1976), and Bodie (1982).

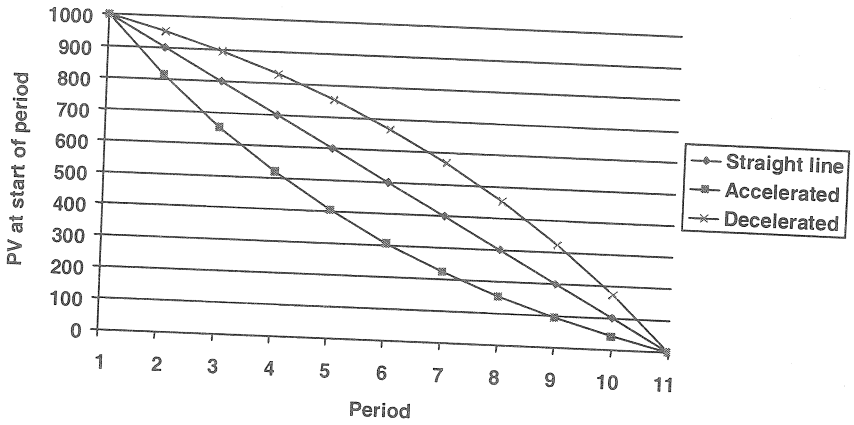
[4] My discussion of this issue draws on Ballas (1991).

[5] There is also no assumption that growth continues indefinitely and, indeed, this would be implausible when $g > r$, for this would imply that the firm has negative cash flows in steady state.

per period. The upper line is an example of decelerated economic depreciation. The decline in asset value *increases* by 15 percent per period. Finally, the middle line shows the case where economic depreciation is the same in each period and asset value declines linearly.

FIGURE 1

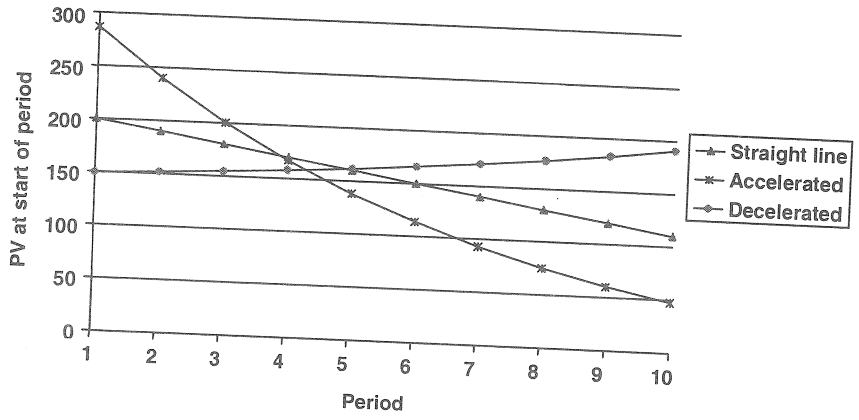
Three types of economic depreciation



Each of these depreciation patterns implies a particular pattern of cash flows and these are illustrated in figure 2. For example, the pattern of decelerated economic depreciation implies that cash flows are lowest in the early years of the asset's life and rise by an increasing dollar amount each year. By contrast, under accelerated and straight-line economic depreciation, cash flow declines as the asset matures [6].

