THE ACCURACY AND BIAS OF EQUITY VALUES INFERRED FROM ANALYSTS' EARNINGS FORECASTS

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July 2000

Comments welcomed

The comments of seminar participants at Berkeley, Illinois, Kobe, Nagoya, Northwestern, Ohio State, and from Peter Easton, Keiichi Kubota, Yue Li, Elisabeth Oltheten, Pervin Shroff, Tom Stober, two reviewers, and, especially, Stephen Penman are appreciated. We are grateful to I/B/E/S Inc. for providing the earnings forecasts used in this paper.

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Abstract

We examine the accuracy and bias of intrinsic equity prices estimated from three accounting-based valuation models using analyst's earnings forecasts over a four-year horizon. The models are: (a) the earnings capitalization model, (b) the residual income model without a terminal value, and (c) the residual income model with a terminal value that assumes residual income will grow beyond the horizon at a constant rate determined from the expected residual income growth rate over the forecast horizon. Our analysis is based on valuation errors that are calculated by comparing estimated prices to actual prices. We contribute to the literature by examining whether: (i) the analysts' earnings forecasts convey information about value beyond that conveyed by current earnings, book value and dividends, (ii) the use of firm specific growth rates in terminal value calculations results in more unbiased and accurate valuations than the use of constant growth rates, and (iii) different models perform better under different ex-ante conditions.

We find that analysts' earnings forecasts convey information about value beyond that conveyed by current earnings, book values and dividends. Each of the models that we used has valuation errors that decline monotonically as the horizon increases implying that earnings forecasts at each horizon convey new value relevant information. We cannot find a clear advantage to using firm specific growth rates instead of a constant rate of 4% across all sample firms. In addition, only 17% of the imputed growth rates could be used in terminal value calculations. The residual income model with a terminal value shows the best performance on average but not in all cases. Different models are appropriate for different firms. The conditions for choosing the appropriate model relate to ex-ante growth indicators such as the current book-to-market, earnings-to-price, dividend-to-price ratios, the present value of the expected residual income over the forecast horizon, the growth rate in expected earnings, and firm size. In all models estimated prices are, on average, biased and inaccurate and they explain at best 70% of the variation in market prices. We examined the quality of the earnings forecasts and the quality of the GAAP earnings as two possible reasons for the biased and inaccurate results. Our tests provide evidence consistent with both of these reasons. Thus, we conclude that the poor model performance is due to information missing from the forecasts and to the practice of conservative accounting.

THE ACCURACY AND BIAS OF EQUITY VALUES INFERRED FROM ANALYSTS' EARNINGS FORECASTS

1. Introduction

This paper examines the accuracy and bias of intrinsic equity prices estimated from three accounting-based valuation models using analysts' earnings forecasts over a four-year horizon. In particular, our analysis attempts to determine ex-ante conditions under which each of the models exhibits high accuracy and low bias. The three models are: a) the earnings capitalization model, b) the residual income model without a terminal value, and c) the residual income model with a terminal value which is based on the assumption that residual income will grow beyond the horizon at a constant rate determined from the expected residual income growth rate over the forecast horizon. The performance of these three models is compared to the performance of two benchmark models: a) the current book value of equity model, and b) the current earnings model. We do this comparison to examine whether the analysts' earnings forecasts convey information about value beyond that conveyed by the two summary accounting numbers reported on a firm's financial statements.[1]

We are motivated to do this study for the following reasons. First, recent research by Penman and Sougiannis (1998) and Francis et al. (2000) comparing the performance of dividend, free cash flow, and accounting valuation models has documented a superior performance for the accounting models in finite horizon valuations.[2] Thus, we feel that this finding calls for further focus on the implementation of the accounting-based models.

Second, although the three accounting models are equivalent in infinite forecast horizons, simple algebraic comparisons indicate that in finite horizons their prices will differ depending on the magnitudes and signs of the present values of the expected residual income and terminal value. Thus, which model will yield the most accurate and unbiased price and under what conditions is an empirical issue. Theoretically, for the residual income model without a terminal value (RIM), and the earnings capitalization model (CM), estimated prices without error are limited to firms with expected zero premium/discount (for RIM) or expected zero change in premium/discount (for CM) at the horizon.[3] In cases where these two models exhibit low accuracy, the residual income model with a terminal value must be used. The terminal value is an estimate of the expected premium/discount at the horizon that is used to increase accuracy and reduce bias.

Third, finding ex-ante determinants of valuation errors is interesting and with practical importance. Consider an analyst, investor or researcher who at a specific point in time and for a particular firm has obtained 1) the firm's financial statements, and 2) forecasts, over a certain horizon, of the firm's future earnings, book values and dividends. Then, in implementing the valuation step of fundamental analysis he/she has to choose an accounting-based valuation model that will result in the most reliable intrinsic value.[4] Obviously, some guidance on how to choose among the alternative models, based on the available actual and forecasted information, can be valuable.

We view our incremental contribution to the literature as being threefold. First, we calculate terminal values in implementing the residual income model by using firm specific growth rates implied by the firm's expected residual income stream. Prior studies such as Penman and Sougiannis (1998), and Francis et al. (2000) have used a constant growth rate of 4% across all sample firms. We feel that it is important to examine whether the use of firm specific growth rates, which should be more consistent with the valuation of individual firms in practice, results in more unbiased and accurate valuations than the use of constant growth rates. Second, our analysis for discovering ex-ante determinants of valuation errors for the different models extends that of Penman and Sougiannis (1998) by the inclusion of additional variables. Third, our examination of whether analysts' earnings forecasts convey information about value beyond that conveyed by reported earnings and book values generalizes prior findings. In particular, we use consensus earnings forecasts over the maximum four-year horizon provided by analysts while Dechow et al. (1999) use only one year ahead forecasts and Francis et al. (2000) use multi-year forecasts from only one analyst, Value Line.

We carry out the empirical work using reported financial statement information and available analysts' earnings forecasts over a four-year horizon for a large sample of publicly traded US firms as reported by IBES Inc. over the period 1981-98. Our analysis is based on ex-ante valuation errors that we obtain by comparing estimated prices to market prices. These comparisons are made under the assumption that market prices are efficient with respect to earnings forecasts.

Our empirical results suggest the following. First, the three multi-period models estimate significantly less biased and more accurate prices than the two benchmark current-period models. Furthermore, the earnings forecasts at each horizon convey new value relevant information and thus each model's valuation errors decline monotonically as the horizon increases. Thus the analysts' earnings forecasts convey information about value beyond that conveyed by reported earnings and book values. Second, we faced serious difficulties in imputing firm specific residual income growth rates from the firm's expected residual income stream. Only 17% of the imputed growth rates could be used in terminal value calculations. In many cases the rates were very close to the discount rate thus leading to unrealistically large intrinsic prices. Also in many cases the growth rate was larger than the discount rate making terminal value calculations impossible. Calculating terminal values using firm-specific growth rates for 17% of the observations and a constant rate of 4% for the remaining 83% of the observations resulted in only marginally more unbiased and accurate valuations than using a constant 4% growth rate across all observations. Third, none of the models dominates in all cases. Different models are appropriate for different conditions. The conditions for choosing the appropriate model relate to ex-ante growth indicators such as the current book-to-market, earnings-to-price, dividend-to-price ratios, the present value of the expected residual income over the forecast horizon, the growth rate in expected earnings, and firm size. Fourth, in all models estimated prices are, on average, biased and inaccurate and they explain at best 70% of the variation in market prices. We examined the quality of the earnings forecasts and the quality of the GAAP earnings as two possible reasons for these results. Our tests provide evidence consistent with both of these reasons. In particular, we find that the poor model performance is due to information missing from the forecasts but not due to bias in the earnings forecasts. We investigated the quality of the GAAP earnings in two cases for which the analysts' forecast horizon accounting earnings may not convey the information the market requires to value a firm: a) the use of conservative accounting in R&D intensive firms, and b) the presence of losses in new to the market firms. In both cases each model's performance was significantly lower than that in control samples of low R&D intensity firms and new to the market firms with profits. We suggest that alternative reasons related to model specification and to market efficiency be investigated in future research.

In section 2 we outline the valuation models and their finite horizon properties. In section 3 we describe the data and discus some implementation issues. In section 4 we present the empirical results, and in section 5 we summarize and conclude the paper.

2. The Valuation Models

In recent theoretical work Ohlson (1995) shows that if a) equity value equals the present value of expected future dividends, and b) forecasts of earnings, $E[\tilde{X}_{t+\tau}]$, book values $E[\tilde{B}_{t+\tau}]$, and dividends $E[\tilde{d}_{t+\tau}]$ satisfy the clean surplus relation, $E[\tilde{B}_{t+\tau}] = E[\tilde{B}_{t+\tau-1}] + E[\tilde{X}_{t+\tau}] - E[\tilde{d}_{t+\tau}]$, then equity value will also be equal to the sum of current book value of equity and the present value of expected residual income. Formally, the Residual Income Model (RIM) yields a price

$$P_t^T(\text{RIM}) = B_t + \sum_{\tau=1}^{T} \rho^{-\tau} E\left[\tilde{X}^a_{t+\tau}\right] \qquad \text{(RIM)} \qquad (1)$$

that approaches the (infinite horizon) price of the dividend discount model, P_t, as T approaches ∞. In (1) B_t is the current book value of equity, ρ is one plus the discount rate, *E* is an expectation conditional on information at time t, and $\tilde{X}^a_{t+\tau} = [\tilde{X}_{t+\tau} - (\rho - 1)\tilde{B}_{t+\tau-1}]$ is residual income at t+τ. In finite horizon implementations of RIM the valuation error (or terminal value calculation) for horizon T is given by

$$VE_t^T(\text{RIM}) = P_t - P_t^T(\text{RIM}) = \rho^{-T}\left[E(\tilde{P}_{t+T}) - E(\tilde{B}_{t+T})\right] \quad (1a)$$

That is, the valuation error equals the present value of the expected premium/discount at the horizon. Therefore, the horizon is determined at the point t+T at which the expected premium/discount becomes zero or, equivalently, the present value of expected residual income becomes zero [and thus $P_t = P_t^T$(RIM)]. The implication is that RIM is more appropriate for firms with decreasing expected premium/discount or residual income. But what about the case in which expected residual income or premium/discount does not decline?

