Fundamentals-Based Risk Measurement in Valuation

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Abstract

We propose a methodology to incorporate risk measures based on economic fundamentals directly in the valuation model. Fundamentals-based risk adjustment in the residual income valuation model is captured by the covariance of excess ROE with market-wide factors. We simplify the covariance risk adjustment such that it can be easily implemented in a practical valuation setting. We demonstrate a method of estimating covariance risk out of sample based on the accounting beta and betas of size and book-to-market factors in earnings. Our empirical analysis shows that value estimates based on fundamental risk adjustment produce significantly smaller deviations from price compared to value estimates based on standard risk adjustment procedures using the CAPM or the Fama-French three-factor model. Further, we find that our single-factor risk measure, based on the accounting beta alone, captures aspects of risk that are indicated by size and book-to-market factors and largely explains the "mispricing" of value and growth stocks. The paper highlights the usefulness of accounting numbers in pricing risk beyond their role as trackers of returns-based measures of risk. Accounting risk measures are based on firm fundamentals that indicate the source of risk and hence the use of these measures directly in valuation is appealing.

1. Introduction

Measurement of risk is perhaps the single-most difficult task in valuing a security. Standard practice estimates risk from prior returns and obtains value by discounting expected future payoffs by the risk-adjusted cost of capital. While risk estimation using returns is simple to implement in practice, it is unclear what aspect of risk is captured by a non-primitive variable such as returns. If firm value is determined by more primitive or fundamental variables, it seems logical that risk also arises from those primitives or fundamentals. Value is created by the operating, investing and financing activities of a firm, and is directly linked with the earnings generating process. Hence, if the source of value generation and therefore the source of risk reside in economic fundamentals such as earnings, it would make sense to measure risk directly from fundamentals.

As far back as 1970, Beaver, Kettler, and Scholes investigated how returns-based measures of risk correlate with accounting measures of risk, such as the accounting beta, and earnings volatility. More recently, Fama and French (1995) examine whether size and book-to-market factors in returns reflect size and book-to-market factors in earnings. Underlying these inquiries is the notion that if risk originates from fundamentals, a good measure of risk ought to be estimated from more primitive variables than returns. Yet, returns-based measures of risk are the practical norm, and their observed correlation with accounting risk measures is generally offered as evidence that the source of risk captured by these measures can be traced to economic fundamentals. Whether risk measures based on fundamentals can play a role in valuation beyond tracking returns-based risk measures remains largely unexplored. In this paper, we propose a methodology that incorporates risk measures based on economic fundamentals *directly* in the valuation model. We ask the question: How does fundamentals-based risk adjustment affect valuation relative to the common practice of adjusting discount factors for risk using single- or multi-factor asset pricing models?

We first analytically simplify the valuation model to derive a risk adjustment that is based on accounting variables. We then identify accounting risk measures based on theory combined with empirical observation and use these measures to provide reasonable predictions of the risk adjustment term at the firm level. The objective is to derive firm value by adjusting expected payoffs with the estimated risk adjustment. We compare how this value deviates from price relative to the value derived by discounting expected payoffs by the risk-adjusted cost of equity.

Our theoretical development uses the residual income valuation model which expresses a firm's market value of equity as the book value of equity plus the present value of expected future residual income (Ohlson, 1995). Residual income (also called abnormal earnings in the literature) is income minus a charge for the use of capital measured by the beginning book value times the cost of capital. We choose the residual income model for our analysis because it allows us to theoretically derive risk measurement based on accounting variables. We show that, under standard assumptions, the risk adjustment term reflects the covariance between a firm's excess return on book equity (income divided by beginning book value minus the risk-free rate) and economy-wide risk factors. We derive a simplification of the covariance risk adjustment in the model that makes it amenable to implementation in a practical valuation setting.

We separately estimate two components of value: the risk-free present value and the covariance risk adjustment. For each firm, we first estimate the risk-free present value (*RFPV*), or value without risk adjustment, using analysts' forecasts of future earnings, current book value of equity, and the risk-free rate as inputs to the residual income model. We estimate the covariance risk adjustment for each firm out of sample by estimating factor loadings (or betas) of various risk factors and estimating factor risk premia. We use the accounting beta and betas of size and book-to-market factors *in earnings* as components of covariance risk.[1] In addition to firm-specific betas, we use betas averaged at the portfolio and industry levels to reduce noise due to the short time-series for estimation. When we use the market excess ROE as the only factor, risk premium is specified by theory as the (scaled) aggregate risk of the market (analogous to the market premium in the CAPM). When risk adjustment is based on multiple factors, we estimate factor risk premia using data from the previous year.

Note that since, theoretically, the risk adjustment term is a function of the covariance between a firm's excess ROE and (unknown) market-wide risk factors, we use excess *ROE betas* associated with the risk factors to estimate covariance risk. Thus, we strive to adhere to the dictates of theory rather than include risk measures on an *ad hoc* basis, such as the *magnitude* of size and book-to-market ratios, earnings or return volatility, or returns-based betas. However, since theory leaves the stochastic discount factor undefined, our choice of specific market-wide risk factors still remains *ad hoc*.

