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RATIO MODELS FOR THE VALUATION OF EQUITY SECURITIES

PLAN

ABSTRACT

It has been suggested that the objective of the accounting measurement process should be to produce an earnings number that could be used as a measure of a firm's value and indeed financial analysts use accounting data to get an estimate of a company's price. This paper is a cross sectional study on British company data over a 17 years period which examines the performance of alternative valuation ratios (price earnings ratio, market to book value ratio, price dividends ratio) as predictive rules of the market capitalization of a corporation.

We use the results of Ballas (1991) about the correct mathematical specification of ratios that involve market data as the numerator and accounting data as the denominator to test for the best definition of earnings and book value of assets which minimizes the dispersion around the mean of the ratio. Subsequently, the performance of the best price earnings ratio is compared to that of the market to book value ratio and the price dividends ratio as well as that of a combined forecast methodology. Finaly, tests for industry effects were carried out which indicate that industry effects are of small economic significance.

I. INTRODUCTION

Over the past twenty years numerous studies have shown that capital market participants use accounting information to price equities.

In textbook situations, arriving at the value of a company is simple: one takes expected future cash flows, discounts them and arrives at the company's value. In most cases however, this is simply not possible because the cash flow data are not available and users have to use accounting data. In situations like Initial Public Offers, division sales, and valuation of companies for tax purposes when capital market data are not available the only way to obtain a "fair value" is to use data from financial statements.

Potentially, there are many ways to analyze the accounting data in order to get an estimate of a firm's value. In this paper we focus on simple, univariate rules; in other words, we test how well can we predict the market value of a company using information on the price earnings, market value to book value and price dividend ratios of other firms.

The first question we aim to answer is what is the best definition of earnings and book value of a company in this context. It is recognized that this resembles a data mining exercise but this has, hopefully, been limited by concentrating only on accounting variables where we could make a case that they refer to wealth accruing to shareholders.

The criterion used, is which variable produces the ratio with the minimum dispersion around the mean. Of course, a valuation madel where there is a constant relationship between earnings (or the book value) of a company and its market capitalization is unsustainable but there many plausible arguments why price earnings ratios should show small variability around the mean. Furthermore, it is easy to show that a ratio relationship is simply a

regression equation with some assumptions about the errors. Thus, the choice criterion is which measure of earnings or book value of assets minimizes the root mean square error of the residuals (or, equivalently, the standard deviation of the ratio). We test this using a sample of UK firms with December year ends for the period 1971-1987.

In addition to examining simple univariate rules we show that because residuals from the three approaches are less than perfectly correlated, a combined forecasting methodology significantly reduces the average prediction error.

This paper concludes by testing how the prediction error changes as we move further away from the announcement date and the effect of using industry specific characteristic ratios.

II. APPLICATIONS

The valuation of the equity of companies is a very important issue for investors, accountants, corporate finance specialists in merchant banks and the courts.

For example, in the case of IPOs accounting data appear to play a major role in determining the issue price. Thus, in the period leading to the big privatizations in the UK, the financial press based its comments on whether the issue price was "fair" on the comparison of the companies' price dividends ratio with that of quoted companies. In a subsequent paper, we shall provide evidence on the extent to which the magnitude of errors in simple valuation rules based on accounting data compare to errors in the issue prices of IPOs.

Accountants are frequently consulted on the valuation of companies for fiscal purposes i.e. for capital transfer tax and capital

gains tax, an obligation that dates back to the 1894 Finance Act of the United Kingdom which established the notion of the "statutory open market valuation". In this case, the valuer must determine the price at which the company would change hands between a (hypothetical) willing seller and a (hypothetical) buyer, both informed. Successive court decisions have defined these terms but a detailed discussion of them is beyond the scope of this paper. It is interesting to note that the UK legislator has not given any guidelines on what should be the determining factors of the valuation but rather left the courts to rely on "commercial practice".

The "leading" modern case in valuation for fiscal purposes (in the UK) has been that of Lynall vs IRC[1] before the House of Lords in 1972 where a company was valued using a dividends multiplier. The general trend in UK litigation has been to use either a dividends or an earnings multiple (as in the case of Buckingham vs Francis (1986)) which is arbitrarily (based on the "feelings" of the expert witnesses) adjusted for non-quoted companies from that applying for companies that are quoted.

Similar principles apply to the USA where, in contrast, the Treasury in reg. 20.2031 - 2(f)(2) listed the factors which are to be considered in establishing the fair market value of non-quoted shares: the company's net worth, prospective earnings, dividend paying capacity and other "relevant factors". However, no guidance is given on how these factors are to be discounted or how they should be weighted (or indeed how they should be measured given that at least two of the "factors" are heavily ingluenced by convention). Thus, there has been litigation, in the cases that the IRS and the taxpayer could not agree on a fair valuation of the company. The most frequently cited precedents are the Bader and Central Trust cases.

To briefly summarize these cases, both used a weighted aver-

1. For a description of this case and all others discussed here see Eastaway and Booth (1985).

age of the estimates of value for a company based on the book value of its assets, earnings and dividends multiplied by the prevailing market to book value of assets, price earnings and price dividends ratios for quoted companies. The two cases differ on how these numbers were estimated and the weights applied but the principles were similar. Finaly, the estimate of value arrived at, was discounted to reflect that the companies were not traded. We will be commenting below on the efficiency of the valuation formulas.