Ohlson (1995) shows that, by using the clean surplus relation to iterate out successive earnings and dividends from book values in (1), the Capitalization Model (CM) yields a price

$$P_t^T(\text{CM}) = (\rho^T - 1)^{-1} E\left[\sum_{\tau=1}^{T} \tilde{X}_{t+\tau} + \sum_{\tau=1}^{T} \tilde{d}_{t+\tau}\left(\rho^{T-\tau} - 1\right)\right] \quad \text{(CM)} \quad (2)$$

that approaches the (infinite horizon) price of the dividend discount model, P_t, as T approaches ∞. The dividend component in (2) appears because, if dividends are paid out in the future, assets are reduced and thus expected subsequent earnings are also reduced.[5] Thus the expectation in (2) is expected aggregated future earnings as if no dividends are paid, or as if all dividends are reinvested in the firm.

In finite horizon implementations of CM the valuation error (or terminal value calculation) for horizon T is given by

$$VE_t^T(\text{CM}) = P_t - P_t^T(\text{CM}) = (\rho^T - 1)^{-1}\left[E\left(\tilde{P}_{t+\tau}\right) - E\left(\tilde{B}_{t+\tau}\right) - \left(P_t - B_t\right)\right] \quad (2a)$$

That is, the valuation error equals the capitalized value of the expected change in the premium or discount at the horizon. Therefore, the horizon is determined at the point t+T at which the expected change in premium/discount becomes zero or equivalently the change in expected residual income becomes zero [and thus $P_t = P_t^T(CM)$]. The immediate implication of (2a) is that CM is more appropriate for firms with constant expected premium/discount or residual income to the forecast horizon.

What about the cases where expected residual income or premium/discount either decreases but does not converge to zero over the forecast horizon, or increases over the forecast horizon? In these cases terminal value calculations are required. For this Penman (1997) suggests combining RIM and CM in deriving appropriate terminal values. In particular, by defining K_S as (one plus) the expected growth in the premium/discount (or residual income) over the S periods beyond the horizon T $\left[\text{i.e. } E\left(\tilde{P}_{t+T+S} - \tilde{B}_{t+T+S}\right) = K_s * E\left(\tilde{P}_{t+T} - \tilde{B}_{t+T}\right)\right]$, Penman provides the following combination (COMBO) model of finite-horizon accounting based valuation:

$$P_t^T(\text{COMBO}) = B_t + \sum_{\tau=1}^{T}\left[\rho^{-\tau} E\left(\tilde{X}^a_{t+\tau}\right)\right] + \frac{\rho^T}{\rho^S - K_S} E\left[\sum_{\tau=1}^{S} \tilde{X}_{t+T+\tau} + \sum_{\tau=1}^{S}(\rho^{S-\tau}-1)\,\tilde{d}_{t+T+\tau} - (\rho^S - 1)\,\tilde{B}_{t+T}\right] \qquad \text{(COMBO)} \qquad (3)$$

The last term in equation (3) is a generalized terminal value calculation based on the perpetual growth of residual income beyond the horizon t+T at the rate K_S-1. For K_S =1 and S=1 the terminal value is equal to the present value of the capitalized residual income at t+T+1, which has been applied by Francis et al. (2000), Frankel and Lee (1998), Lee et al. (1999), and Penman and Sougiannis (1998). Setting K_S =1 and S=1 implies that the firm's expected premium/discount or residual income will remain constant to perpetuity after t+T. Of course, the cases of K_S>1 and K_S<1 are also likely for firms with growing or declining expected residual income over the analysts' forecast horizon. Prior studies by Francis et al. (2000), and Penman and Sougiannis (1998) have assumed the case of K_S>1, with values such as 1.02, 1.04, uniformly applied to all sample firms. However, in this study we impute a firm's K_S from its expected residual income stream and implement COMBO to examine the accuracy of the estimated prices in this particular case. We view the use of firm specific K_S being more appropriate because equity valuation is a task applied on a firm-by-firm basis.

Penman (1997) points out that K_S reflects not only earnings power but also measurement error in accounting earnings and book values that results from the consistent application of conservative accounting rules. That is, expected premiums/discounts (or residual earnings) beyond the horizon grow due to the practice of conservative accounting that keeps expected book values lower than normal (in the absence of conservative or aggressive accounting). Thus it is essential that we examine the extent to which such an error is present and affects our results. We therefore test the extent to which conservative accounting affects the accuracy and bias of our estimated prices.

It should be noted that although the above three models are equivalent for an infinite horizon, they differ for a given finite horizon, t+T. Thus, the three models yield three different prices depending on the magnitudes and signs of the present values of the expected residual income and terminal value, as the comparison of the models in the appendix indicates. Which model will yield the most accurate and unbiased price and under what conditions is an empirical issue examined in this study.

The performance of these multi-horizon (T>0) accounting-based models is compared to the performance of two zero-horizon (T=0) accounting-based models pointed out by Ohlson (1995): the Book Value Model (BVM)

$$P_t(BVM) = B_t \qquad \text{(BVM)} \quad (4)$$

in which current book value is sufficient for all expected future payoffs (by applying the cost of capital to current book value), and the Earnings Model (ERM)

$$P_t(ERM) = \frac{\rho}{\rho - 1} X_t - d_t \qquad \text{(ERM)} \quad (5)$$

in which current earnings is sufficient for all expected future payoffs (by applying the cost of capital to current earnings). As Ohlson and Zhang (1999) point out, these two zero-horizon models can be thought of as benchmarks in the evaluation of the multi-horizon models using forecasts. If analysts' earnings forecasts convey relevant information about future expected premiums/discounts, then models based on such forecasts should outperform these two benchmark models.

3. Data and Implementation Issues

3.1 Data

Earnings forecasts are taken from the 1999 summary I/B/E/S tape, which is one of the most comprehensive databases of earnings forecasts in the U.S. Median fiscal-year-end forecasts are used for each firm. These median forecasts are determined from the analyst forecasts available on file with I/B/E/S Inc. as of the third Thursday of the fiscal-year-end month[6]. Earnings forecasts for the current and subsequent four years are available as well as an expected five-year earnings growth rate. We focus our analysis on firms for which either expected five-year earnings forecasts or growth rates are available so that we can utilize the maximum possible four-year horizon. We use the analysts' predicted growth rate, GR, to obtain earnings forecasts for future years not explicitly provided by the analysts. Thus, if for a given firm analysts have provided forecasts for t and t+1, $\left(\tilde{X}_t \text{ and } \tilde{X}_{t+1}\right)$, we obtain the forecasts for $\tilde{X}_{t+1+\tau}$ as $\tilde{X}_{t+1+\tau} = \tilde{X}_{t+1} * (1 + GR)^{\tau}$.

Our sample consists of 36,532 firm-year observations over the period 1981-1998. Of these total observations, 22,705 consist of one-year forecasts, 9,420 of two-year forecasts, 1,279 of three-year forecasts, and 3,128 of four-year forecasts. Market prices, reported accounting earnings, book values of equity, dividends, and other accounting variables required for the analysis are taken from the 1999 active and research COMPUSTAT files[7]. The sample includes firms with all possible fiscal year ends. Forecast dates and fiscal year end dates provided by I/B/E/S are used to ensure that the forecasted earnings correspond to the correct fiscal year[8]. The available current and forecasted variables for each firm are used in (1), (2), (3), (4) and (5) to calculate, for each possible horizon, t+T, intrinsic prices $P_t^T(\bullet)$. These prices are then compared to the actual fiscal-year-end closing market price of the firm at t. Thus the fiscal year end closing price, P_t, is assumed to reflect the market's best assessment of the earnings forecasts released only the previous week. Signed percentage and absolute errors are calculated for each firm and for each t+T to examine prediction bias and prediction accuracy, respectively.

3.2 Implementation Issues

Discount Rates

In implementing the models we used four alternative measures of the discount rate: a) the risk-free rate (T-Bond rate) for the relevant calendar year plus an equity risk premium of 6 percent per annum for all firms (approximately the historical equity premium reported in Ibbotson and Sinquefield 1983);[9] b) the discount rate given by the capital asset pricing model (CAPM) using the same risk-free rate and risk premium, but with betas estimated for each firm;[10] c) industry discount rates following the procedure employed by Francis et al. (2000); and d) a 12 percent rate for all firms and all years as in Dechow et al. (1999). In terms of bias and accuracy of estimated prices the fixed discount rate of 12 percent had the best performance, with second the risk-free rate plus 6 percent risk premium, third the industry specific rates and last the firm-specific rates. We report results based on the constant rate of 12 percent.