FIGURE 2

Cash flows associated with three types of economic depreciation

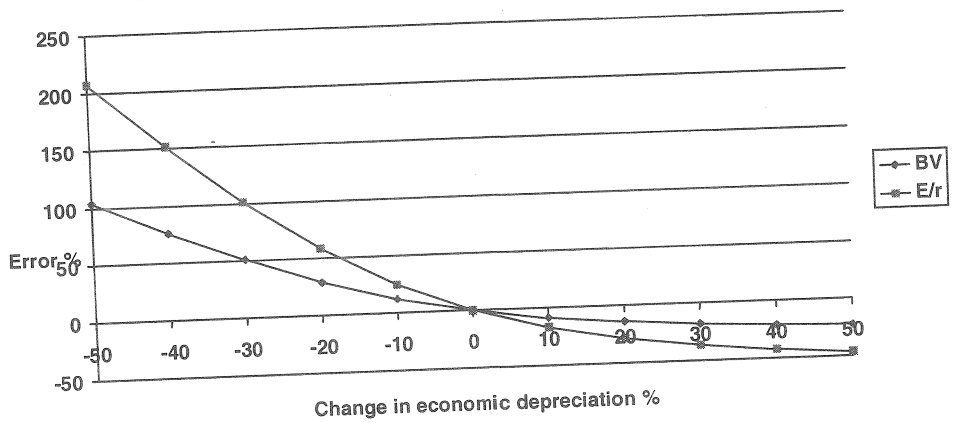


[6] For example, under straight-line depreciation, the value of the asset declines linearly and, since the firm expects to earn in each year the cost of capital on its assets, the economic income also must decline linearly. Cash flow is equal to the constant depreciation plus the linearly declining economic income.

Now suppose that in period 9 you estimated firm value (*a*) by capitalizing firm earnings at the cost of capital *r*, and (*b*) by the net book value of assets. For a given growth rate, the errors in your two estimates would depend on the economic depreciation of the assets. For example, in figure 3 I have arbitrarily assumed a growth rate of 20 percent and have plotted the valuation errors as the economic depreciation moves from accelerated to straight-line and then to decelerated. Notice that when economic depreciation and the accounting depreciation are both straight-line, then both book value and capitalized earnings provide exact measures of firm value. In any other case value is estimated with error and these errors are positively correlated. This is a general result. In the particular example, shown in figure 3, book value measures are less sensitive than capitalised earnings to errors in accounting depreciation, and therefore they provide the more accurate measure of value when depreciation is not straight line. As we shall see shortly, this is true only when the growth rate lies outside the range $-r$ to $+r$ [7].

FIGURE 3

Valuation errors in BV and E/r for 20% growth rate and changing economic depreciation patterns (NB negative nos. represent accelerated depreciation)



I now look at what happens when we hold economic depreciation constant but vary the growth rate. For example, figure 4 shows what happens for a wide range of growth rates [8] when accounting depreciation is straight-line but economic depreciation is accelerated. In this case book value always overestimates firm value but the error declines asymptotically as the firm's growth rate increases. For very high growth rates the older assets are increasingly unimportant and therefore the errors in the depreciation method also dwindle in their effect. For very low growth rates capitalized earnings underestimate firm value and for very high growth rates they overestimate value. This suggests that there is some

[7] As we noted in footnote 5, growth rates in excess of the cost of capital are implausible since they imply negative cash flows in steady state.

[8] For very low growth rates the estimated values are negative and inconsistent with limited liability.

growth rate at which capitalized earnings always gives a correct measure of value and this in fact is the case when the growth rate is zero. As I noted earlier, capitalized earnings are a more accurate measure of firm value as long as the growth rate lies between minus the capitalization rate and plus the capitalization rate.

FIGURE 4

Valuation error when true depreciation is accelerated ($r = 10\%$)