We compare valuation errors from our model with those from benchmark models that are estimated with the same model and inputs but where payoffs are discounted by the risk-adjusted cost of equity. Our empirical findings show that the median valuation error (absolute deviation of value estimate from price) is significantly lower when firm value is estimated

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[1]Analogous to the market beta, the accounting beta is the covariance of a firm's excess ROE with the market's excess ROE. Returns-based size and book-to-market factors are commonly used to estimate cost of equity. Our use of size and book-to-market factors *in earnings* (based on differential ROEs of extreme portfolios) is consistent with Fama and French (1995) who document that common factors (market, size, and book-to-market) in returns mirror common factors in earnings and that the market and size factors in earnings help explain those in returns. For our sample, we find that these three accounting risk measures have a significant positive correlation with risk priced by the market.

using fundamental risk adjustment including all three market-wide factors compared to that using the standard risk adjustment made to discount factors based on the Fama-French three-factor model. Valuation errors of the benchmark model are more than twice in magnitude relative to those of our model when we use betas averaged at the portfolio and industry levels. Mean errors are likewise lower than those of the benchmark Fama-French model except for the firm-level beta estimation.

Interestingly, median valuation errors with risk adjustment based on the accounting beta alone are very close in magnitude to those using three factors for all levels of estimation. Median valuation errors of this single-factor model based on portfolio and industry level estimations are lower than those of the benchmark CAPM by about 34%. We find this to be truly impressive given that our beta estimations are based on a short time-series of annual data. The parsimonious nature of the single-factor model and the fact that the factor risk premium is derived from theory (and not from fitted estimates from the previous year) makes this a desirable model and particularly valuable in a practical valuation setting.

A closer analysis of risk estimates at the industry level shows that the covariance risk based on fundamentals is higher for the auto and banking industries and lower for the energy and utility industries, consistent with our expectation and the findings of prior studies (Fama and French, 1997, Gebhardt et al., 2001, and Easton et al., 2002). This suggests that our covariance risk estimation at the industry level produces meaningful estimates.

While low valuation errors provide evidence that on average valuation with fundamental risk adjustment is closer to price relative to valuation with standard methods of risk adjustment, does our measure of fundamental risk capture risk that is unexplained by measures based on say the CAPM? More specifically, can our risk measure explain the documented mispricing of certain stocks? Prior research has documented persistent high returns to high book-to-price (value) stocks and low returns to low book-to-price (growth) stocks. Excess returns generated by strategies that buy value and short growth stocks have been attributed to mispricing and/or to mismeasurement of CAPM risk. If high book-to-price stocks are undervalued and low book-to-price stocks are overvalued, this should be evident from the difference between our value estimate and price. Using the one-factor (accounting beta) model to estimate covariance risk, we find that the difference in the ratio of value to price of the extreme book-to-price portfolios is significantly lower than the difference with CAPM risk adjustment. Thus, our fundamentals-based measure of risk captures a significant portion of the risk reflected in book-to-price ratios and to a large extent explains the "mispricing" of value and growth stocks. Results are similar for strategies based on firm size. These results validate our fundamentals-based covariance risk measure and are consistent with the findings of Cohen, Polk, and Vuolteenaho (2003).[2]

We acknowledge that our risk adjustment based on fundamentals may be more complex to implement than the risk-adjusted cost of equity based on single- or multi-factor models. However, unlike returns-based risk measures, our measure is not subject to the circularity involved in estimating risk from returns and avoids contamination due to possible mispricing when risk measures are calculated from high-frequency returns data. These benefits, along with the evidence of our measure's empirical validity, commend its use in practical valuation despite its complexity.

To summarize, this paper contributes by incorporating accounting measures of risk directly in the valuation model both theoretically and practically. To our knowledge, this is the

[2]Based on a variance decomposition of the price-to-book ratio, these authors find that the mispricing component of the variance is insignificant when risk is measured as "cash flow" covariances.

first paper that explores the direct valuation role of accounting risk measures. Accounting risk measures are based on firm fundamentals that indicate the source of risk and hence the use of these measures directly as risk adjustments in valuation is appealing. While our research takes the first step in broadening the role of accounting risk measures in valuation, it opens up interesting possibilities for capturing the source of risk at an elemental level, for example, by disaggregating the ROE and measuring risk arising from profit margins, asset turnover, and leverage.[3]

The rest of the paper is organized as follows. Section 2 presents the theoretical development of the covariance risk adjustment. Section 3 describes the data, sample selection, and research design. Empirical results are reported in Section 4, followed by concluding remarks in Section 5.