Dividend and Book Value Forecasts

In implementing models (1), (2), and (3) dividend or book value forecasts as well as earnings forecasts are required. However, the I/B/E/S files do not report dividend or book value forecasts and, in general, analysts do not provide these forecasts as consistently as they provide earnings forecasts. Thus we calculated future dividends using a procedure similar to the one employed by Frankel and Lee (1998). Thus, in each base year t we calculate the mean dividend payout ratio from t-2 to t. Then, we obtain the forecasted dividend at t+1, t+2, etc. by multiplying the mean payout ratio by the analysts' earnings forecast for t+1, t+2, etc. When the mean payout ratio or the earnings forecast is negative we set future dividends equal to dividends at t. When dividends at t are zero we set future dividends equal to zero.

To implement the RIM and COMBO models we use the clean surplus relation to obtain future book values. For example, the predicted book value for the current year, $\tilde{B}_t$, is calculated as $\tilde{B}_t = B_{t-1} + \tilde{x}_t - \tilde{d}_t$ where B_{t-1} is the observed book value at t-1, $\tilde{x}_t$ is the earnings forecast for t, and $\tilde{d}_t$ is the predicted dividend at t obtained as explained above. Then to obtain $\tilde{B}_{t+1}$ we use $\tilde{B}_{t+1} = B_t + \tilde{x}_{t+1} - \tilde{d}_{t+1}$ and so on for longer horizons.[11]

The Horizon Issue

In implementing RIM and CM the horizon is four years, i.e. T=4. However, in implementing COMBO the horizon T can take different values depending on what values S (periods beyond the horizon) takes. Specifically, four cases are possible: (1) T=0, S=4, (2) T=1, S=3, (2) T=2, S=2, and (3) T=3, S=1. This implies that more than one K_S can be calculated for this sample. Clearly, the choice of T and S is a major issue in implementing COMBO, and for that reason Penman (1997) calls the horizon an "elusive" notion. Since there is no theoretical prescription, the issue is examined empirically in this paper. Thus, we estimate COMBO prices using all possible combinations of T and S and search for the combination that yields the most accurate estimated prices.

4 Empirical Results

4.1 Valuation Errors

Valuation errors are measured as

$$VE_t^T(\bullet) = \frac{P_t - P_t^T(\bullet)}{P_t} \tag{6}$$

where P_t is the firm's stock price at t, and $P_t^T(\bullet)$ is the intrinsic price at t calculated by the relevant model from earnings forecasts up to horizon T. The absolute valuation error is $AVE_t^T(\bullet) = |VE_t^T(\bullet)|$.

Panel A of Table 1 reports summary statistics for signed, $VE_t^T(\bullet)$, and absolute, $AVE_t^T(\bullet)$, valuation errors for the pooled sample. The errors for the benchmark models BVM and ERM are for horizon of zero (T=0). The errors for RIM, CM and COMBO are for horizons of one, two, three and four years (T>0). These errors are calculated by increasing the horizon one year at a time.

When forecasts are used, Ohlson and Zang (1999) argue that the monotonic decline in errors may not be the case because of the idiosyncratic nature of the forecasts. In addition, Ohlson and Zang (1999) show that for a given horizon errors can differ across models. We are thus motivated to report and test differences in errors across models and horizons. This extends Penman and Sougiannis (1998) by showing that valuation errors decrease as the horizon increases with forecasted data as well as with actual data. We report results for two variations of COMBO. In COMBO1 K_S is imputed and thus varies across firms (see details below) while in COMBO2 K_S=1.04.

The results of Panel A indicate that signed and absolute errors differ across horizons and models in terms of both median and mean values and also in terms of variability[12]. We compare the errors statistically by pooling the observations over the base years 1981-1998 and applying a t-test[13]. Signed and absolute errors of the multi-horizon models RIM, CM, and COMBO are significantly lower than the errors of the zero-horizon models BVM and ERM (t-values are not reported here). In all models median signed and absolute errors decline monotonically as the horizon increases. In addition, we find that the decrease in error from horizon 1 to horizon 4 is statistically significant in all cases. However, the decreases are not dramatic, implying that most of the value relevant information is conveyed by the earnings forecasts in the early years of the horizon. The mean errors also decline monotonically in all models with the exception of COMBO1 errors.

In all horizons the results differ significantly across the models. The COMBO1 model yields the lowest mean and median signed and absolute errors while RIM yields the highest. The superior performance of COMBO1 is consistent with Ohlson and Zang's (1999) analytical results. All errors are skewed and their variability increases with the horizon with the exception of RIM errors. Clearly, at horizon 4 the differences between COMBO1 and COMBO2 signed and absolute errors are marginal, although we find them statistically significant. Since COMBO1 errors have higher variability than COMBO2 errors, we cannot argue that imputing firm specific K_S is superior to setting K_S=1.04 for all sample firms.

Overall, the results of Panel A indicate that earnings forecasts at each horizon convey new value relevant information and thus estimated price bias decreases while accuracy increases as the horizon increases. These results are consistent with Ohlson and Zang's (1999) monotonicity property. However, mean and median signed and absolute errors for RIM and CM are significantly larger than zero implying that estimated prices are biased downward (undervaluation is the common case) and are not accurate. Although the COMBO1 and COMBO2 models perform significantly better than the other models, their estimated prices cannot be called unbiased and accurate. It is also difficult to argue that imputed residual income growth rates are preferable to the constant rate commonly used of 4%.

Some key implementation details are in order here. In implementing RIM and COMBO we first compare the sign of the firm's premium/discount at t, $(P_t - B_t)$ to the sign of the expected residual income in year 1 ahead $(\tilde{X}_{t+1})$. If $P_t - B_t > 0$ but $\tilde{X}_{t+1} < 0$ or the opposite, we set P_t(RIM) = P_t(COMBO) = B_t because there is inconsistency between the market's expectation and the forecasted residual income. We detected 9,153 such cases or 25% of our total observations of 36,532. Also, when residual income reverses sign within the horizon, $\left[\text{i.e. } \tilde{X}_{t+\tau} > 0 \text{ but } \tilde{X}_{t+\tau+1} < 0\right]$ or the opposite, we stop the valuation at t+τ because, theoretically, a reversal in expected residual income implies that expected premiums/discounts have become zero and thus value is determined at the point of the reversal (see section 2). In this case P_t(RIM)=P_t(COMBO). In addition, when the sign of the terminal value is opposite to the sign of P_t-B_t we set the terminal value to zero and again P_t(RIM)=P_t(COMBO) for the same reason given above. We found 1,126 (3%) such cases.

In implementing COMBO1 using firm specific K_S for all possible combinations of T and S, we found that for T=3 and S=1 COMBO1 displayed the lowest bias and highest accuracy (with a constant discount rate of 12%). Panel B of Table 1 reports summary statistics for $K_s = K_1 = \tilde{X}^a_{t+4} / \tilde{X}^a_{t+3}$ that could be calculated for 27,379 cases. Its median, Q1, and Q3 values of 1.16, 1.07, and 1.28 respectively, indicate that the sample consists mostly of growth firms although for some firms K_S>1.0 may be only the result of conservative accounting. Clearly, the values are large relative to the discount rate of 12%. Restricting K_S to values less than the discount factor of 1.12 resulted (in most cases) to very low ρ-K_S values and thus to explosive intrinsic values. In order to prevent intrinsic values from exploding we imposed the restriction ρ-K_S >=0.08 which, although arbitrary, resulted in the lowest possible valuation errors. This restriction implies that the maximum value for K_S is 1.04. Under this restriction, K_S for only 4,721 out of 27,379 cases (17%) could be used in implementing COMBO1.

Panel C of Table 1 reports summary statistics for $K_s = K_1 = \tilde{X}^a_{t+4} / \tilde{X}^a_{t+3}$ of those 4,721 cases. Since the upper quartile value is 1.00, most of this sub-sample consists of firms with declining residual income. K^*_S is the "optimal" rate K_S in that it yields zero valuation error for each firm at horizon t+4, i.e. the rate for which $VE_t^4(\bullet)$=$AVE_t^4(\bullet)$=0. Values of K^*_S greater than K_S indicate that these 4,721 firms are undervalued by COMBO because ρ-K^*_S < ρ-K_S, which results in higher estimated prices.

Panel D of Table 1 reports summary K_S=K_1 and K^*_S statistics for 27,379 cases for which K_S was used in implementing COMBO1: 4,721 imputed K_S and 22,658 K_S set equal to 1.04. Note that the variability of K^*_S is much higher than the variability of K_S and this is caused by implausible extreme values. These extreme values reflect large undervaluations or overvaluations, i.e. cases in which COMBO1 yields very large errors. The reported K_S statistics reveal the well-known difficult task of estimating terminal values in valuation analysis and practically, the limited use of imputed residual income growth rates.

An alternative way to examine bias in the estimated prices and whether they explain the cross sectional variation of actual market prices is regression analysis. For this we estimate regressions in which we regress the log of actual market price on the log of the estimated price. Thus the regression is:

$$\log(P_{it}) = \alpha + \beta \log\left[P_{it}^4(\bullet)\right] + u_{it} \tag{7}$$

If the estimated prices are unbiased, the intercepts will be equal to zero and the slopes will be equal to one. The results from this regression for all sample firms and for firms valued with the lowest error by one of the models (see below for details) are reported in the two columns of Table 2 titled “Univariate Regressions”. The regression coefficients confirm the results reported in Table 1. That is, the intercepts are always significantly different than zero while the slopes are significantly different than one. In terms of explanatory power BVM shows the lowest (41%) while COMBO1 shows the highest (67%) when all firms are considered[14]. COMBO2 yields the same regression results, as COMBO1 and thus we do not report them. The explanatory power of COMBO1 (and COMBO2) is quite similar to that reported by prior studies such as Francis et al. (2000). For firms with the lowest errors, estimated prices have smaller bias and explain more of the variation in market prices (over 70%) than in the all firms' case.