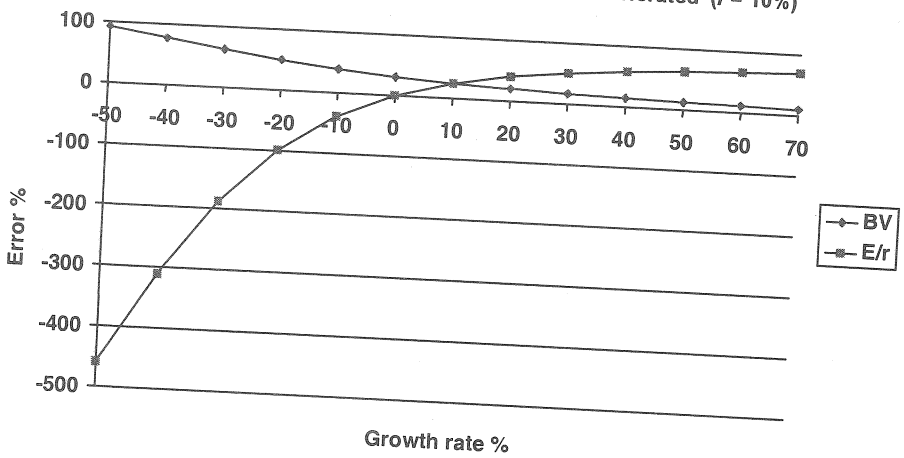
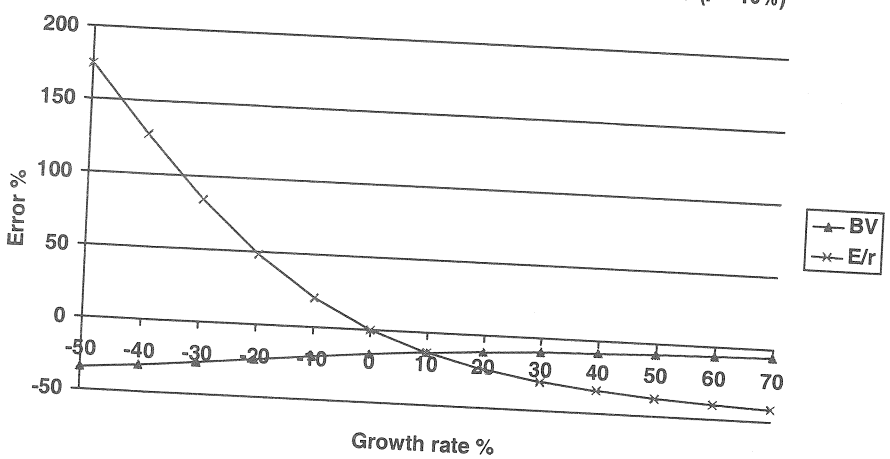


Figure 5 shows what happens when true depreciation is decelerated. The picture is now turned upside down, with book value always underestimating firm value and capitalized earnings overestimating value at low growth rates and underestimating at high growth rates. As in the case of accelerated depreciation, capitalized earnings has zero error when the growth rate is zero and is the more accurate method when the growth rate is within the range $-r$ to $+r$. Indeed, these two results are independent of the particular depreciation pattern.

FIGURE 5

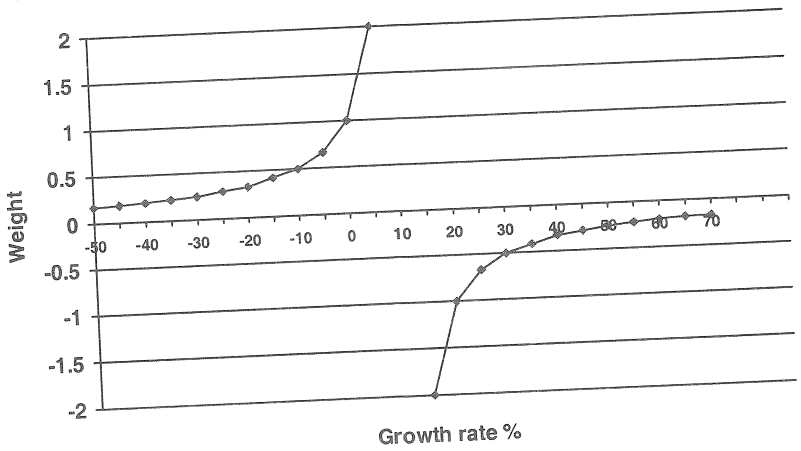
Valuation error when true depreciation is decelerated ($r = 10\%$)



As long as the growth rate is not equal to the capitalization rate, there is some combination of capitalized earnings and book value that will give an exact measure of firm value. So you might think that the best way to estimate firm value is to employ some weighted average of the two methods. The good news is that the optimal weights are independent of the depreciation method. However, figure 6 illustrates the problem with determining the optimal weights. The optimal weight on capitalized earnings is positive but close to zero for very low growth rates and approaches infinity as the growth rate approaches the capitalization rate from below; it is negative but close to zero for very high growth rates and approaches minus infinity as the growth rate approaches the capitalization rate from above. So to know how to weight the two estimates, you need to know the growth rate but not the true depreciation schedule. I will return to this point shortly.