In addition to tax cases, Market Comparable Formulae have been applied to cases where there has been a change in the ownership structure of a company. For example, in the case of mergers and acquisitions even of traded companies, valuations based on accounting data are used by all three parties (bidder, incumbent management and shareholders) and referred in the financial press. Also, in litigation in the USA on the fairness of price recommended by management to shareholders the courts have taken a weighted average of the company's market capitalization and the value implied by a simple price earnings ratio. Or, in the case of MBOs, courts and independent financial experts apparently accord major emphasis to earnings-based-forecasts in their assessments of fair value in non-arm's-length acquisitions[2].

Much of this paper has a normative tone; how one can use simple accounting neasures of profitability and (book) asset values to value companies. But in addition, a better modelling of the relationship between accounting variables and security prices may have important positive implications. For example, our findings have clear relevance to Fisher Black's (1980) argument that "users of financial information ... want an earnings figure that measures value, not change in value" and therefore "would like the accounting process to give an earnings figure they can simply multiply by 10 to get an estimate of value".

2. For example, see DeAngelo (1986).

III. METHODOLOGICAL ASSUMPTIONS OF RATIO ANALYSIS

The use of ratio models to value a company has a long history in practice and most financial analysis textbooks devote a significant number of pages to ratio techniques. Boatsman and Baskin (1981) compared the predictive performance of three valuation rules: a modification of the CAPM, the price earnings ratio and the indexing in the values of the assets of the company for economy or industry - wide changes in asset values. Their conclusions were that the CAPM has a slight advantage over price earnings ratios adjusted for growth which is not significant for practical purposes.

Leclair (1990) examined the performance of price earnings ratios in the valuation of closely held companies in comparison to the Adjusted Book Value method. His conclusions were that the earnings based approach outperforms the ABV one although there are industry variations and, surprisingly, that combined prediction methods (such as those used by the US courts) are unnecessary because the book value of assets and dividends have low explanatory power on the residuals of the price earnings method. This last conclusion is based on the small R^2 of the relevant regressions but ignores the values of the coefficients (which are related to the weights that ought to be applied) which are quite high.

This extensive use of accounting ratios assumes that there is a roughly proportional relationship between the size/dependent variable in the numerator (in this case market capitalization) and the deflatory/explanatory variable in the denominator (in our case measures of profitability or book value of assets). For example, it is assumed that in the case of the price earnings ratio the relationship is of the form:

$$\frac{Price_i}{Earnings_i} = \beta + \varepsilon_i \qquad (1)$$

where price refers to market capitalization of company i, earnings are used as an example for all accounting variables we will be using, β is the ratio location statistic[3] and ε_i is an error term. An alternative functional form if we assume that the relationship is multiplicative is given by equation (2):

$$\frac{Price_i}{Earnings_i} = \beta \times \varepsilon_i \tag{2}$$

If the proportiomality assumption is valid the economic interpretation of the characteristic ratio is straightforward: it represents an unbiased measure of both the marginal effect and the average effect of the independent variable (earnings) on the dependent one (price).

However, as Lev and Sunder (1979) and Whittington (1980) suggest, there are a number of reasons why the proportionality assumption will not be valid.

The most frequently discussed statistical problems with the ratio methodology are:

a) the presence of an intercept as in the classical regression model.

b) dependence on other variables and non-linearity in the relationship.

c) violations of the assumption of normally distributed residuals.

d) whether the relationship is additive or multiplicative and whether the error is homoscedastic.

The last is the most important issue because it affects the choice of the characteristic ratio (e.g. the number times which earnings must be multiplied to get the value of the company) and the criterion used to evaluate alternative valuation rules. Implicit is also the assumption that earnings and other financial variables

3. The desirable propertiy of this statistic is that it should be a measure of the marginal effect of earnings on prices; at the simplest level, it can be estimated as the arithmetic mean of the ratios of all the companies in the sample.

are exogenous and not determined by the market value of the company.

Ballas (1991) presents an empirical investigation of these methodological issues. His main results can be summarized as follows:

a) The exclusion of the intercept from the model (if the relationship is linear) is not warranted.

b) Though the relationship exhibits statistically significant deviations from the linear case these are trivial in an economic sense.

c) The valuation ratios are approximately log - normally distributed.

d) The relationship is best modelled as multiplicative and, given the previously mentioned results, the parameters' estimators are independent of the distribution of the residuals.

The conclusion that can be drawn from these results is that it is most appropriate to estimate the characteristic ratio as the mean of the log - transformed ratios. The criterion used to assess the predictive performance of ratios that use alternative accounting variables is the standard deviation of the log - transformed ratio; because we employ data for 17 cross sections, we will be looking at the (median) error over all periods and for how many periods each rule had the minimum error.

IV. SAMPLE SELECTION CRITERIA AND DEFINITION OF VARIABLES

The data sample that will be used in this paper has been extracted from two databases maintained by the Institute of Finance and Accounting at the London Business School. Companies' ac-

counting data were extracted from the mini version of EXSTAT and capital market data from the London Share Price Database/ Source file (henceforth to be called EXSTAT and LSPD respectively).