We also estimate combined regressions and we report the results in corresponding columns of Table 2. The purpose of these regressions is to examine whether combining the prices of different models yields improvements in bias and explanatory power. The results show marginal improvements in both bias and explanatory power relative to the univariate regressions. The combination of the two benchmark models, BVM and ERM, explains 59% of the variability in market prices which, however, is only 1% above the explanatory power of ERM alone. The much larger coefficient of the ERM price (0.50) relative to the BVM price (0.14) implies that the market relies more heavily on earnings than book values. Adding the CM price to the regression increases the R^2 from 0.59 to 0.67 indicating again that analysts' earnings forecasts convey information incremental to reported current earnings and book values of equity. The larger coefficient of the CM price (0.67) relative to the BVM price (0.07) and ERM price (0.07) shows that the market relies more on future earnings than current earnings and book values. The combined RIM-CM-COMBO regression explains 71% while COMBO alone explains 67% of the variation in market prices. The COMBO coefficient obtains the largest coefficient (0.53) indicating that the terminal value calculation captures a substantial portion of value. Overall, these results suggest that estimated prices are significantly downward biased and they explain about 70% of the variation in market prices.

While the statistics of Tables 1 and 2 show that COMBO performs better than the other four models, it is not clear whether it dominates in all cases. To examine the extent of dominance we compare the absolute valuation errors of the five models. Thus we examine how many firms are valued by each model with the highest accuracy and under what conditions (when each model captures best expected premiums/discounts).

Table 3 reports the results from this comparison of models. BVM generates the lowest errors for 11% of the sample firms, ERM for 10%, RIM for 13%, CM for 18%, and COMBO1 for 48%. The lowest errors generated by one model are statistically lower than the errors generated by the other models, e.g. the lowest 3,505 errors of ERM are statistically lower than the errors of the other four models for the same 3,505 firms. The comparison t-statistics (not reported) are significant at the 1% level or better. These results indicate that none of the models dominates in all cases but different models are more accurate under different conditions. The statistics reporting values for several key variables available at time t can be viewed as ex-ante conditions under which each of the models generates the lowest valuation errors. Although the variability statistics show that the variables overlap, we find that all variables differ statistically across groups[15]. Thus reliable choices can be made among the models based on these variables. Clearly, growth indicators such as the book-to-market (BM), the present value of the expected residual income over the four-year forecast horizon (PVRI), the analysts' forecasted long-term growth in earnings (GR), and the imputed $K_{S,}$ along with size (MV) indicate that RIM (or BVM) should be selected for low growth small size firms while COMBO should be selected for high growth large size firms. For firms with moderate growth and moderate size CM should be selected. ERM should be selected for firms with high EP and DP ratios, moderate BM, and moderate to large size. Note the increasing pattern in the expected residual income stream (RIs) of all groups, which is consistent with the below 1.0 (normal) BM values[16].

4.2 Explanations for the valuation errors

The main message of the above results is that none of the models performs well. Even in cases where a model performs better than the other models (Table 3), estimated prices are biased and not accurate[17]. The poor performance may be due to one or more of the following reasons. One reason can be the models themselves. That is, the models do not summarize well the value implications of analysts' earnings forecasts. A second reason can be the quality of the earnings forecasts. That is, analysts' forecasts may be biased and inaccurate and this translates into biased and inaccurate value estimates. A third reason can be the quality of the GAAP earnings analysts try to predict. That is, analysts may do well in their predictions but within the analysts' forecast horizon accounting earnings do not convey the information the market requires to value a firm. A fourth reason can be market inefficiency. That is, market prices do not reflect the values implied by the analysts' forecasts summarized by the valuation models. We feel that the investigation of the above possible explanations is necessary in order to bring closure to the question of whether the use of analysts' earnings forecasts in accounting-based valuation models can lead to accurate and unbiased intrinsic prices. The remainder of this study we focus on the examining the quality of the forecasts and of the GAAP earnings as potential explanations of the biased and inaccurate results of the models. The examination of market efficiency and the development of superior models (or terminal values) are left for future research.

Table 4 Panel A, reports analysts' earnings forecasts errors for the sample firms for horizons 0 to 4. For each horizon signed forecast errors are calculated as the difference between actual earnings and forecasted earnings scaled by the absolute value of actual earnings. Absolute forecast errors are calculated as the absolute value of the signed forecast errors. The significantly negative signed errors and their pattern indicate that the earnings forecasts are optimistic in all horizons and the optimism increases with the forecast horizon. The significant absolute errors and their pattern indicate that the forecasts are not accurate and accuracy decreases with the forecast horizon. These results are consistent with prior studies investigating the accuracy and bias of analysts' earnings forecasts (see Brown (1993) for a review). The question now is whether these properties of the earnings forecasts affect the performance of the valuation models.

If the market uses the forecasts in an efficient manner, then it should adjust for the optimism and use additional information that is missing (inaccuracy) from the forecasts. We have no way of knowing whether and how the market adjusts for the analysts' optimism. Thus we assume that the market has perfect foresight (knows the earnings to be realized over the subsequent four years), and we implement COMBO using realizations of earnings, book values and dividends as in Penman and Sougiannis (1998). If the market corrects the optimism in the forecasts then ex-post valuation errors should be lower than ex-ante valuation errors. Panels B and C of Table 4 report COMBO2 ex-post and ex-ante valuation errors respectively, for 17,364 sample firms that had both earnings realizations and forecasts over the period 1981-1994. The results indicate that the ex-ante errors (both signed and absolute) are significantly lower than the ex-post errors in all four horizons. The implication is that the bias in the analysts' forecasts does not seem to cause the valuation errors.

We now examine whether a reason for the significant valuation errors is information missing from the earnings forecasts. That is, we test whether in the valuation process the market uses information beyond that conveyed by the four-year earnings forecasts. From results in prior studies we are motivated to consider the following ex-ante variables (i) the current book-to-market ratio (BM), (ii) the current dividend-to-price ratio (DP), (iii) the current earnings-to-price ratio (EP), (iv) the size of the firm (MV), (v) the firm's estimated beta (beta), (vi) the expected EPS growth rate (GR), (vii) the present value of the firm's expected residual income over the five-year forecast horizon (PVRI), (viii) the percentage change in inventory minus the percentage change in sales (INV), (ix) the percentage change in Accounts Receivable minus the percentage change in sales (AR), (x) the percentage change in sales minus the percentage change in gross margin (GM), (xi) the percentage change in Selling and Administration expenses minus the percentage change in sales (SNA), and (xii) the change in the effective tax rate relative to the average effective tax rate in the last three years, multiplied by the change in earnings per share (ETR)[18]. In the literature, financial variables such as BM, EP, DP, and size have been related to pricing anomalies, e.g. Fama and French (1992), Lakonishok et al. (1994), and also to information about future profitability e.g. Penman (1996). Since the market may use information about earnings beyond the analysts' four-year horizon, it is possible that these variables convey information not in analysts' forecasts and/or not in current financial statements. The variables INV, AR, GM, SNA, and ETR are the signals identified by Lev and Thiagarajan (1993) as been value relevant but shown by Abarbanell and Bushee (1997) as not (fully) reflected in analysts' earnings forecasts.

We associate the above variables to the signed and absolute valuation errors of RIM, CM, and COMBO1 using a regression equation. Since the relationship between the errors and these variables may be nonlinear, we specify a regression model that includes both linear and quadratic terms of the variables. We also include in the model year dummies to control for economy wide effects and industry dummies to control for industry specific variation of the errors. Table 5 reports the regression results for the absolute errors equation. The regression R^2s indicate that the model explains 45% of the variation in RIM errors, 19% of the variation in CM errors, and 14% of the variation in COMBO1 errors. The regression coefficients for both the linear and quadratic terms are in almost all cases significant indicating a nonlinear relationship. Consistently, in all four regressions, BM obtains negative while $(BM)^2$ obtains positive coefficients. This implies that the errors decrease as BM increases they reach a minimum, and then increase. That is, the relationship between $AVE_t^4(.)$ and BM is U-shaped. The minimum can be calculated by setting in each case the partial derivative of $AVE_t^4(.)$ with respect to BM equal to zero, i.e. $\partial AVE^4_t(°) / \partial BM_t = \gamma_{11} + 2\gamma_{12} BM_t = 0$. Thus the minimum error for RIM is at BM=-0.806/-0.628=1.28, for CM is at BM=1.23, and for COMBO1 is at BM=0.62. These values indicate that COMBO is the most appropriate model for the valuation of low BM firms which is consistent with the results of Table 3. The coefficients of EP and $(EP)^2$ are consistently negative implying that the valuation errors from all models are decreasing in EP, i.e. the errors are high in low EP ratios and converge to zero when EP ratios become normal (equilibrium rate of return). The coefficients of the remaining variables can be interpreted in a similar manner. Note the significance of the Lev and Thiagarajan (1993) signals, which is consistent with the Abarbanell and Bushee (1997) results. Regression results for the signed errors equations are stronger. The R^2s are 58%, 43% and 35% for RIM, CM and COMBO1 respectively. Overall, these regression results support the argument that the market uses information beyond that conveyed by analysts earnings forecasts[19].