FIGURE 6

Optimal weight placed on capitalized earnings in estamating market value



Of course, for any sample of firms you could estimate a common set of weights on the two estimates that would minimize (say) the mean square error in your combined estimates. Unfortunately these common weights depend on the mean growth rate for the sample of firms and the dispersion of the growth rates. For example, as the dispersion of growth rates among firms rises, the possibility of large errors from capitalising earnings also rises and therefore the weight placed on book value should increase. To make matters worse, notice that when true depreciation is held constant and growth varied, the errors in the two valuation methods are negatively correlated. When growth is held constant and depreciation varied, the errors are positively correlated. Thus the actual correlation between the valuation errors could be either positive or negative depending on the relative dispersion in growth rates and true depreciation. In practice therefore we are likely to find

the correlation between market and accounting measures of value is quite unstable from year to year and from sample to sample. This makes it even more difficult to devise an optimal combined forecast and poses considerable difficulties for anyone doing empirical work on the relationship between market and accounting measures of value.

I noted earlier that the weights placed on capitalized earnings and book value are independent of the error in the depreciation method, though they are not independent of the growth rate. This suggests that there should be some expression that links book value, capitalised earnings and growth rate to provide an error-free estimate of market value. This is indeed the case and involves a simple restatement of a valuation formula analyzed by Ohlson (1990) and Feltham and Ohlson (1995,1996) [9]. If the steady-state accounting rate of return is r_{book} and the cost of capital is r, then regardless of the depreciation schedule, the book value BV will understate firm value by $BV(r_{book} - r)/(r - g)$. In other words, the book value needs to be adjusted for the fact that the firm is expected to earn an excess return on book assets equal to the difference between the accounting rate of return and the cost of capital. These apparent rents will grow with the firm at the rate g. When there are no cash flow shocks, this constant-growth version of the Feltham/Ohlson formula combines earnings and book value information to give an exact measure of value [10]. It does so because the accounting numbers can be translated into cash flow forecasts over the life of the existing assets and the new assets have zero net present value. However, not only does the expression require knowledge of the growth rate, g, but, as I will show shortly, it can break down badly when there are cashflow shocks.

Accounting Measures of Value with Cash Flow Shocks

So far I have assumed that the firm's investments have zero NPV and that there are no surprises in the cash flows. Suppose, for example, that after the firm has reached steady state, a windfall event causes investors to revise upward their estimate of firm cash flow in the coming year by (say) 20 percent. This could be either a one-off shock or it could cause investors to revise their estimate of cash flows in later years. I will assume that they revise their forecast of cash flows for all existing projects but not for projects that are still unborn. Thus the present value of growth opportunities remains zero and the cash flow shocks induce negative autocorrelation in earnings levels as existing projects mature. In this respect my simple assumption captures some of the observed behaviour of accounting earnings.

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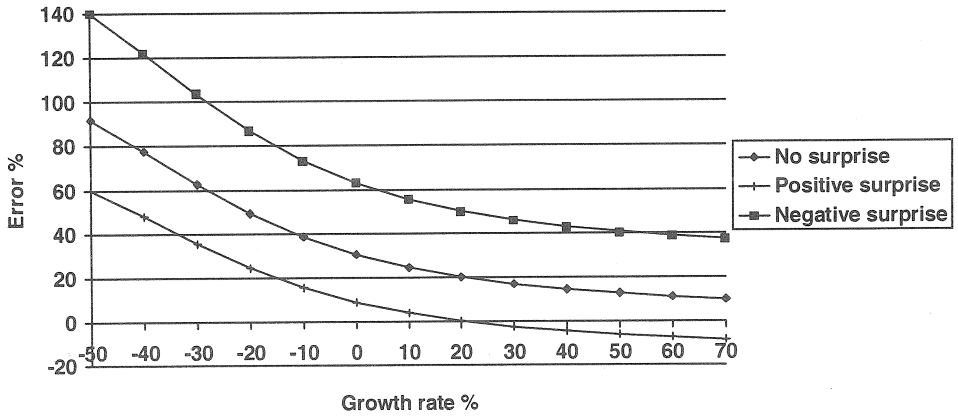
[9] See also, for example, Edwards, E. and Bell, P. (1961).