2. Theoretical Development

In this section, we derive a simplified covariance risk adjustment in the residual income valuation model. The residual income model expresses value as the current book value of the firm plus the present value of expected future residual income, where residual income (or abnormal earnings) equals earnings in excess of a normal return on beginning-of-period book value. Hence, value depends on the stock variable (book value) and the flow variable (residual income) that relates to the firm's future wealth generation. Assuming the clean surplus relation (i.e. the change in book value equals earnings minus dividends), the residual income model is

[3]Based on insights from the discussion in Penman (2003, Chapter 18) about how the drivers of ROE determine fundamental risk, we plan to incorporate the components of ROE risk in our future analysis. The current paper is perhaps the first response to Penman's call for a shift in focus from returns-based risk to fundamental risk estimation.

equivalent to the dividend discounting model (Ohlson, 1995, and Feltham and Ohlson, 1995).[4] We start with a general representation of the present value of expected dividends formula

$$V_t = E_t \sum_{j=1}^{\infty} m_{t,t+j} d_{t+j} \tag{1}$$

where V_t = value of equity at date t, d_t = dividends at date t, $m_{t,t+j}$ equals the j-period stochastic discount factor, and $1/E_t[m_{t,t+j}] = R^f_{t,t+j} = (1+r^f_{t,t+j})$ equals one plus the risk-free return from date t to $t+j$.[5] Assuming the clean surplus relation,

$$B_t = B_{t-1} + x_t - d_t,$$

where B_t = book value of equity at date t, x_t = earnings for period t, and defining residual income (or abnormal earnings) as

$$x^a_{t+j} = x_{t+j} - r^f_{t+j-1,t+j} B_{t+j-1},$$

we can express the residual income valuation model as

$$V_t = B_t + E_t \sum_{j=1}^{\infty} m_{t,t+j} x^a_{t+j} \tag{2}$$

Separating the expected residual earnings component and the risk component, and substituting $E_t[m_{t,t+j}] = 1/R^f_{t,t+j}$, we obtain

[4] Besides the important fact that risk adjustment using fundamentals emerges theoretically in the residual income model, the model has some advantages over the dividend discounting and the discounted cash flow models in terms of covariance risk estimation. Covariance of dividends as payoffs is not likely to provide a good measurement of risk because dividend policies tend to be arbitrary and do not vary much over time. And, covariance based on earnings rather than free cash flows may provide a better indication of risk given that earnings are more reasonable measures of performance than free cash flows over short horizons (Penman and Sougiannis, 1998).

[5] $m_{t,t+j}$ is a set of contingent claims prices scaled by state probabilities, also referred to as state-price density (Cochrane, 2001).

$$V_t = \left(B_t + \sum_{j=1}^{\infty} \frac{E_t[x^a_{t+j}]}{R^f_{t,t+j}} \right) + \left(\sum_{j=1}^{\infty} Cov_t[m_{t,t+j}, x^a_{t+j}] \right) \tag{3}$$
$$\equiv RFPV + \text{Risk Adjustment}$$

where *RFPV* or the "risk-free present value" equals current book value plus the present value of expected future residual earnings discounted at the risk-free rate.[6, 7] Note that, in contrast with standard practice, risk adjustment in (3) is made to expected payoffs in the numerators and not to discount factors in the denominators of the valuation model. To simplify the model, we assume a flat and non-stochastic risk-free rate and express *RFPV* as a finite period calculation with a terminal value at the horizon *t+T*

$$RFPV_t = B_t + \sum_{j=1}^{T-1} \frac{FEROE_{t+j} E_t[B_{t+j-1}]}{(1+r^f)^j} + \frac{FEROE_{t+T} E_t[B_{t+T-1}]}{(1+r^f)^{T-1}(r^f - g)} \tag{4}$$

where $FEROE_{t+j} = \dfrac{E_t[x_{t+j}]}{E_t[B_{t+j-1}]} - r^f =$ forecasted excess return on equity (forecasted EROE), $(1+r^f)^j = R^f_{t,t+j}$ (all *j*), and *g* = long-run rate of growth in residual earnings. The third term on the RHS represents the terminal value which assumes that residual earnings at *t+T* will grow at the rate *g* to perpetuity.

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[6]Our notation differs slightly from that of Feltham and Ohlson (1999). They incorporate risk in the residual income model as

$$V_t = B_t + \sum_{j=1}^{\infty} (R^f_{t,t+j})^{-1} (E_t[x^a_{t+j}] + Cov_t[x^a_{t+j}, Q_{t,t+j}])$$

where $Q_{t,t+j} =$ risk-adjustment index $= m_{t,t+j} R^f_{t,t+j}$.

[7]The stochastic discount factor in consumption-based models is the marginal rate of substitution, $m_{t,t+j} = \beta \dfrac{u'(c_{t+j})}{u'(c_t)}$, where β is the subjective discount factor, c_t is consumption at date *t*, and *u*(*c*) denotes an investor's utility function. Thus, $m_{t,t+j}$ is the rate at which an investor is willing to substitute consumption at date *t+j* for consumption at date *t*. Since the utility function *u*(*c*) is concave for risk averse investors, the marginal utility $u'(c_{t+j})$ and the stochastic discount factor, $m_{t,t+j}$, are decreasing in future consumption, c_{t+j}. This implies that the marginal value of a unit payoff is high (low) when aggregate consumption is low (high). Thus, a higher covariance of payoff with consumption results in a lower asset value.

Implementation of the risk adjustment in (3) poses a difficulty. Equation (3) requires us to estimate an infinite set of covariances which is not practically feasible. Our objective in the analysis that follows is to simplify the risk adjustment term such that we can make reasonable estimates of the covariance term with available data. We express the infinite set of covariances as a single (constant) covariance of excess ROE with market-wide factors which can be estimated from historical data. Expressing residual earnings in return form -- excess ROE -- allows us to make the assumption of constant covariance, which is a less reasonable assumption for the non-stationary earnings series.