Next we examine the extent to which the quality of the GAAP earnings and book values is a potential explanation for the valuation errors. The practice of conservative accounting can affect the quality of the accounting numbers within the analysts' forecast horizon. Penman (1999) points out that the need for estimating terminal values can arise not only from earnings power (economic growth) but also from measurement error consistently applied in the measurement of earnings and book values of equity. Such consistent measurement error prevents premiums/discounts or changes in premiums/discounts from converging to zero and is usually the result of conservative accounting rules that are consistently applied. The implication is that the RIM and CM errors will increase in the level of conservatism while the COMBO errors will be invariant to the level of conservatism if the terminal values capture the conservatism effect.

A frequently discussed conservative accounting rule that introduces measurement error in both earnings and book values is the expensing of R&D expenditures mandated by SFAS No. 2. In this study we examine the valuation errors and characteristics of R&D firms in our sample to determine the extent of the error introduced by the expensing rule and its effect on the accuracy and bias of the estimated prices from each of the valuation models.

Since the expensing rule for R&D expenditures is considered as one of the most conservative accounting rules in U.S. GAAP, the examination of R&D firms is most likely to reveal the hypothesized effects. To test this we form two R&D portfolios by ranking our sample R&D firms on their R&D expenditures to book value of equity ratios (RDB). We expect larger errors (higher level of conservatism) for the above the median (high) RDB portfolio as more R&D capital will be missing from the book values of those firms relative to the below the median (low) RDB portfolio.

Panel A of Table 6 reports median valuation errors and descriptive statistics for the two RDB portfolios and for one non-R&D portfolio. The results show that both the signed and absolute valuation errors for all models of the high RDB portfolio are significantly larger than the errors of both the low RDB and non-R&D portfolios, consistent with our expectations (t-statistics are not reported). The descriptive statistics show that while the non-R&D and the low RDB portfolios are similar they both differ from the high RDB portfolio. The median values of BM, EP, and DP of the high RDB portfolio are significantly lower than the values of the other two portfolios, which is consistent with higher conservatism as RDB increases. However, they are also consistent with higher growth: the median PVRI, GR, K_S and RI values of the high RDB portfolio are significantly larger than the corresponding values of the low RDB and non-R&D portfolios. This in turn implies that RDB captures both growth and conservatism effects.

We make an attempt to separate the two effects by classifying our R&D sample firms by growth, GR, and R&D-to-book, RDB. Specifically, in each RDB portfolio we first ranked the sample firms by GR and we divided them into five portfolios. Then, we ranked the firms in each GR portfolio by RDB and we divided those firms into five RDB portfolios. Panel B (C) of Table 4 reports median COMBO1 absolute valuation errors for the 25 GR-RDB portfolios for firms with high (low) RDB. In both panels the errors increase across the growth portfolios (down the columns), indicating that the model does not fully capture growth regardless of the level of conservatism (although the error spread is smaller in panel C). However, across the RDB portfolios (the rows) the errors increase in Panel B but they are almost invariant in Panel C. These patterns indicate that COMBO does not totally capture the effects of conservative accounting when its practice is most likely to be an issue (high RDB firms)[20]. The large error values in both panels B and C are consistent with information missing from the earnings forecasts. From the reported forecast errors it is clear that analysts have more difficulty in predicting earnings of high R&D intensity firms than earnings of non-R&D or low R&D intensity firms.

Another case where the quality of GAAP earnings and book values may be low within the analysts' forecast horizon is young firms reporting losses. For such firms there is not a long history of data for the analysts to detect patterns and the presence of losses increases uncertainty. Thus, earnings forecasting becomes more difficult and it is possible that profits cannot be predicted within the analysts' four-year forecast horizon. To test this we examine sample firms in the second year in the market (new firms) with losses in t and t-1. As a benchmark we use sample firms also in the second year in the market but with profits in t and t-1. Table 7 reports median valuation errors and descriptive statistics for the two sets of firms. The results show that the estimated prices of the loss firms are less accurate (but not always more biased) than the estimated prices of the profit firms. In addition, the descriptive statistics show significantly lower expected residual income over the horizon for the loss firms than for the profit firms. The zero median present value of the expected residual income (PVRI) for the loss firms clearly shows how little information is conveyed within the four-year forecast horizon relative to the information the market has used to value the firms. The median forecast errors indicate that analysts have more difficulty in predicting earnings of loss firms than profit firms. However, even if analysts were less optimistic and more accurate it is clear that the four-year forecast horizon would not be sufficient to value the loss firms. The implication is that in such cases the forecast horizon must be extended beyond four years.

5. Conclusion

In this paper we examine the accuracy and bias of equity prices estimated from three alternative accounting based valuation models using multi-year analysts' earnings forecasts. Two of the models: the residual income model (RIM) and the earnings capitalization model (CM) do not use terminal values. The third model is a residual income model with a terminal value based on the combination of RIM and CM (COMBO). Our sample consists of a large number of publicly traded U.S. firms with analysts' earnings forecasts over a four-year horizon and covers the period 1981-98. Our analysis is based on valuation errors that are calculated by comparing estimated prices to actual prices.

We find that the three multi-period models perform significantly better than two one-period models based on current earnings and book values. Thus the earnings forecasts convey information useful in equity valuation. The monotonic decline in ex-post valuation errors shown by Penman and Sougiannis (1998) is also detected in the ex-ante errors of this study. This implies that the forecasts for all horizons provided must be used in valuation. We also find that the imputation and use of firm-specific expected residual income growth rates is not trivial. More importantly, we cannot find a clear advantage to using such rates instead of a constant rate of 4% across all sample firms. Although the combination model (COMBO) shows the best performance it does not dominate in all cases. Different models are appropriate for different firms. The conditions for choosing the appropriate model relate to ex-ante growth indicators such as the current book-to-market, earnings-to-price, dividend-to-price ratios, the present value of the expected residual income over the forecast horizon, the growth rate in expected earnings, and firm size.

In all models we find estimated prices to be, on average, biased and inaccurate. We examined two possible explanations for these results. The quality of the earnings forecasts and the quality of the GAAP earnings analysts try to predict. Our tests suggest that the bias in the earnings forecasts does not lead to poor model performance. Information missing from the forecasts is a reason for the poor performance. We identified a set of financial variables that correlate with the valuation errors and thus their information, although used by the market, is not fully reflected in the earnings forecasts. Since analysts' forecasts are inaccurate, information may be missing from the forecasts and/or the four-year analysts' forecast horizon is not as long as the market's horizon. We also find evidence that the poor model performance relates to the quality of GAAP earnings. The earnings of young firms with losses are not very informative even if they are predicted with accuracy. A horizon longer than the analysts' four-year horizon must also be used. The use of conservative accounting such as the expensing of R&D expenditures reduces the information in book values and earnings of R&D intensive firms and thus requires forecast horizons longer than four years leading to poor model performance.

Additional explanations for the poor performance of the models deserve investigation. Of particular interest is the possibility of accurate model prices but inaccurate (inefficient) market prices. Another avenue for research is the development of better terminal value expressions.

Appendix

A Comparison of the Three Models

In the absence of premium/discount information the three models (1), (2), and (3) can be shown to systematically differ for a given finite horizon, t+T. Thus,

$$\text{If } \sum_{\tau=1}^{T} \rho^{\tau} E\left[\tilde{X}^{a}_{t+\tau}\right] > 0 \text{ then } P_t^T(\text{RIM}) < P_t^T(\text{CM}) \tag{A1}$$

while

$$\text{If } \sum_{\tau=1}^{T} \rho^{\tau} E\left[\tilde{X}^{a}_{t+\tau}\right] < 0 \text{ then } P_t^T(\text{CM}) < P_t^T(\text{RIM}) \tag{A2}$$

Relation (A1) indicates that when the present value of the residual income to the horizon is expected to be positive the capitalization model (CM) will result in higher values than the residual income model (RIM)[21]. Relation (A2) indicates that the opposite will be true when the present value of the residual income to the horizon is expected to be negative. Also, setting K_s=1 and S=1 to simplify the analysis with COMBO,

$$\text{If } \frac{\rho}{\rho - 1} E\left[\tilde{X}^{a}_{t+T+1}\right] > 0 \text{ then } P_t^T(\text{RIM}) < P_t^T(\text{COMBO}) \tag{A3}$$

while

$$\text{If } \frac{\rho}{\rho - 1} E\left[\tilde{X}^{a}_{t+T+1}\right] < 0 \text{ then } P_t^T(\text{COMBO}) < P_t^T(\text{RIM}) \tag{A4}$$

Relation (A3) indicates that when the terminal value at the horizon is expected to be positive then COMBO will result in higher values than RIM. Relation (A4) indicates that the opposite will be true when the terminal value is expected to be negative. Finally,

$$\text{if } \sum_{\tau=1}^{T} \rho^{\tau} E\left[\tilde{X}^{a}_{t+\tau}\right] > 0 \text{ and } \left(\frac{\rho^T}{\rho^T - 1} - 1\right) \sum_{\tau=1}^{T} \rho^{T} E\left[\tilde{X}^{a}_{t+\tau}\right] > \frac{\rho^T}{\rho - 1} E\left[\tilde{X}^{a}_{t+\tau+1}\right] \text{ then } P_t^T(\text{COMBO}) < P_t^T(\text{CM}) \tag{A5}$$

while

$$\text{if } \sum_{\tau=1}^{T} \rho^{\tau} E\left[\tilde{X}_{t+\tau}^{a}\right] < 0 \quad \text{and} \quad \left(\frac{\rho^{T}}{\rho^{T}-1} - 1\right) \sum_{\tau=1}^{T} \rho^{T} E\left[\tilde{X}_{t+\tau}^{a}\right] < \frac{\rho^{T}}{\rho - 1} E\left[\tilde{X}_{t+\tau+1}^{a}\right] \qquad \text{(A6)}$$

$$\text{then } P_t^T(CM) < P_t^T(COMBO)$$

Relation (A5) indicates that when the present value of the residual income to the horizon is expected to be positive and greater than the terminal value of the combination model at the horizon, the capitalization model (CM) will result in higher values than the combination model (COMBO). Relation (A6) indicates that when the inequalities reverse the CM prices will be lower than the COMBO prices.