From this database we extracted all companies which fulfilled the following criteria:

a) Accounting year end around the end of December since it is the period when the biggest percentage (40%) of British companies prepare their financial reports. However, acceptable accounting year end dates were between 21/12 and 10/1 to counter the problem of switching accounting year ends by British companies identified by Barron (1984). Essentially, this problem arises because many firms target a specific day (e.g. last Friday of the year) as year end rather than a specific date.

b) At least four year of both accounting data (of which at least two should have been profitable) and share price data.

c) Finally, companies with non positive book value of common equity capital (including reserves) were excluded from the analysis. Initially, companies with negative net worth were dropped because the UK company law provides that these companies could be forced into receivership. One observation was also dropped from the sample because the sum of the assets did not match that of liabilities plus book value of equity (beyond rounding error).

The LSPD is a research database that includes capital market price data and other general information about all companies quoted in the London Stock Exchange. From it we extracted the number of shares and price data for the end of March immediately after the accounting year end. If prices were more than seven days old at that time the company was dropped from the sample. Prices at the end of March were used because at that point we can assume that the great majority of companies in the sample have reported their financial results[4] and therefore, this informa-

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4. This information was given to us in discussions with financial analysts and the data collection staff at EXTEL.

tion has been impounded in prices and that the financial information is still relevant (see also the last section in this paper).

In total the sample comprises 6402 data points distributed across 17 years but because of the various restrictions the number of data points fluctuates considerably across the years as can be seen in figure 1.

The variables that we will be using in this paper were defined as follows:

a) Market Capitalization: The product of the number of common shares issued by the company times the price at the end of
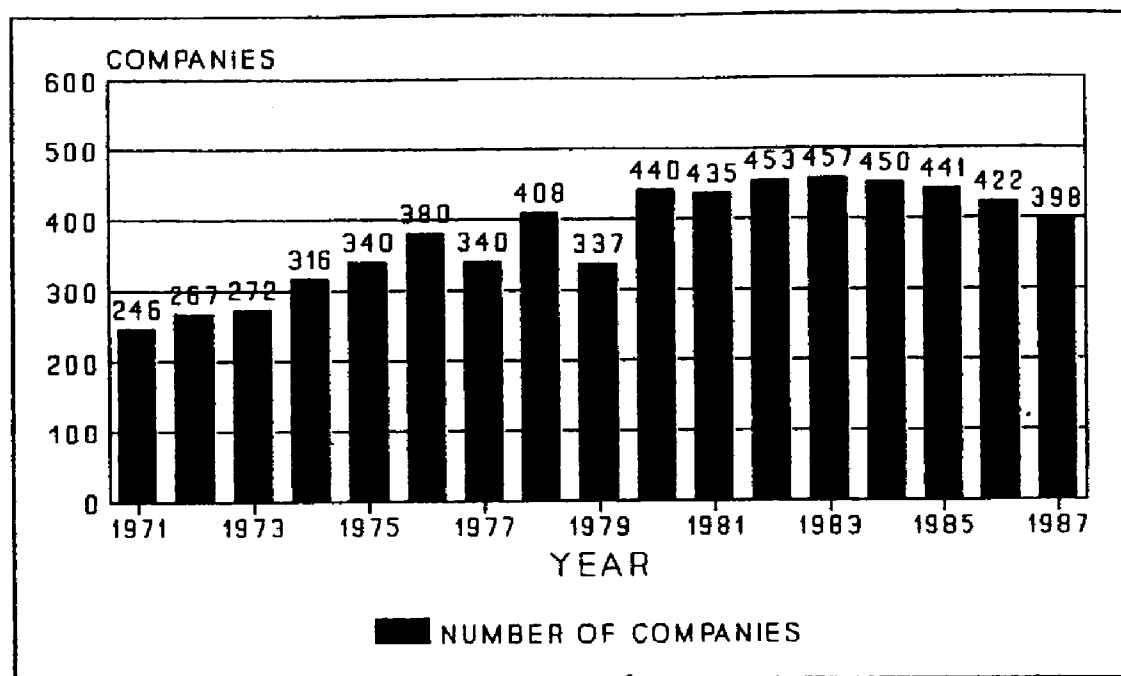

Figure 1. Number of Companies in the sample per year.

March. If the company has more then one type of common equity security issued (e.g. A and B shares or shares registered under different names), the market capitalization is the sum of all of

them. In terms of market capitalization, the average company in our sample is smaller than the companies comprising the Financial Times All Share Index.

b) *Profit and Loss Account Items*[5]:

    i) Operating profit (OPROF): Profit before interest (and taxes) and other income.

    ii) Earnings before tax (EBT) but after the creditors have been paid off.

    iii) Profits after tax or net profit (NET).

    iv) Profits after adjusting for extraordinary items (EXTRA).

c) *Balance Sheet Variables*[6]:

    i) Total book value of assets (BOOK).

    ii) Book value of assets minus intangible assets (BOOI).

    iii) Book value of equity capital (or SHARe capital): The total of the balance sheet values of issued equity share capital, excluding the balance sheet value of issued preference capital, but including various reserves.

    iv) Corporate net worth (OEP) which is defined as the difference in the book value of assets minus the sum of the liabilities.

d) *Dividends:* (gross).

When we test for industry effects, we use the Institute of Actuaries industrial classification scheme except that we aggregated industries in 19 groups (details of the aggregation scheme can be found in the appendix).