Appendix 1 derives a simplification of the risk adjustment term in (3) as

$$\text{Risk Adustment}_t \approx \sum_{j=0}^{\infty} \frac{E_t[B_{t+j}]}{(1+r^f)^j}\ Cov[m, EROE] \tag{5}$$

This derivation assumes that the covariance between excess ROE and the stochastic discount factor is constant across time, consistent with constant betas over time as is generally assumed in empirical estimations of the cost of equity. Further, assuming the same terminal value growth rate as in equation (4), we get

$$\text{Risk Adjustment} \approx K_t Cov[EROE, m] \tag{6}$$

where $K_t = \left[\sum_{j=0}^{T-1} \frac{E_t(B_{t+j})}{(1+r^f)^j} + \frac{E_t(B_{t+T})}{(1+r^f)^{T-1}(r^f - g)} \right]$.

Substituting $m = a - \sum_l b_l f_l$, where f_l = an economy-wide risk factor, we can re-write equation (3) as

$$(RFPV_t - V_t) = K_t \sum_l b_l Cov[EROE, f_l] \tag{7}$$

We refer to the LHS term, the difference between the risk-free present value and V_t, as "priced risk". Thus, while the general model requires covariance risk adjustment to every future payoff term in the formula, equation (7) reduces the risk adjustment to a single term that can be easily estimated as a weighted sum of covariances of excess ROE with economy-wide risk factors. Note that this risk adjustment is an aggregate price-level measure rather than a short-term return-level measure. Return-level risk measures typically estimate covariances (betas) using high-frequency returns data and hence may be contaminated by mispricing (if present). Our price-level measure based on covariances of excess ROE with market factors avoids this problem.[8] In the next section, we define variables used in the empirical analysis and describe the covariance risk estimation procedure.

3. Data, Sample Selection, and Research Design

Our sample includes firms with required data on Compustat, CRSP, and *I/B/E/S* databases. We include only firms with December fiscal year ends.[9] To estimate earnings-based betas, a firm is required to have data on annual earnings (before extraordinary items) and beginning-of-year book value for at least ten consecutive years prior to the valuation year. We use the residual income model to obtain value estimates for each firm at the end of April of each year of our sample period, 1982-2005. To obtain our firm value estimates, we use the per share beginning-of-year book value, analysts' EPS forecasts for the subsequent five years, and the yield on 10-

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[8]Cohen, Polk, and Vuolteenaho (2003) argue that the price-level criterion is appropriate in the context of long-term investment decisions and in tests of market efficiency.

[9]Similar to other valuation studies, we exclude non-December fiscal year-end firms so that (i) betas as well as priced risk are estimated at the same point in time for each firm-year observation, and (ii) portfolios can be formed on the basis of characteristics that are measured at the same point in time for all firms.

year U.S. government bonds as the risk-free rate.[10] We use the *I/B/E/S* mean consensus analysts' EPS forecasts in April for one and two years ahead and apply the long-term growth rate forecast to the two-year-ahead forecast to obtain forecasts for years three to five. We eliminate firms with negative two-year-ahead forecasts because growth from this negative base is not meaningful. To mitigate problems due to small denominators and outliers, we also delete firms with beginning-of-year book value and end-of-April price less than or equal to ten cents, and with end-of-April book-to-market ratios less than 0.01 and greater than 100. Our final sample ranges from 415 firms in 1982 to 1,132 firms in 2005.

We estimate firm value by separately estimating its two components: (i) *RFPV* as the current book value plus the present value of expected future residual earnings discounted at the risk-free rate, and (ii) the risk adjustment term in equation (7). The following sub-sections explain our estimation procedure.

3.1 Estimation of RFPV

To estimate *RFPV* from equation (4), we make assumptions that are standard in the literature on earnings-based valuation (for example, Frankel and Lee, 1998, Claus and Thomas, 2001, Gebhardt et al., 2001, Easton et al., 2002, and Baginski and Wahlen, 2003). Book value per share for subsequent years is forecasted using the clean surplus relation, i.e. $B_t = B_{t-1}$ + forecasted EPS_t – forecasted dividend per share_t. Dividend per share is forecasted by assuming a constant expected payout that equals the current payout ratio. For firms experiencing negative current earnings, we obtain an estimate of the payout ratio by dividing current dividends by 6% of total assets (a proxy for normal earnings based on the historical long-run

[10]Yields on 10-year U.S. Government bonds are obtained from Federal Reserve Bulletins (Table 1.35) for April of each year.

return on total assets for U.S. companies). We use several terminal growth rate assumptions to estimate the terminal value in the *RFPV* calculation, including zero growth, a 3% growth rate that approximates the long-run inflation rate, and a "fade" rate that assumes that a firm's ROE reverts (linearly) to the median industry ROE at date *t+12* (see Gebhardt et al., 2001). The same growth rate assumption is applied to estimate value using benchmark models (for example, the model using CAPM risk-adjusted cost of equity to discount expected future residual earnings). Given that we are primarily interested in *relative* valuations, our results and inferences are not in general sensitive to the growth rate assumption. Hence, we only report results based on a 3% terminal growth rate.