[10] Since in the absence of shocks both the numerator and the denominator change sign at the same point, the expression is correct regardless of the sign of $(r - g)$.

Since all the firm value comes from assets in place and all future cash flows are increased by 20 percent, the cash flow surprise also causes the present value of the firm to increase by 20 percent. On the other hand, since the book value of the existing assets is determined by the initial cost of the assets and by the predetermined depreciation schedule, it is unchanged by the shock to the cash flow. Thus, as figure 7 illustrates for the case of accelerated depreciation and cash flow shocks of plus and minus 20 percent, the possibility of cash flow shocks widens out the range of possible errors when using book value as a guide to firm value.

FIGURE 7

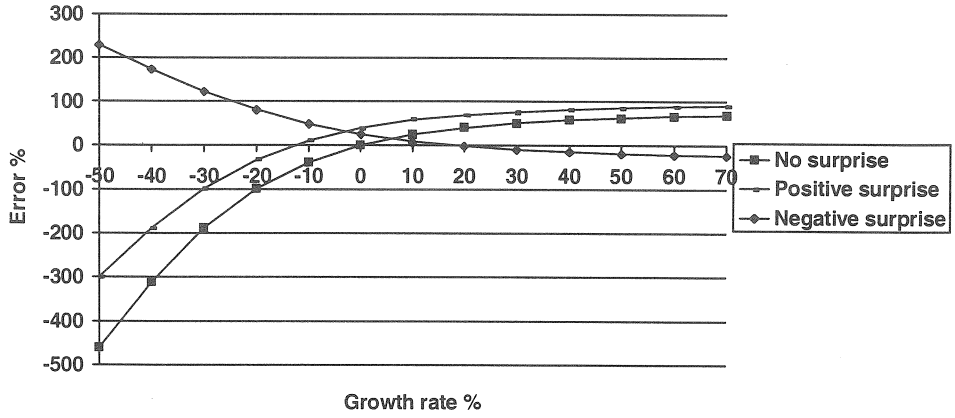
Errors from BV valuations with accelerated depreciation and earning surprises



Since the surprise affects cash flow, it also affects earnings but because depreciation is unchanged, the proportionate effect on earnings is greater than on cash flow. Also by capitalising earnings by the cost of capital, we are implicitly assuming that the change in cash flow is permanent rather than limited to the duration of the project. As a result, the opportunity for surprises widens the range of errors when estimating values from capitalized earnings (see figure 8). If the growth rate is zero, the error in capitalised earnings is simply equal to the proportionate shock in cash flow times the annual investment discounted at the cost of capital. For example, if the shock doubles the cash flows on a $1 investment and r = 10 percent, then the error from using capitalised earnings is $1/.1 or $10. This is likely to be proportionately quite large in the case of a firm making a series of relatively short-term investments. My earlier statement that capitalized earnings provides the superior estimate when g is between minus and plus r also no longer holds when there is the possibility of cash flow shocks. It is nevertheless the case that the errors from capitalizing earnings tend to be lowest when the growth rate is relatively moderate.

FIGURE 8

Errors from capitalized earnings valuations with accelerated depreciation and earning surprises



The apparent solution is to use the constant-growth version of the Feltham/Ohlson formula which we know to be precise when investments have zero NPV. Unfortunately, this can give very large errors when there are shocks to earnings. This is illustrated in figure 9 where I show the error for a variety of growth rates. When the growth rate is zero, the book value terms drop out of the formula and the error is identical to that from capitalised earnings. However, the assumption that the firm is in steady state causes the apparent rents to be capitalized at (r - g). Thus, when the growth rate approaches the capitalization rate, the estimated firm value approaches minus or plus infinity.