5. The calculation of the profit and loss account variables, in terms of EXSTAT items is as follows: Operating PROFit = #62, Earnings Before Tax = OPROF +#63 +#64 +#65 -#66 -#67 -#68 -#69, NET earnings = EBT -#70 -#71 -#72 -#73 -#74 -#75, and earnings adjusted for EXTRAordinary items = NET -#77.

6. The calculation of balance sheet variables in terms of EXSTAT data items is as follows: BOOI = (SUM of (#6 to #12)) + (SUM of (#14 to #18)), BOOK= BOOI + #8, SHAR = SUM of (#27 TO #32) and OEP = SHAR + #28 + #33.

V. SIMPLE MODELS OF ACCOUNTING NUMBERS CAPITALIZATION

Most of the voluminous literature on Market Based Accounting Research treats accounting earnings as information signals; Black (1980) suggests that it is possible to find a valuation role for them.

There are three possible categories of ratios that one can use to value a company: the price earnings ratio, the market to book value of the company and the price dividends ratio where dividends can also be seen as "free" cash flow to shareholders.

In this section we first compare the predictive performance of ratios using alternative definitions of earnings in order to select the definition that is optimal for valuation models. Subsequently, the same is done for price to book ratios. Then, the two rules that use accounting variables, i.e. the price earnings ratio and the market to book value of assets ratio are compared with the dividends capitalization model to examine whether accounting statistics of value have superior information to that contained in current dividends. Finally, we examine the correlation of the residuals from the three approaches in order to examine whether the accounting variables have incremental information to divident payments and therefore, whether we can improve on the univariate prediction model. It should be emphasized that the sample changes across sections; we use the maximum number of companies for which all variables for that section are defined.

V.1. Price Earnings Ratios

Black (1980) calls for the selection of accounting measurement rules that will result in accounting income approximating permanent income which is usually defined as the constant sum that could be distributed to the shareholders in perpetuity. In our

empirical tests we focus on alternative, traditional income measures to discover which is the best one in this respect.

The use of price earnings ratios is widespread. Their use can be explained by a simple transformation of the Gordon valuation equation where a constant, over time, dividend payout ratio is assumed or by the Modigliani and Miller argument that the value of the firm in the absence of growth opportunities should equal the present value of a perpetuity of a constant stream of earnings.

Our aim is to identify an accounting earnings variable that would approximate permanent earnings as suggested by the two explanations for the usage of price earnings ratios. Thus we are faced by the question of which of the claims on the firm's cash flows are perceived by shareholders as representing transitory perturbations of permanent earnings.

Among the measures of profitability tested, we did not include a gross profit figure (because data were not available) with the least aggregated measure used in the tests being operating profit which is the number that most approximates the firm's income generation capacity but which is likely to be biased because it includes the effect of accounting depreciation schedules (and other smaller items such as cost of inventories). The second profit measure used was earnings before taxes (which includes other "profit" sources such as foreign exchange gains and losses and income from associated companies). The next profitability measure is profit after tax or net earnings. The tax payable by the company is a function of both its cash flows and the allowable offsets (e.g. accelerated depreciation, investment bonuses etc). Thus the influence of tax payments is not clear cut: it may be increasing noise because of the different bases of tax assessment from economic values or taxes may be smoothing errors in the accounting measurement process. In addition tax incentives, which affect the accounting valuation process may be creating value because they limit the government's claim. This argument is consistent with the widely held view that accounting choices can have real economic effects.

TABLE

TABLE I

Comparison of root mean square error for the log-transformed ratio of market capitalization to various profitability measures

Year	PE1	PE2	PE3	PE4
1971	.499	.490	.498	.466
1972	.556	.475	.454	.444
1973	.589	.554	.547	.598
1974	.570	.510	.517	.745
1975	.570	.484	.490	.548
1976	.574	.519	.565	.579
1977	.528	.481	.493	.623
1978	.565	.511	.512	.564
1979	.609	.579	.615	.648
1980	.738	.742	.672	.823
1981	.771	.731	.755	.769
1982	.794	.617	.631	.795
1983	.803	.641	.594	.782
1984	.787	.674	.628	.848
1985	.714	.598	.517	.668
1986	.710	.543	.535	.660
1987	.642	.549	.507	.550
MEDIAN	.609	.549	.535	.648

where:
PE1: ratio of market capitalization to operating profit,
PE2: ratio of market capitalization to profit before tax,
PE3: ratio of market capitalization to net profit,
PE4: ratio of market capitalization to profit adjusted for extraordinary items.

Finally, earnings after extraordinary items were included in order to examine whether extraordinary items are capitalized at the same rate as earnings from ordinary business activities. Extraordinary items should not affect the earning power of the firm and thus should simply be treated as noise.

The average prediction errors using each profit measure are presented in table I. As it can be seen there is very little to choose

between using earnings before tax and net earnings[7] because both ratios minimize the forecasting error in the same number of years though net earnings have a smaller median error.

Furthermore, we "pooled"[8] the prediction errors for the four alternative profit measures and ran a sign test to examine whether the superiority of net profits might be due to sampling error. The results were that the prediction error using net profits or profits before tax versus that using operating profits or earnings adjusted for extraordinary items was smaller at the 5% level.