3.2 Estimation of covariance risk (out-of-sample)

To estimate covariance risk, we use equation (7) to calculate priced risk as ($RFPV_t$ - P_t) scaled by P_t,

$$\frac{(RFPV_t - P_t)}{P_t} = \sum_l b_l \frac{K_t Cov[EROE, f_l]}{P_t} \tag{8}$$

and separately estimate the two components of the risk adjustment term: factor sensitivity, $K_t Cov[EROE, f_l]/P_t$, and factor premium, b_l. While the estimation of fundamental betas (i.e. $Cov[EROE, f_l]$) using excess ROE is similar to the estimation of betas using returns, the estimates are noisier due to the relatively small number of observations in the estimation period (at least 10 and up to 20 annual observations). Hence, in addition to firm-specific betas, we also use portfolio betas and industry betas to reduce the noise in estimating covariance risk. Our explanation of the estimation procedure given below is based on firm-specific betas.

3.2.1 Estimation of factor sensitivities (betas) and factor risk premia

To estimate $Cov[EROE, f_l]$, we use three fundamentals-based risk measures, namely, the accounting beta, and betas of size and book-to-market factors *in earnings*. We estimate the accounting beta as the slope coefficient from a regression of a firm's excess ROE on the market's excess ROE, which is analogous to the market beta using a firm's accounting rate of return instead of its market return.[11] Fama and French (1992) find that average returns are negatively correlated with firm size and positively correlated with the book-to-market ratio. They argue that, if stocks are priced rationally, systematic differences in average returns must be due to differences in risk. Hence, these so-called anomalous findings of higher returns to small firms and high book-to-market stocks may arise because these variables proxy for unnamed risk factors in expected returns.[12] Fama and French (1995) show that common factors in returns (market, size, and book-to-market) mirror common factors in earnings and that the market and size factors in earnings help explain those in returns. Thus, similar to returns-based risk factors used in the prior literature, we use the return on *book* equity for the market, and size and book-to-market factors in *earnings* as (accounting) risk factors that explain priced risk.

For each firm, we estimate betas or the sensitivity of a firm's excess ROE to (i) the market's excess ROE (MKT.EROE), (ii) ROE of the SMB (small minus big) portfolio (SMB.ROE), and (iii) ROE of the HML (high minus low book-to-market) portfolio (HML.ROE). Analogous to the Fama-French factors in returns, the SMB (HML) factor *in*

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[11]Beaver, Kettler, and Scholes (1970) show that the accounting beta is correlated with market-based measures of risk, such as the market beta and return volatility. A recent paper by Baginski and Wahlen (2003) finds a positive correlation between the accounting beta and priced risk in the cross-section.

[12]Chan and Chen (1991) postulate that the risk captured by book-to-market ratios is a relative distress factor, because firms that the market judges to have poor prospects, as signaled by their low stock prices and high book-to-market ratios, have higher expected returns (they are penalized with higher costs of capital) than firms with strong prospects.

earnings is the ROE of a portfolio of small (high book-to-market) firms minus the ROE of a portfolio of large (low book-to-market) firms. The extreme portfolios comprise the top and bottom 30% of observations. For each firm *i*, betas are estimated from the following regressions using the time-series over at least ten years and up to twenty years preceding the valuation year, t ($\tau = t\text{-}21 \ldots t\text{-}1$):

$$EROE_{\tau} = \alpha + \beta_{ACCT} MKT.EROE_{\tau} + \varepsilon_{\tau} \tag{9}$$

$$EROE_{\tau} = \alpha^{'} + \beta_{ESMB} SMB.ROE_{\tau} + \varepsilon_{\tau}^{'} \tag{10}$$

$$EROE_{\tau} = \alpha^{''} + \beta_{EHML} HML.ROE_{\tau} + \varepsilon_{\tau}^{''} \tag{11}$$

where β_{ACCT} is the accounting beta, β_{ESMB} is the beta of the size factor in earnings, and β_{EHML} is the beta of the book-to-market factor in earnings.[13]

To estimate factor premia, we run the cross-sectional regression (8) using data from year $t\text{-}1$ relative to the valuation year t,[14]

$$\frac{(RFPV_{t-1} - P_{t-1})}{P_{t-1}} = c_1 Cov_{ACCT} + c_2 Cov_{ESMB} + c_3 Cov_{EHML} + \nu_{t-1} \tag{12}$$

where $Cov_{ACCT} = K_{t-1}\hat{\beta}_{ACCT} / P_{t-1}$, $Cov_{ESMB} = K_{t-1}\hat{\beta}_{ESMB} / P_{t-1}$, $Cov_{EHML} = K_{t-1}\hat{\beta}_{EHML} / P_{t-1}$, c_1, c_2, and c_3 are the estimated factor risk premia, and ν_{t-1} is the error term. $\hat{\beta}_{ACCT}$, $\hat{\beta}_{ESMB}$, and $\hat{\beta}_{EHML}$ are the slope coefficients estimated from regressions (9), (10), and (11) for each firm. Note that the independent variables reflect the sum of covariances of *residual earnings* with the

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[13]We estimate betas by winsorizing excess ROE at ±0.50; our results are not sensitive to different winsorization schemes.