FIGURE 9

Errors from constant-growth version of Feltham-Ohlson valuation model with accelerated depreciation and earning surprises

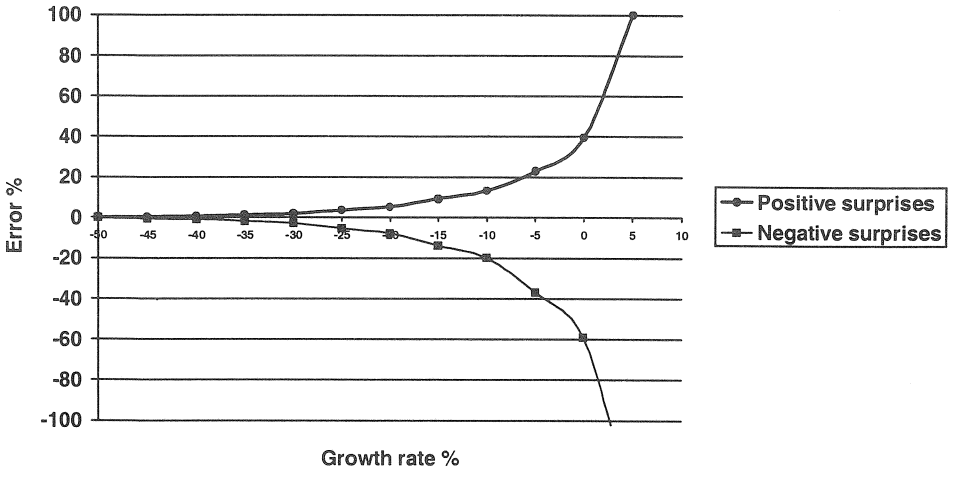
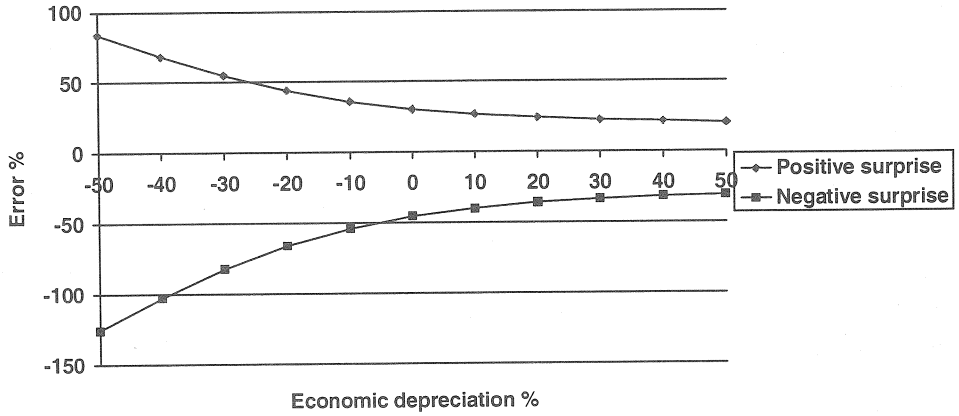


Figure 10 gives an example of how the errors from using the constant-growth version of the Feltham/Ohlson model vary with changes in the rate of economic depreciation. For any growth rate less than the cost of capital, the valuation error declines asymptotically to a non-zero constant as the economic depreciation becomes more decelerated.

FIGURE 10

Valuation errors in constant-growth version of Feltham/Ohlson valuation model for zero growth rate and changing depreciation patterns and earning surprises (NB negative nos. represent accelerated depreciation)



It is worth stressing that these problems arise not because of an error in the Feltham/Ohlson valuation model, but because in applying it I have assumed that the firm is in steady state whereas in fact the cash flow shock is transient. If we knew exactly how the shock was going to impact future earnings, then we could adjust book value by summing the discounted values of the excess earnings for each future year. This would give us an exact measure of firm value, but it is difficult to see how we could ever hope to isolate the impact of shocks in this way [11].