Relations (A1)-(A6) indicate that for a given forecast horizon t+T the three models will yield three different prices. However, they do not indicate which of the three prices will be the most accurate. Clearly, the model that best captures expected premiums/discounts will yield the most accurate price. Discovering this is an empirical question that this paper addresses.

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Footnotes

1 Ohlson and Zhang (1999) call for such an empirical comparison.

2 In comparing the models Penman and Sougiannis (1998) use ex-post while Francis et al. (2000) use ex-ante values of the fundamental variables.

3 Theoretically, when expected premium/discount forecasts at the horizon are available the two models will yield prices without error for any firm. However, in practice, the prediction of the expected premium/discount at the horizon is the exception not the rule. Value line seems to be an exception as it reports forecasted P/E ratios at the horizon. Abarbanell and Bernard (1996), Claude et al. (2000), and Francis et al. (2000) convert these expected P/Es into expected premiums/discounts and use them in estimating prices.

4 The accuracy and bias of an estimated price can be of great concern to: a) an investor who wants to determine whether to buy, hold, or sell a firm's stock, b) an analyst who wants to provide, along with his earnings forecasts, a stock recommendation, and c) a researcher who wants to use such a price in examining a specific research question.

5 See Penman and Sougiannis (1997) for an empirical documentation of this dividend displacement property in GAAP earnings.

6 The I/B/E/S summary tape provides also mean ("consensus") forecasts. Since mean forecasts can be affected by extreme values and/or outdated forecasts, in this study we use median forecasts which are likely to be less noisy.

7 Philbrick and Ricks (1991) suggest that the actual earnings per share (EPS) numbers reported by COMPUSTAT are more accurate than those reported by I/B/E/S.

8 The I/B/E/S fiscal year end information was also verified against the corresponding data in the COMPUSTAT files.

9 We use the treasury-bond yield to measure the risk-free rate. Bond yields, from one- to five-year maturities by month, are obtained from the Federal Reserve Statistical Release G.13. This allows us to use the prevailing risk free rate at the beginning of the firm's fiscal year end month and incorporate the yield curve in our estimates.

10 Firm betas are estimated from the market model using maximum 60 and minimum 24 monthly returns up to the month prior to the earnings forecast release, the value-weighted market index and the Dimson (1979) correction for non-synchronous trading. Monthly stock returns are obtained from the monthly CRSP files.

11 The results are robust to using actual year-end book values for the current year t. Such actual values at t can be used in our setting since most of the earnings and dividend activity are known one week before fiscal year end.

12 In our analysis we controlled for outliers as follows: (a) we eliminated the firms in the top and bottom 1% of the book-to-market, earnings-to-price and expected EPS growth distributions in the current year; (b) when calculated prices were negative valuation errors were set to 100%, and (c) valuation errors greater than 400% were set to 400%.

13 We use pooled t-tests throughout the empirical analysis.

14 Although in terms of bias ERM and BVM do not differ, ERM has much higher explanatory power than BVM, 58% versus 41%.

15 The comparison t-statistics (not reported) are significant at the 5% level or better.

16 We also plot comparative cumulative distributions of the absolute valuation errors of the five models (available upon request). The plots show that one model yields smaller errors than another model by second-order stochastic dominance. For example, for about 90% of the cases COMBO1 yields smaller errors but for the

remaining 10% RIM dominates. The implication again is that different models are appropriate for different cases.

17 The Table 3 signed and absolute valuation errors are significantly different from zero at the 1% level or better.

18 Effective tax rate is defined as tax expense divided by pretax income adjusted for amortization.

19 The year dummies are in all regressions significant. Some industry dummies are also significant indicating that the performance of the models varies by industry and thus the choice of the model should be made by taking into account not only key firm characteristics but also the industry a firm operates in.

20 The R&D to book ratio is a level variable and as such it can indicate cases where the R&D expensing rule affects book value. However, growth in R&D affects earnings calculated under the expensing rule. Thus, instead of RDB we used the growth in R&D (from t-2 to t) and repeated the analysis of Table 6. The results are very similar to those reported in Table 6.

21 For a given finite horizon t+T

$$P_t^T(CM) - P_t^T(RIM) = \left(\frac{\rho^T}{\rho^T - 1} - 1\right)\sum_{\tau=1}^{T}\rho^{-\tau}E\left(\tilde{X}_{t+\tau}^a\right)$$

TABLE 1

Panel A: Summary Statistics of signed and absolute ex-ante valuation errors for 36,532 firms with a four year earnings forecast horizon over the period 1981-1998.

Valuation Model	Summary Statistic	Signed Errors VE^T_t (.) Forecast Horizon (years) 0	1	2	3	4	Absolute Errors AVE^T_t (.) Forecast Horizon (years) 0	1	2	3	4
BVM (T=0)	Median	0.45					0.49				
	Mean	0.36					0.50				
	S.D.	0.48					0.33				
	IQR	0.48					0.40				
RIM (T>0)	Median		0.43	0.41	0.39	0.37 *#		0.47	0.44	0.42	0.40 *#
	Mean		0.34	0.33	0.31	0.29		0.48	0.46	0.44	0.42
	S.D.		0.46	0.45	0.44	0.44		0.32	0.31	0.31	0.31
	IQR		0.47	0.45	0.44	0.43		0.40	0.38	0.38	0.36
ERM (T=0)	Median	0.44					0.46				
	Mean	0.41					0.49				
	S.D.	0.41					0.31				
	IQR	0.43					0.39				
CM (T>0)	Median		0.35	0.32	0.29	0.27 *#		0.38	0.36	0.34	0.33 *#
	Mean		0.29	0.25	0.22	0.19		0.41	0.40	0.39	0.38
	S.D.		0.42	0.43	0.46	0.48		0.30	0.31	0.33	0.35
	IQR		0.40	0.40	0.41	0.42		0.34	0.33	0.32	0.32
COMBO1 (T>0) (k_s varies)	Median		0.26	0.04	-0.02	0.11 *#		0.32	0.31	0.31	0.27 *#
	Mean		0.19	-0.21	-0.22	-0.01		0.36	0.53	0.50	0.37
	S.D.		0.44	0.86	0.79	0.59		0.31	0.71	0.65	0.46
	IQR		0.41	0.66	0.67	0.49		0.32	0.42	0.43	0.32
COMBO2 (T>0) (k_s=1.04)	Median		0.26	0.20	0.16	0.13 *#		0.32	0.30	0.28	0.28 *#
	Mean		0.20	0.12	0.07	0.03		0.37	0.37	0.37	0.38
	S.D.		0.45	0.50	0.53	0.57		0.32	0.37	0.39	0.43
	IQR		0.42	0.44	0.44	0.49		0.33	0.32	0.32	0.32

TABLE 1

Statistic	Median	Mean	S.D.	Q1	Q3	Minimum	Maximum
Panel B: k_s Summary Statistics for 27,379 firm-years for which k_s could be imputed.							
k_s	1.16	1.28	3.99	1.07	1.28	0.00	561.45
Panel C: k_s Summary Statistics for 4,721 firm-years for which k_s was imputed and used.							
k_s	0.97	0.89	0.19	0.86	1.00	0.00	1.04
k^*_s	1.05	1.10	8.17	0.89	1.13	-162.22	426.33
Panel D: k_s Summary Statistics for 27,379 firm-years for which k_s was used: 4,721 imputed and 22,658 set equal to 1.04							
k_s	1.04	1.01	0.10	1.04	1.04	0.00	1.04
k^*_s	1.01	1.22	42.73	0.89	1.06	-984.34	6,917.73

* Indicates the four-year horizon errors are significantly lower than shorter horizon errors.

\# Indicates that the four-year horizon errors differ significantly across the five models.

$VE_t^T(.) = \frac{P_t - P_t^T(.)}{P_t}$ where P_t is the market price at time t and $P_t^T(.)$ is the model price for horizon T, T=1,2,3,4.

BVM = Current Book Value Model
RIM = Residual Income Model
ERM = Current Earnings Model
CM = Capitalization Model
COMBO1 = Combination Model with K_s imputed from the firm's expected residual income.
COMBO2 = Combination Model with K_s = 1.04
S.D. = Standard Deviation
IQR = Interquartile Range
k_s = One plus the one-year growth rate in expected residual income calculated as $\tilde{X}^a_{t+4}/\tilde{X}^a_{t+3}$ where $\tilde{X}^a_{T+\tau}$ is residual income at time $t+\tau$.
k^*_s = One plus the one-year growth rate in expected residual income that yields zero valuation errors at horizon t+4, i.e., the firm specific rate that yields $VE^4_{it}(.) = AVE^4_{it}(.) = 0$.