[14]Baginski and Wahlen (2003) regress the same dependent variable as in equation (12), i.e. priced risk, on accounting risk measures (accounting beta and standard deviation of excess ROE), and other risk measures (market beta, log of size, and log of book-to-market ratio) and find that accounting risk measures exhibit significant explanatory power for priced risk.

respective market factor (scaled by P_{t-1});[15] however, to estimate the independent variables, we break down residual earnings into two components, excess ROE and book value, to obtain more reliable empirical estimates of covariances. Note further that our risk measures are based on *covariances of excess ROE* as suggested by theory; however, our choice of the covariates or market-wide factors remains *ad hoc*.[16]

We obtain the predicted value of $(RFPV_t - V_t)/V_t$ by first multiplying the estimated coefficients from regression (12), $\hat{c}_1$, $\hat{c}_2$, and $\hat{c}_3$, by the respective covariances from the previous year, Cov_{ACCT}, Cov_{ESMB}, and Cov_{EHML}, and then taking the sum of these products. Using this estimate of risk adjustment and our estimate of *RFPV*, we obtain the estimate of firm value, *V*.

We estimate firm value using the three risk factors (the market's excess ROE, and size and book-to-market factors in earnings) as explained above, based on our finding that these factors have significant explanatory power for priced risk in the cross-section (see Appendix 2 and Table A1). In the interest of parsimony, we also estimate firm value using only one risk factor, the market's excess ROE. An additional advantage of this risk measurement is that the factor premium can be derived from theory. For the market portfolio, $\hat{\beta}_{ACCT}$ =1, hence the factor premium equals $(RFPV_{Mt} - P_{Mt})/K_{Mt}$, or the market's priced risk scaled by the aggregate (capitalized) book value of the market portfolio (an accounting analog of the market risk

[15]Technically, the independent variables are covariances of residual earnings with the respective market factor divided by the variance of the market factor which is a cross-sectional constant and hence is inconsequential in explaining the dependent variable.

[16]In consumption-based models, a higher covariance of payoff with consumption results in higher risk and lower asset values. Since our measure of payoff is excess ROE, we use the market's excess return on equity to capture change in aggregate consumption. Interestingly, we find that the correlation between the *market's excess ROE* and per capita consumption growth over the period 1963-2004 is 0.33 in contrast with a low correlation of 0.08 between the excess *market return* and consumption growth.

premium). Thus, for the one-factor model, our estimate of the risk adjustment term equals $[(RFPV_{Mt-1} - P_{Mt-1}) / K_{Mt-1}]Cov_{ACCT}$, where Cov_{ACCT} is estimated for each firm *i* in the previous year *t-1*.

3.3 Estimation of benchmark models

We estimate firm value from different benchmark models using the same data within the forecasting horizon, and the same risk-free rate and terminal growth rate assumption that we use to obtain our estimate of firm value. The benchmark models incorporate risk in the denominator of the residual income valuation model to discount expected future residual earnings. The risk-adjusted cost of equity is estimated using the CAPM, and the Fama-French three-factor model. For estimation of the CAPM cost of equity, we estimate betas using monthly security returns and returns on the CRSP (NYSE-AMEX-NASDAQ) value-weighted market index over a period of 60 months ending in April of the valuation year (minimum of 40 months). Expected market risk premium is measured as the arithmetic average of value-weighted market returns minus the risk-free rate from 1926 until the end of April of the valuation year. For estimation of the cost of equity using the Fama and French (1993) three-factor model, we estimate betas using excess returns of the market, the SMB, and the HML portfolios over a period of 60 months ending in April of the valuation year and calculate the expectations of the three factor premia using the arithmetic average from 1926 until April of the valuation year.[17] We compare our model based on firm-specific, industry, and portfolio risk adjustments with benchmark models using firm-specific, industry, and portfolio-level cost of equity, respectively.

[17]Monthly data of the three factors is obtained from Kenneth French's website, for which we are grateful.

3.4 Portfolio and industry level estimation

We also estimate covariance risk at the portfolio and industry levels, to mitigate the noise in firm-specific betas which are estimated using a short time-series.[18] We construct twenty-five size-B/P portfolios of sample firms by first forming quintiles of firm size (market capitalization) and then, within each size quintile, forming five portfolios based on the book-to-price ratio (B/P), where size and B/P are measured at the end of April of each year. We estimate portfolio betas as the portfolio means of firm-specific betas ($\hat{\beta}_{ACCT}, \hat{\beta}_{ESMB}$, and $\hat{\beta}_{EHML}$) and obtain factor premia by estimating regression (12) for the previous year *t-1* relative to the valuation year *t*. Regression (12) is estimated with firm-level (not portfolio-level) observations, with portfolio betas replacing firm-specific betas in constructing the independent variables. For estimation of industry betas and factor premia we form industry groups based on the Fama-French 48-industry classification (Fama and French, 1997) and follow the same estimation procedure as used for size-B/P portfolios.