In subsequent tests the price to net earnings ratio will be used because of its slightly better performance (on average) and because it is more consistent with previous research and practice.

V.2. Market to Book Value Ratios

As in the case of profitability measures we selected four measures of the book value of assets that reflect different distributions of the firm's assets to the shareholders.

If the accounting process could give a perfect measure of the replacement cost of the firm's assets (including goodwill), then net (of debt) book value of assets should have been equal to the firm's market capitalization. However, this assumption is unlikely to be true in practice. If instead, the error in the book value of assets compared to the market one is assumed a constant μ over all assets, irrespective of age, and described by a relationship of the form:

$$MCAP_i = \mu.BOOK_i.\varepsilon_i$$

(3)

we have a ratio model.

7. If operating profit was adjusted for other income, then we would have three earnings measures with roughly the same performance as predictors of market capitalization.

8. That is we created variables of forecasting errors with the forecasting error in each of the 17 periods as an observation.

Our aim is to identify a measure of the firm's book value of physical capital which is most closely related to the equity market value of the firm.

TABLE II

Comparison of root mean squared error for log-transformed ratios of capitalization to various historical cost valuations of assets

Year	PB1	PB2	PB3	PB4
1971	.671	.684	.610	.636
1972	.607	.618	.533	.558
1973	.650	.659	.559	.571
1974	.660	.671	.581	.594
1975	.668	.673	.590	.603
1976	.636	.642	.609	.614
1977	.599	.615	.564	.571
1978	.590	.595	.524	.533
1979	.705	.713	.661	.668
1980	.768	.777	.728	.726
1981	.779	.781	.691	.705
1982	.852	.861	.823	.834
1983	.850	.877	.784	.809
1984	.821	.828	.785	.822
1985	.731	.735	.713	.734
1986	.639	.643	.621	.642
1987	.560	.566	.552	.554
MEDIAN	.668	.673	.610	.636

where:
PB1: market to book value of assets,
PB2: market to book value of all assets excluding intangibles,
PB3: market to book value of equity,
PB4: market to net worth.

The first accounting valuation measure is the total book value of all the assets and the second measure was the book value of assets excluding intangible assets for which there is frequently no

really clear method of valuing them and therefore are likely to be simply noise though managers sometimes argue that they help provide a fairer picture of the company's value[9]. The other two accounting valuation measures are derived from the liabilities side of the balance sheet and are more likely to reflect the value of the firm to its owners because they exclude debt. The book value of equity capital is, in essence, the money that the shareholders put towards the cost of its assets and the firm's net worth is the book value of assets after its debts are repaid (net worth differs from share capital mainly because of the inclusion of preference shares).

Our results, presented in table II on the next page, indicate that the book value of capital is the accounting valuation measure that is most closely associated with the firm's capital market value because it has the smallest deviation from the mean i.e. the smallest prediction error.

As in the case of profitability measures we carried out a sign test to examine whether this superiority of shareholders' capital variable was due to sampling error; the results were that the expected prediction error using the book value of capital as the independent variable is significantly less, over time, than using any other variable at the 5% significance level.

V.3. Comparing the Predictive Power of the Three Approaches

Having determined which are the "best" measures of accounting profitability and value, we are now ready to test the hypothesis outlined above. In the comparison we will include the firm's current dividend payments both because theories of firm valua-

9. See for example the debate on brand valuation in the UK.

tion assume that dividends are the valued attribute and in order to examine whether accounting variables provide any additional information, for valuing the firm, over and above that represented by current dividend payments[10]. For some of the purposes that we outlined in the introduction, e.g. non-arm's length acquisitions, dividends are the least suitable variable because they are the easiest for management to manipulate by decreasing the payout ratio just prior to the buyout.

The results are presented in table III. It can be seen that earnings and dividends have similar performance though dividends perform slightly better with a smaller prediction error in 9 years of the 17 in the sample.

Furthermore, the price earnings ratio has a smaller prediction error than the market to book value of equity ratio for 12 years in the sample which suggests that accountants have produced a better measure of value in the earnings figure than in the usual statement of a company's value the balance sheet.

V.4. Correlation of Errors Using Alternative Variables

As we saw in the previous section, the price-dividends ratio outperforms any other univariate rule in explaining cross-sectional variation in share prices. However, we must also examine whether the other variables have incremental explanatory power by looking how the residuals from each ratio correlate with those from the others. If the value of the correlation coefficient is near 1 then the variable would offer little, if any, additional information.

10. As it has already been said, an alternative view of dividends is as free cash flow available to shareholders.

TABLE III
Comparison of root mean square error of the three valuations ratios

Year	PB	PE	PD
1971	0.604	0.479	0.483
1972	0.527	0.451	0.424
1973	0.556	0.545	0.499
1974	0.517	0.516	0.451
1975	0.522	0.492	0.422
1976	0.518	0.533	0.465
1977	0.504	0.492	0.499
1978	0.505	0.521	0.536
1979	0.582	0.694	0.534
1980	0.630	0.744	0.552
1981	0.628	0.806	0.551
1982	0.731	0.625	0.608
1983	0.708	0.566	0.648
1984	0.757	0.603	0.656
1985	0.688	0.551	0.631
1986	0.619	0.541	0.615
1987	0.532	0.516	0.547
MEDIAN	0.582	0.541	0.536

where:
PB: market to book value of equity,
PE: price earnings and,
PD: price dividends.