TABLE 2

Pooled Regressions of Market Values on Estimated Values

Estimates	All Firms: Univariate Regressions		All Firms: Combined Regression BVM,ERM		All Firms: Combined Regression ERM, RIM, CM		All Firms: Combined Regression RIM, CM, COMBO1		Firms with lowest AVE^4_t (.): Univariate Regressions	
Panel A: BVM										
Intercept	1.62	(0.009)	1.48	(0.008)					0.84	(0.031)
Slope	0.59	(0.004)	0.14	(0.005)					0.80	(0.013)
R^2	0.41								0.76	
Panel B: ERM										
Intercept	1.59	(0.007)			0.85	(0.010)			0.04	(0.029)
Slope	0.60	(0.003)	0.50	(0.004)	0.07	(0.005)			1.03	(0.010)
R^2	0.58		0.59						0.92	
Panel C: RIM										
Intercept	1.03	(0.009)					0.59	(0.009)	0.12	(0.024)
Slope	0.78	(0.003)			0.07	(0.008)	0.20	(0.006)	0.97	(0.010)
R^2	0.59								0.91	
Panel D: CM										
Intercept	0.94	(0.008)							0.09	(0.016)
Slope	0.77	(0.003)			0.67	(0.009)	0.13	(0.009)	1.01	(0.006)
R^2	0.65				0.67				0.93	
Panel E: COMBO1										
Intercept	0.70	(0.009)							0.55	(0.015)
Slope	0.80	(0.003)					0.53	(0.008)	0.91	(0.005)
R^2	0.67						0.71		0.82	

*

TABLE 2

Notes

The univariate regressions are:

$$\log (P_{it}) = \alpha + \beta \log [P^4_{it}(.)] + u_{it}$$

where P_{it} is the market price of firm i at time t, and $P^4_{it}(.)$ is the model price of firm i using four-year earnings forecasts available at time t.

The combined BVM, ERM regressions are:

$$\log (P_{it}) = \alpha + \beta_1 \log [P_{it}(BVM)] + \beta_2 \log [P_{it}(ERM)] + e_{it}$$

The combined ERM, RIM, CM regressions are:

$$\log (P_{it}) = \alpha + \beta_1 \log [P_{it}(ERM)] + \beta_2 \log [P4it(RIM)] + \beta_3 \log [P^4_{it}(CM)] + e_{it}$$

The combined RIM, CM, COMBO1 regressions are:

$$\log (P_{it}) = \alpha + \beta_1 \log [P^4_{it}(RIM)] + \beta_2 \log [P^4_{it}(CM)] + \beta_3 \log [P^4_{it}(COMBO1)] + e_{it}$$

Numbers in parentheses are standard errors.

TABLE 3

Summary statistics for 36,532 firms with a four-year earnings forecast horizon partitioned into lowest absolute valuation errors generated by each valuation model.

Statistic:	VE^4_t (.)	AVE^4_t (.)	BM	EP	DP	MV	β	PVRI	GR	K_s	RI_{t+1}	RI_{t+2}	RI_{t+3}	RI_{t+4}
BVM: Generated the lowest absolute valuation errors for 4,160 firm-years (11%)														
Median	0.19	0.24	0.73	0.05	0.01	0.25	1.00	-0.90	0.12	0.97	-0.33	-0.30	-0.27	-0.23
Mean	0.20	0.30	0.74	0.03	0.02	1.56	1.06	-1.97	0.14	0.93	-0.74	-0.65	-0.61	-0.56
S.D.	0.33	0.24	0.32	0.12	0.03	6.11	0.58	66.39	0.09	0.43	19.61	21.18	22.91	24.81
IQR	0.40	0.34	0.40	0.08	0.04	0.74	0.66	1.55	0.07	0.27	0.57	0.52	0.50	0.51
ERM: Generated the lowest absolute valuation errors for 3,505 firm-years (10%)														
Median	0.02	0.09	0.69	0.08	0.02	0.32	1.00	1.06	0.12	1.09	0.40	0.46	0.51	0.58
Mean	0.04	0.17	0.75	0.08	0.03	0.38	1.05	2.34	0.13	1.43	0.56	0.75	0.95	1.19
S.D.	0.30	0.25	0.42	0.09	0.05	3.73	0.52	6.72	1.07	4.01	1.13	1.80	2.99	4.45
IQR	0.20	0.20	0.51	0.05	0.04	1.03	0.61	3.41	0.06	0.26	1.04	1.12	1.23	1.40
RIM: Generated lowest absolute valuation errors for 4,578 firm-years (13%)														
Median	0.00	0.11	0.84	0.07	0.01	0.18	1.06	0.69	0.13	1.11	0.11	0.15	0.17	0.19
Mean	-0.04	0.20	0.87	0.04	0.02	0.82	1.16	1.34	0.15	1.35	0.15	0.30	0.40	0.49
S.D.	0.37	0.32	0.41	0.14	0.05	2.30	0.54	6.71	0.10	3.18	1.36	1.51	1.94	2.46
IQR	0.23	0.20	0.55	0.08	0.04	0.55	0.58	3.93	0.08	0.28	1.01	0.97	0.93	0.92
CM: Generated lowest absolute valuation errors for 6,657 firm-years (18%)														
Median	0.05	0.09	0.58	0.06	0.01	0.25	1.05	1.44	0.14	1.14	0.36	0.53	0.69	0.82
Mean	0.07	0.16	0.65	0.04	0.02	1.34	1.16	2.12	0.16	1.38	0.41	0.65	0.85	1.04
S.D.	0.31	0.28	0.41	0.11	0.04	4.57	0.53	3.48	0.10	7.33	1.12	1.22	1.40	1.65
IQR	0.16	0.14	0.49	0.06	0.03	0.78	0.59	3.49	0.10	0.30	0.92	1.03	1.23	1.47
COMBO1: Generated lowest absolute valuation errors for 17,632 firm-years (48%)														
Median	0.21	0.21	0.41	0.05	0.01	0.48	1.00	1.95	0.15	1.20	0.45	0.59	0.74	0.91
Mean	0.21	0.24	0.45	0.05	0.02	2.43	1.10	2.45	0.17	1.46	0.57	0.75	0.93	1.13
S.D.	0.21	0.17	0.26	0.06	0.02	7.69	0.54	2.74	0.09	5.21	0.84	0.89	0.96	1.08
IQR	0.29	0.26	0.31	0.03	0.03	1.38	0.59	2.70	0.08	0.23	0.75	0.82	0.91	1.05

TABLE 3

Notes

BM =	Book-to-Market ratio at time t
EP =	Earnings-to-Price ratio at time t
DP =	Dividends-to-Price ratio at time t
MV =	Market Capitalization at time t
β =	Firm betas estimated from the market model at time t
PVRI =	The present value of expected residual income over the four-year forecast horizon
GR =	Analysts' five year expected growth rate in earnings per share.
K_s =	One plus the one-year growth rate in expected residual income calculated as $\tilde{X}^a_{t+4} / \tilde{X}^a_{t+3}$ where $\tilde{X}^a_{T+\tau}$ is residual income at time $t+\tau$.
$RI_{t+\tau}$ =	Expected residual income at $t+\tau$, τ=1, 2, 3, 4.

Table 4

Panel A: Analysts' Earnings Forecast Errors

Summary Statistic	Signed Forecast Errors, Forecast Horizon (years) 0	1	2	3	4	Absolute Forecast Errors, Forecast Horizon (years) 0	1	2	3	4
Number of Firms	35,783	29,956	24,990	21,092	17,896	35,783	29,956	24,990	21,092	17,896
Median	-0.01 *	-0.14 *	-0.25 *	-0.34 *	-0.42 *	0.09 *	0.27 *	0.38 *	0.47 *	0.53 *
Mean	-0.62	-1.59	-2.15	-2.61	-3.13	0.79	1.74	2.32	2.81	3.33
S.D.	4.91	9.66	12.67	13.98	17.93	4.89	9.63	12.64	13.94	17.89
IQR	0.32	1.10	1.39	1.63	1.83	0.37	0.98	1.23	1.45	1.65

Panel B: Summary Statistics of COMBO2 (Ks=1.04) signed and absolute **ex-post** valuation errors for 17,364 firms using four years ahead **actual** earnings over the period 1981-1994.

Summary Statistic	Signed Errors VE^4_t(COMBO2), Forecast Horizon (years) 0	1	2	3	4	Absolute Errors AVE^4_t(COMBO2), Forecast Horizon (years) 0	1	2	3	4
Median		0.33	0.30	0.30	0.29 #		0.36	0.36	0.36	0.36 #
Mean		0.29	0.25	0.24	0.22		0.41	0.41	0.42	0.42
S.D.		0.42	0.47	0.49	0.50		0.30	0.33	0.35	0.36
IQR		0.43	0.47	0.47	0.47		0.37	0.39	0.38	0.38

Panel C: Summary Statistics of COMBO2 (Ks=1.04) signed and absolute **ex-ante** valuation errors for 17,364 firms using four years ahead earnings **forecasts** over the period 1981-1994.