4. Empirical Results

Table 1 reports descriptive statistics of our sample firms over three sub-periods: 1982-89, 1990-97, and 1998-2005. In Panel A, we present means and medians of variables that we use as inputs to the residual income valuation model. The mean and median price per share increases over the three sub-periods, while the mean and median book value per share remains more or less stable. The mean (median) book-to-price ratio declines from a high of 0.75 (0.71) in 1982-

[18]For out-of-sample estimation, we also winsorize firm-specific accounting betas at 0 and +3 and size and book-to-market betas at ±3. Results are substantially similar when we winsorize accounting betas at 0 and 5 and size and book-to-market betas at ± 5.

89 to 0.52 (0.45) in 1998-05 reflecting the effect of the bull market of the mid-to-late1990s. The mean (median) dividend payout ratio steadily declines from 45% (41%) in the earliest sub-period to 29% (24%) in the latest sub-period. Analysts' expectations of ROE for the subsequent one and two years trend slightly upward compared to the reported ROE; the upward trend is discernible in all sub-periods. The mean analysts' long-term growth rate forecasts increase slightly from 11.7% in the earliest sub-period to 13.3% in the latest sub-period. The risk-free rate which is the 10-year government bond rate significantly declines over our sample period with a mean of 10% in 1982-89 to a mean of 5% in 1998-05. A similar declining trend is visible in the cost of equity estimates based on the CAPM and the Fama-French three-factor model.

Panel B of Table 1 presents the mean and median estimates of the risk-free present value based on the residual income valuation model using current book value, analysts' earnings forecasts, the forecasted dividend payout ratio, and the risk-free rate as inputs. The risk-free present value (*RFPV*) increases steadily over time. The increasing trend in *RFPV* is consistent with declining risk-free rates over this time period. Priced risk (*RFPV-P*) as a percentage of the risk-free present value also increases steadily over the three sub-periods. Similar to Baginski and Wahlen (2003), the mean priced risk exceeds price in the last two sub-periods. This high magnitude of priced risk is shown by these authors to be consistent with the magnitude of implied risk premia reported by other studies over the same time period (for example, Gebhardt et al., 2001, and Claus and Thomas, 2001).

4.1 Comparison of valuation errors

In Table 2, we report valuation errors of the residual income model with fundamental risk adjustment (in the numerator) and compare them with errors of benchmark models (residual income model with risk-adjusted cost of equity using CAPM or the Fama-French three factors). Errors from the one-factor (accounting beta) model and the CAPM are reported in panel A, and those from the three-factor (accounting beta and earnings-based size and book-to-market) model and the Fama-French model are reported in panel B.[19] We report (i) percentage absolute errors, measured as the absolute difference between value (V) and price (P), divided by price, and (ii) rank errors, measured as the absolute difference between the rank of V (V_R) and the rank of P (P_R), where V_R and P_R are obtained each year by ranking V and P separately and dividing the rank by the number of sample firms in that year (the rank variable ranges from zero to one). We report rank errors because they are less susceptible to outliers and are free from biases. Both panels report errors of our model with betas estimated at the firm level, portfolio level (25 size-B/P portfolios) and industry level (48 industries), and of the CAPM and Fama-French models with cost of equity estimated at the firm level, portfolio level, and industry level.

From panel A, column (1), based on portfolio-level (industry-level) estimation, 63.1% (63.9%) of firms have lower absolute valuation errors using the one-factor (accounting-beta) fundamental risk adjustment relative to the CAPM. The one-factor model obtains significantly lower absolute valuation errors compared to the CAPM at the portfolio and industry levels as indicated by the matched-pair t-statistic as well as the two-sample median test. When

[19]For the CAPM and Fama-French model, the cost of equity is estimated using the 10-year government bond rate consistent with the risk-free rate used for our model with fundamental risk adjustment. We conduct sensitivity analysis to ensure that our results are not due to our choice of the risk-free rate or the market premium. First, when we use the one-year T-bill rate as the risk-free rate (to conform to standard practice), valuation errors continue to be significantly lower for our model relative to benchmark models for all estimation levels. Second, the valuation errors for the CAPM decrease but are still significantly higher than those from our model, when we replace the historical average market risk premium of 6.5% (relative to the 10-year government bond rate) by 5% or 3%, based on the findings of recent papers (Claus and Thomas, 2001, Gebhardt, et al., 2001, and Easton and Sommers, 2006) that the implied market risk premium is significantly lower than the historical premium.

accounting beta is estimated at the firm level, the mean (median) valuation error is higher (lower) than that of the CAPM. Median errors at the firm, portfolio, and industry levels are lower than CAPM median errors by 8.8%, 33.7%, and 34.6%, respectively. As expected, both mean and median errors are significantly lower when accounting betas are estimated at the portfolio and industry level.[20] The improvement achieved by portfolio/industry level estimation is not as substantial in the case of CAPM errors. Results of rank errors follow a similar pattern.