In table IV we report the correlations between the prediction errors of the three "best" models. Though the correlations are uniformly positive, they are far from perfect suggesting that the accounting variables have incremental information not captured by current dividends.

Table V presents the correlation coefficients for the errors across all ratios for the whole sample (excluding companies with non- positive net profits and dividends): there is a clear pattern of strong correlation of the errors from the variables from the same statement (i.e. errors from the various price earnings ratios are

highly correlated etc) and a weak correlation with variables from other sources. Thus, it is likely that extensions to the methodology which involve either decomposition of the accounting variables to their determining parts or use of variables from other financial statements can improve the prediction power.

TABLE IV

Cross correlation of the forecasting errors. All correlations significant at the 5% level

Year	PB to PD	PB to PE	PE to PD
1971	0.538	0.479	0.616
1972	0.422	0.337	0.387
1973	0.557	0.539	0.507
1974	0.492	0.431	0.326
1975	0.398	0.345	0.233
1976	0.397	0.465	0.234
1977	0.337	0.445	0.127
1978	0.527	0.446	0.258
1979	0.599	0.326	0.406
1980	0.566	0.346	0.460
1981	0.467	0.305	0.394
1982	0.556	0.430	0.412
1983	0.514	0.468	0.529
1984	0.531	0.437	0.554
1985	0.504	0.471	0.529
1986	0.398	0.405	0.456
1987	0.252	0.185	0.425

VI. COMBINED FORECAST MODELS: A COMPARISON OF RATIO BASED VALUATION MODELS AND USA COURT ACCEPTED FORMULAS

One of the most important arguments for developing valuation

models is in order to value privately held companies for fiscal purposes.

As the results presented in the previous section suggest, it should be possible to improve our estimates of value by employing a linear combination of the three approaches.

The equation that we used in our tests was:

$$MCAP = \beta_0 + \beta_1.SHAR + \beta_2.NET + \beta_3.DIVIDEND \qquad (4)$$

where all variables refer to the prediction based on that variable. If we abstract from the intercept, this is equivalent to a geometric mean of the three predictions. Because the ratios are log transformed, the coefficients of the explanatory variables are actually the power to which each of them must be raised. In the forecasting literature, the inclusion of the constant and whether the weights should add to one are topics of considerable interest: the conclusion seems to be that not constraining the coefficients results in a more efficient forecast though less robust (Bunn 1990). Two versions of equation 4 were estimated. In the first, the coefficients were fixed to those used by the USTC in the Central Trust case in 1962. These were 20% for the estimate based on the market to book value of equity, 50% for that based on the price earnings ratio and 30% for the estimate based on the price dividends ratio. In the other version, the weights were estimated using OLS[11] as suggested in the forecasting literature[12].

Our results are presented in table VI. As it can be clearly seen, both MCF approaches which use three variables dominate univariate prediction methods - because they have smaller predic-

11. White's robust estimator of the covariance matrix was used to obtain the OLS result.
12. In the cases before the US courts considerable emphasis is given in the use of "comparable" firms. In this section the entire sample of firms was used but in the final section results for industry effects are reported.

tion errors with the flexible coefficients equation being marginally superior.

TABLE V

Pearson correlation coefficient of the prediction errors from alternative ratio. Due to the size of the sample, all coefficients are significant at the 1% level

	PB1	PB2	PB3	PB4	PE1	PE2	PE3	PE4
PB2	0.995							
PB3	0.835	0.832						
PB4	0.858	0.855	0.986					
PE1	0.537	0.535	0.423	0.445				
PE2	0.367	0.368	0.324	0.345	0.710			
PE3	0.378	0.380	0.362	0.380	0.656	0.852		
PE4	0.327	0.329	0.343	0.357	0.513	0.694	0.786	
PD1	0.475	0.474	0.513	0.497	0.392	0.459	0.432	0.341

where:
PB1: market to book value of assets,
PB2: market to book value of assets excluding intangibles,
PB3: market to book value of share capital,
PB4: market to net worth,
PE1: price to operating profit,
PE2: price to earnings before tax,
PE3: price to net profit,
PE4: price to net profit adjusted for extraordinary items and
PD1: price to dividends.

It is interesting to note, that in the flexible coefficients case, the sum of the weights was sufficiently close to 1 for half the years to make imposing a constraint unnecessary. Furthermore, the range of the weights for the book value of equity is from a low of 7% to a high of 35%, for earnings the range is 16% to 54% and for dividends 19% to 52% suggesting that, on average, the courts tend to give too much weight to profits and too little to dividends[13].

13. Of course, this criticism is mitigated by the fact that we are using UK data; in the USA dividend policy differs considerably.