Summary Statistic	Signed Errors VE^4_t(COMBO2), Forecast Horizon (years) 0	1	2	3	4	Absolute Errors AVE^4_t(COMBO2), Forecast Horizon (years) 0	1	2	3	4
Median		0.26	0.20	0.16	0.07 #		0.32	0.29	0.28	0.24 #
Mean		0.19	0.11	0.07	-0.03		0.36	0.36	0.36	0.33
S.D.		0.44	0.50	0.52	0.52		0.31	0.36	0.39	0.40
IQR		0.41	0.45	0.46	0.46		0.32	0.32	0.32	0.30

* Indicates significance at the 5% level or better

\# Indicates that ex-poste errors differ significantly from ex-ante errors.

TABLE 5

Pooled Regressions of Absolute Valuation Errors at horizon t+4 $AVE^4_t(.)$ on Financial Variables at t.

$$AVE^{4}_{it}(\bullet) = \alpha + \sum_{y=1}^{15} b_y \, Year_y + \sum_{j=1}^{K} c_j \, IND_{ij} + \sum_{n=1}^{12} \left[\gamma_{n1} X_{nit} + \gamma_{n2} (X_{nit})^2\right] + u_{it}$$

where X is a vector of variables given in the table below.

Independen Variables	Dependent Variables					
	AVE^4_t(RIM)		AVE^4_t(CM)		AVE^4_t(COMBO1)	
BM	-0.806	(-68.543)	-0.212	(-14.855)	-0.068	(-3.843)
$(BM)^2$	0.314	(56.239)	0.086	(13.178)	0.055	(6.826)
DP	-0.046	(-0.492)	-1.163	(-9.748)	-1.060	(-5.791)
$(DP)^2$	-0.097	(-0.733)	2.651	(12.045)	6.570	(6.395)
EP	-0.223	(-10.144)	-0.620	(-22.743)	-0.420	(-12.542)
$(EP)^2$	-0.102	(-2.832)	-0.401	(-9.059)	-0.214	(-3.951)
ln MV	-0.008	(-1.475)	0.011	(1.619)	-0.009	(-1.139)
$(\ln MV)^2$	0.001	(3.159)	-0.000	(-0.027)	0.000	(0.008)
β	-0.006	(-0.759)	-0.026	(-2.620)	0.006	(0.522)
$(\beta)^2$	-0.001	(-0.331)	0.011	(3.140)	0.004	(0.861)
GR	0.337	(7.725)	-0.079	(-1.367)	-0.259	(-2.882)
$(GR)^2$	-0.224	(-3.427)	0.497	(5.412)	1.371	(8.128)
PVRI	-0.004	(-8.109)	-0.013	(-19.392)	0.003	(3.760)
$(PVRI)^2$	0.0001	(11.133)	0.0004	(13.473)	0.0003	(22.528)
INV	-0.001	(-2.059)	-0.000	(-0.587)	0.001	(1.426)
$(INV)^2$	$2.4\ e^{-07}$	(1.980)	0.000	(0.519)	-0.000	(-1.457)
AR	0.005	(1.767)	-0.004	(-1.007)	-0.006	(-1.324)
$(AR)^2$	-0.0002	(-2.067)	0.000	(0.782)	0.000	(0.931)
GM	-0.007	(-2.852)	0.013	(3.265)	0.015	(2.860)
$(GM)^2$	-0.0001	(-2.879)	0.0003	(3.603)	0.0003	(2.721)
SNA	-0.038	(-7.951)	0.015	(2.406)	0.028	(3.179)
$(SNA)^2$	-0.000	(-0.925)	0.002	(3.591)	0.005	(2.116)
ETR	-0.002	(-0.591)	-0.009	(-2.499)	-0.009	(-1.935)
$(ETR)^2$	-0.0000	(-0.598)	0.0002	(2.624)	0.001	(4.503)
Adj R^2	0.45		0.19		0.14	

TABLE 5

Notes

Numbers in parentheses are t-statistics.

INV =	the percentage change in inventory minus the percentage change in sales
AR =	the percentage change in Accounts Receivable minus the percentage change in sales
GM =	the percentage change in sales minus the percentage change in gross margin
SNA =	the percentage change in Selling and Administration expenses minus the percentage change in sales
ETR =	the change in the effective tax rate relative to the average effective tax rate in the last three years, multiplied by the

The remaining variables are defined in the notes to Table 3.

TABLE 6

Panel A: Median Absolute Valuation Errors and Descriptive Statistics for non-R&D firms and firms above and below the median R&D Expenditures to Book Value (RDB) ratio over the period 1981-1998.

	Non-R&D Firms	Firms above the Median RDB*	Firms below the Median RDB
N	22,058	7,237	7,237
VE^4_t(BVM)	0.41	0.65	0.36
AVE^4_t(BVM)	0.45	0.66	0.42
VE^4_t(RIM)	0.33	0.54	0.29
AVE^4_t(RIM)	0.38	0.55	0.34
VE^4_t(ERM)	0.40	0.59	0.43
AVE^4_t(ERM)	0.43	0.59	0.44
VE^4_t(CM)	0.25	0.38	0.23
AVE^4_t(CM)	0.32	0.41	0.29
VE^4_t(COMBO1)	0.11	0.17	0.08
AVE^4_t(COMBO1)	0.27	0.31	0.24
RDB	0.00	0.44	0.06
BM	0.58	0.32	0.63
EP	0.06	0.04	0.06
DP	0.01	0.00	0.02
MV	0.35	0.32	0.34
β	0.99	1.33	1.09
PVRI	1.19	1.99	0.96
GR	0.13	0.20	0.13
K_s	1.14	1.20	1.14
RI_{t+1}	0.32	0.42	0.22
RI_{t+2}	0.44	0.60	0.38
RI_{t+3}	0.54	0.79	0.50
RI_{t+4}	0.65	1.01	0.64
FE_t	-0.01	-0.02	-0.02
FE_{t+1}	-0.11	-0.26	-0.20
FE_{t+2}	-0.19	-0.45	-0.33
FE_{t+3}	-0.27	-0.62	-0.43
FE_{t+4}	-0.34	-0.73	-0.48
AFE_t	0.09	0.12	0.10
AFE_{t+1}	0.23	0.40	0.31
AFE_{t+2}	0.32	0.58	0.45
AFE_{t+3}	0.40	0.71	0.53
AFE_{t+4}	0.46	0.81	0.57

* Indicates that the reported variables for firms above the median RDB are significantlydifferent from the variables for non-R&D firms and for firms below the median RDB.

TABLE 6

Panel B: Median COMBO1 Absolute Valuation Errors for firms **above** the median R&D Expenditures to Book Value (RDB) ratio classified by expected Growth in Earnings (GR) and R&D to Book Ratio (RDB).

		R&D to Book Ratio (RDB) Low 1	2	3	4	High 5
Growth Rate (GR) Low	1	0.21	0.22	0.23	0.24	0.32
	2	0.25	0.25	0.26	0.31	0.32
	3	0.24	0.23	0.27	0.29	0.27
	4	0.27	0.29	0.32	0.32	0.33
High	5	0.36	0.34	0.36	0.39	0.43

Panel C: Median COMBO1 Absolute Valuation Errors for firms **below** the median R&D Expenditures to Book Value (RDB) ratio classified by expected Growth in Earnings (GR) and R&D to Book Ratio (RDB).

		R&D to Book Ratio (RDB) Low 1	2	3	4	High 5
Growth Rate (GR) Low	1	0.27	0.23	0.24	0.25	0.23
	2	0.22	0.23	0.20	0.20	0.21
	3	0.19	0.23	0.22	0.22	0.23
	4	0.24	0.25	0.20	0.22	0.28
High	5	0.29	0.27	0.29	0.30	0.29

Notes

see notes to tables 1,2, and 3 for variable definitions.

$FE_{t+\tau}$ = Analysts' earnings signed forecast errors at $t+\tau$

$AFE_{t+\tau}$ = Analysts' earnings absolute forecast errors at $t+\tau$

TABLE 7

Median Valuation Errors and Descriptive Statistics

	Firms in the second year in the market with **losses***	Firms in the second year in the market with **profits**
N	801	3,203
VE^4_t(BM)	0.45	0.59
AVE^4_t(BM)	0.61	0.60
VE^4_t(RIM)	0.38	0.45
AVE^4_t(RIM)	0.54	0.47
VE^4_t(ERM)	1.00	0.47
AVE^4_t(ERM)	1.00	0.49
VE^4_t(CM)	0.40	0.27
AVE^4_t(CM)	0.61	0.35
VE^4_t(COMBO1)	-0.04	0.05
AVE^4_t(COMBO1)	0.53	0.30
BM	0.35	0.37
EP	-0.11	0.05
DP	0.00	0.00
MV	0.10	0.14
β	1.38	1.16
PVRI	0.00	1.80
GR	0.25	0.20
K_s	1.22	1.23
RI_{t+1}	-0.13	0.39
RI_{t+2}	0.02	0.53
RI_{t+3}	0.10	0.68
RI_{t+4}	0.21	0.87
FE_t	-0.83	0.00
FE_{t+1}	-1.06	-0.22
FE_{t+2}	-1.27	-0.52
FE_{t+3}	-1.45	-0.78
FE_{t+4}	-1.60	-0.97
FE_t	0.87	0.08
FE_{t+1}	1.10	0.34
FE_{t+2}	1.33	0.59
FE_{t+3}	1.54	0.80
FE_{t+4}	1.82	0.97

Notes

Variable definitions are given in the notes to Table 1,3, and 6.
* Indicates that the reported variables for firms with losses are significantlydifferent from the variables for firms with profits.