A digression on inflation

Historic cost accounting does not distinguish whether the growth in cash flows over the project's life or the growth in the amount of investment is real or simply a consequence of inflation. Inflation does, however, make it more likely that the nominal growth rates will be higher and thus shifts the pattern of economic depreciation towards decelerated depreciation.

[11] Since the error stems from the assumption that the abnormal earnings are perpetual, one might hope to reduce this error by capitalising the abnormal earnings at a lower rate. Unfortunately, the multiple that needs to be applied to these abnormal earnings is a function both of the depreciation rate and the growth rate.

Under current cost accounting the source of growth does become relevant. If the write-up in asset values is added back to reported earnings, capitalising steady-state accounting earnings at the nominal cost of capital continues to value the firm correctly when the growth rate is zero and there are no earnings surprises. Capitalising the adjusted earnings also provides a more accurate estimate than book value as long as growth is between plus and minus the capitalisation rate. If the growth rate is not zero, the effect on the valuation error of the change from historic cost to current cost accounting depends on both the true depreciation rate and the level of inflation. For example, if true depreciation is decelerated (accelerated) and inflation is positive (negative), then both capitalised adjusted CCA earnings and CCA book value provide better estimates than under historic cost accounting. In the remaining circumstances current cost accounting provides worse estimates.

Since the Feltham-Ohlson formula is exact under clean-surplus accounting, the obvious solution is to add back asset appreciation to CCA earnings and apply the steady-state version of the formula. Unfortunately, in the real world of periodic shocks to earnings, all bets are off, for once again the use of currently available accounting data with the Feltham-Ohlson formula can lead to very large and unstable valuation errors.

Summary and conclusion

The simple steady-state model that I have described is very stylized and there are limits as to how much one can hope to learn from such models, particularly when there are growth opportunities and shocks to cash flows. However, it is clear that, if we wish to use simple accounting rules of thumb more intelligently, we need to understand the source of the error variance. Stylized models can provide some signposts on how to do this.

I have focused in this paper on three estimates of a firm's market value — book value, earnings capitalized at the cost of capital, and a combined measure that is a simple application of the Feltham/ Ohlson valuation formula to a firm in steady state. Even in the absence of earnings surprises, the book value of the firm's assets is an unreliable measure of a firm's market value unless accounting depreciation equals expected economic depreciation. Capitalized earnings also measures value with error, unless either the firm is in steady state with zero growth or accounting depreciation equals expected economic depreciation. As long as there are no earnings surprises, the proportionate errors in these two measures depend on the firm's growth rate and the cost of capital but not on the depreciation pattern. Therefore there must exist a weighted average of the two measures, where the weights depend only on the growth rate and cost of capital, that will give an exact measure of value. This weighted average is provided by a simple application of the Feltham/ Ohlson valuation formula to a firm in steady state. Unfortunately, when there are earnings surprises, all bets are off, for none of the models can be relied upon to provide an accurate measure of value.

It is trivially obvious that, unless the form of the earnings shock is specified, no simple valuation formula could possibly be expected to provide an accurate measure of firm value. What is somewhat less obvious is the relationship between the valuation errors and the rates of depreciation, the firm's growth rate, and the form and magnitude of any earnings shocks. Moreover, not only is each of the measures subject to error but these errors cannot be relied on to cancel out when valuing a portfolio of firms. Thus, the choice of simple accounting formulas to value (say) a portfolio of unquoted securities requires difficult judgments to be made about the form of the errors.

These examples are also a warning about the difficulties of doing empirical work in the area. Since the errors in each rule of thumb are correlated with growth, economic depreciation and earnings shocks, all of which are likely to vary across firms and across time, the analysis of the responsiveness of firm value to variations in the level of accounting variables is likely to prove problematic.

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