TABLE VI

Comparison of forecasting errors using court accepted formulae and univariate ratios

Year	PB	PE	PD	CTRUST	FLXIBLE
1971	.604	.479	.483	.417	.417
1972	.527	.451	.424	.364	.360
1973	.556	.545	.499	.459	.451
1974	.517	.516	.451	.401	.385
1975	.522	.492	.422	.363	.338
1976	.518	.533	.465	.405	.383
1977	.504	.492	.499	.385	.380
1978	.505	.521	.536	.408	.403
1979	.582	.694	.534	.501	.470
1980	.630	.744	.552	.539	.501
1981	.628	.806	.551	.552	.487
1982	.731	.625	.608	.530	.520
1983	.708	.566	.648	.514	.504
1984	.757	.603	.656	.539	.520
1985	.688	.551	.631	.495	.492
1986	.619	.541	.615	.465	.456
1987	.532	.516	.547	.399	.377
Median	.582	.541	.536	.459	.451

where:
PB: market to nook value of equity,
PE: price earnings ratio,
PD: price dividends ratio,
CTRUST: combined forecast with weights fixed, and
FLXIBLE: combined forecast with floating weights.

VII. AGEING OF DATA

One of the oldest problems in financial reporting is to ensure that the information contained in the published accounts is timely.
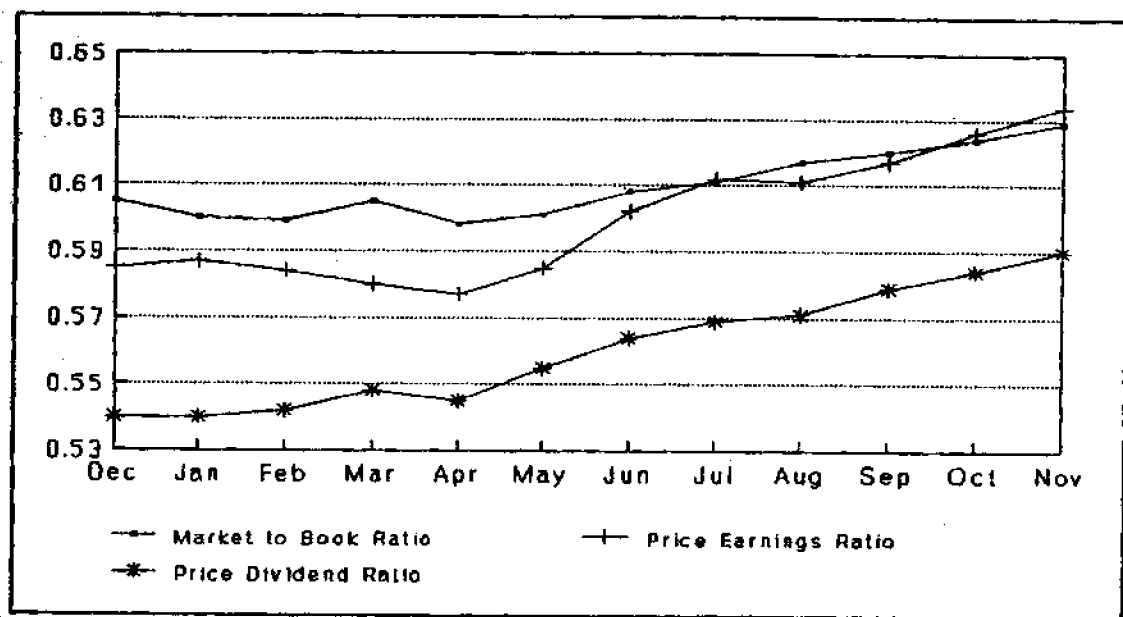
Figure 2. The change in the size of error as we move away from the (approximate) announcement date.

Evidence from event studies suggests that financial statements are, at least partially, successful in this respect since on their release there is a price reaction (for a review of the Market Based Accounting Research literature see Foster (1986)). We were interested to examine using our ratio methodology whether financial information continues to be useful after a period of time has elapsed, to explain cross sectional variations in prices. If financial statements provide information that was interpretable in the same way (or not superseded by new information) until the next annual report gets released we would expect the root mean square of the prediction errors to remain roughly steady even though we moved away from the announcement period.

We tested for this by taking the average prediction error for every month end from the accounting year end in December to

the next November averaged over the 17 years in the sample.

Our results presented in figure 2 suggest that as we move away from March the prediction error increases steadily. This is reasonable given the new information that becomes available about the companies such as semi-annual reports, new about the economy and other companies in the same industry cannot but affect the way accounting information is interpreted.

VIII. INDUSTRY EFFECTS

In practice, it is common to examine the financial ratios of a company in comparison to those in the same industry; evidence by Lev (1969) and others suggests that companies' accounting ratios tend to cluster around an industry standard. Furthermore, many previous studies of the valuation of companies concentrated on an industry (usually US electric utility companies or banks) using mainly Modigliani and Miller's argument of a risk class. In this section we aim to examine whether this practice is justified by looking whether we can improve the explanatory power of our models using industry specific multipliers.

The first test was the Kruskal-Wallis non-parametric test of randomness in the differences of the value of the ratio between classes from the sample mean. The results confirm that at least one of the industries (excluding the "other" category) has a different multiplier from the sample mean at the 5% significance level: in the case of the market to book value of equity this was true for 16 out of the 17 years in the sample, for the price earnings ratio for 15 and for the price dividends ratio for 14 years.

However, the more interesting question is whether we can improve the predictive power of our methodology by using a differ-

ent ratio benchmark for each industry. By using a finer set to compute our capitalization coefficients we decrease the error in the estimation of the capitalization coefficients which is due to using a largely heterogeneous set of firms. On the other hand we increase that part of error which is due to random disturbances and decrease the efficiency of our estimates because we will have fewer degrees of freedom.

We regressed[14] each ratio on a complete set of dummies and found an average reduction (throughout the 16 years in our sample) in the forecasting error for the market to book value of equity ratio of 6.9%, for the price earnings ratio of 4.4% and for the price dividends ratio of 4.8%. This result is small, in an economic sense, in comparison to average reductions of 27%, 22.1% and 16.5% using the combined forecast methodology[15].

Thus, the question arises whether there are specific industries that have ratios standing out from the sample average. A stepwise regression procedure was used to identify the industries that were statistically significant in explaining the cross sectional variation in the ratios. The results suggest that very few industries have consistently different ratio means from the cross-section sample over time.

IX. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The aim of this paper has been to examine simple valuation

14. As it has already been mentioned, for the total sample of firms, linearity in the relationship between market capitalization and share capital, earnings and dividends is a good working assumption. This is not necessarily the case any longer but no formal testing was carried out.

15. Use of industry specific, characteristic ratios reduces the prediction error in the combined forecast case by 6.1%.

rules which are frequently employed in practice.

The results of Ballas (1991) suggest that a multiplicative relationship must be assumed between market capitalization, the independent financial variables and the error term and that the characteristic ratio should be the mean of the log-transformed ratio. As a criterion to evaluate alternative valuation rules we employed variance minimization.

Empoloying this methodology, the best single measure of profitability for valuation purposes was (marginally) net profit and that of the book value of assets the book value of equity. Nevertheless, the best univariate valuation rule is the price dividends ratio which is significantly outperformed by a combined forecast methodology such as the one employed by the US tax courts.

Finally, we examined the implications of using industry specific characteristic ratios and concluded that little additional information can be gained this way.

Clearly, ad hoc valuation rules based on simple aggregate measures of earnings or book value are not likely to be efficient. In a later paper, we test for the effect of other variables (such as measures of growth and risk) and we decompose earnings and assets in line items in order to derive efficient estimators of value.

APPENDIX

INDUSTRIAL CLASSIFICATIONS

1. *Building Materials*
    12. Bricks and Roofing Tiles
    13. Builders Merchants
    14. Building Materials/Quarry Products/Asbestos
    15. Cement and Concrete
    16. Paint
    17. Timber

2. *Contracting & Construction*
    18. Constructing and Construction
    30. Heating and Ventilation

3. *Electricals & Electronics*
    19. Electricals (excluding Radio and TV)
    35. Electronics

4. *Engineering, Mechanical*
    20. Cold Formed Fastings and Turned Parts
    22. Industrial Plant, Engines & Compressors
    23. Mechanical Handling
    24. Pumps and Valves
    25. Steel and Chemical Plant
    26. Wires and Ropes
    27. Miscellaneous Engineering Contractors
    28. Machine and Other Tools
    29. Miscellaneous Engineering Contractors

5. *Metals, Metal Forming*
    21. Founders and Stampers
    32. Metallurgy
    33. Special Steels
    34. Miscellaneous Metal Forming

6. *Motors*
    41. Motor Components
    42. Motor Distributors
    43. Motor Vehicles

7. *Food, Drink and Tobacco Manufacturing Industries*
    45. Breweries
    46. Wines and Spirits
    49. General Food Manufacturing
    50. Milling and Flour
    63. Tobacco

8. *Leisure and Recreation Services*
    36. Radio and TV
    47. Hotels and Caterers
    48. Leisure

9. *Retail Distribution*
    51. Food retailing
    55. Departmental Stores
    56. Furnishing Stores
    57. Stores, Mail order
    58. Stores, Multiple

10. *Paper Manufacturing & Publishing*
    52. Newspapers and Periodicals
    53. Publishing and Printing
    54. Packaging and Paper

11. *Textiles*
    37. Floor Covering
    59. Clothing
    60. Cotton and Synthetic
    61. Wool
    62. Miscellaneous Textiles

12. *Chemical Manufacturing*
    66. Plastic and Rubber Fabricators
    67. Health and Household Goods
    68. General Chemicals

13. *Oil & Gas*
    70. Oil & Gas

14. *Shipping & Transport*
    71. Shipping
    72. Transport and Freight

15. *Holding Companies*
    73. Holding Companies

16. Business Services
- 75. Agencies
- 76. Miscellaneous Business Services

17. Banking, Finance, Insurance, and Leasing
- 77. Banks
- 78. Foreign Banks
- 79. Discount
- 80. Hire Purchase
- 81. Insurance (Life)
- 82. Insurance (Composite)
- 83. Insurance (Brokers)
- 84. Investment Trusts
- 85. Merchant Banks and Issuing Houses
- 86. Property
- 87. Financial (Miscellaneous Financial Trusts)

18. Commodity Groups
- 89. Rubbers
- 90. Teas
- 91. Copper
- 92. Mining Finance
- 93. Tin
- 94. Diamonds
- 95. Gold
- 96. Miscellaneous Mines and Collieries
- 97. Overseas Trade

19. Other
- 38. Furniture and Bedding
- 39. Household Appliances
- 40. Kitchen and Tableware
- 44. Security and Alarm Services
- 64. Footwear
- 65. Toys and Games
- 74. Laundries and Cleaners
- 88. Telecommunications

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