From panel B, our model with risk estimated using three factors obtains significantly lower errors at the portfolio and industry levels compared to the Fama-French three-factor model. Similar to the one-factor model, median errors in the case of firm-level estimation are lower, whereas mean errors are higher relative to the benchmark model (which is not surprising given the noise in estimation of earnings-based betas using a short time-series). Median errors at the firm, portfolio, and industry levels are lower than benchmark-model median errors by 26.4%, 60%, and 57.6%, respectively. Interestingly, while the results of the within-sample regression show that earnings-based size and book-to-market betas have some incremental explanatory power over the accounting beta (Table A1 in Appendix 2), we see minimal improvement in valuation errors when risk is estimated *out of sample* using the three-factor model vis-à-vis the one-factor model. This is also true for the standard benchmark models–CAPM valuation errors are consistently lower than those from the Fama-French three-factor

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[20]The magnitude of our median valuation error based on the industry-level CAPM cost-of-capital is close to the median valuation error of 30% obtained by Francis, Olsson, and Oswald (2000).

model.[21]

Analysis by sub-periods (1982-89, 1990-97, and 1998-05) shows that median errors of our model are lower than those of benchmark models for both the one-factor and the three-factor models at all levels of estimation for all sub-periods. In all three sub-periods, mean errors are similarly lower except for those obtained from firm-level risk estimation (untabulated).

Overall, the improvement achieved by our model is significant in magnitude when risk is estimated using three accounting factors. What we find to be truly impressive is that even a parsimonious model, where risk is captured by the accounting beta alone, yields significantly lower valuation errors than benchmark models, especially with portfolio- and industry-level estimations. Note that for portfolio- and industry-level estimations, the components of value, namely the risk-free present value and the fundamental risk adjustment, are estimated for each firm with all *firm-level* variables except the factor betas. Thus, overall risk estimates are obtained for each firm separately even when we report them as "portfolio" or "industry" level.

4.2 Fundamental risk estimates of selected industries

From Table 2, fundamental risk estimation at the industry level yields low valuation errors. In Table 3, we report (out-of-sample) estimates of covariance risk obtained for the energy, utility, auto and banking industries.[22] Prior studies, in particular, Fama and French (1997), Gebhardt et al. (2001), and Easton et al. (2002), find that estimated risk premia for

[21]While multiple risk factors improve risk estimation within sample, it is interesting to note that the Fama-French three-factor model leads to higher deviations of value from price when risk is estimated out of sample, probably due to the additional noise in estimating multiple betas and factor premia.

[22]The industry groups are based on the following 4-digit SIC codes: energy, 1310-1389, 2900-2911, 2990-2999; utility, 4900-4999; auto, 2296, 2396, 3010-3011, 3537, 3647, 3694, 3700-3716, 3790-3792, and 3799; and banking, 6000-6199. These industry groups are defined in Fama and French (1997).

firms in the energy and utility industries are lower whereas that for firms in the auto and banking industries are higher than for firms in other industries. Consistent with the findings of these studies, we find that the median covariance risk estimate based on fundamentals (divided by beginning price) is higher for the auto and banking industries and lower for the energy and utility industries. This result suggests that our covariance risk estimation at the industry level produces meaningful estimates. From a practical standpoint, analysts who are industry specialists can easily adopt our method of risk estimation to obtain firm value. Note that even the one-factor (accounting beta) model obtains differential risk estimates for the selected industries. Hence, covariance risk can be estimated for a firm using few inputs, namely, industry accounting beta and market's priced risk, in addition to other variables used for the standard valuation model.

4.3 Value-to-price ratios for B/P and size groups

Table 2 shows that valuation errors obtained from our model with covariance risk adjustment based on the accounting beta alone are lower than those obtained from the CAPM, especially at the portfolio and industry levels. While the accounting beta can be viewed as a measure of fundamental risk, we would like to know what aspects of risk it captures relative to other standard models. The finance literature has documented persistent high returns to value (high book-to-price) stocks and low returns to growth (low book-to-price) stocks. The documented excess returns to strategies that buy value and short growth stocks have been attributed to mispricing of stocks or to mismeasurement of risk or both. If high book-to-price (B/P) stocks are undervalued and low book-to-price stocks are overvalued, then we should observe a high value-to-price ratio (V/P) for high B/P stocks and a low V/P ratio for low B/P stocks. On the other hand, if excess returns are observed because the standard models of expected returns mismeasure risk, we should observe no difference in the V/P ratios for high versus low B/P stocks if our covariance risk adjustment measures risk more accurately.

Table 4 reports V/P ratios of B/P and size quintiles over our sample period for estimations at the firm, portfolio, and industry levels. We report the yearly median V/P ratio using the one-factor (accounting beta) model for each quintile averaged across years. B/P and size quintiles are formed at the end of April each year. B/P ratio equals the book value of common equity as of the beginning of the valuation year divided by price at the end of April of that year. Size is measured as the market capitalization at the end of April of each year. V/P ratio from the CAPM is also reported for the purpose of comparison.

Consistent with prior research, V/P ratios based on CAPM risk adjustment are substantially higher for the highest B/P quintile relative to the lowest B/P quintile at all levels of estimation (Table 4, panel A). In contrast, the difference in V/P ratios of extreme quintiles is relatively small for our model. Moreover, the absolute difference in V/P ratios between the highest and lowest quintiles is significantly lower for our model relative to the CAPM as indicated by the Wilcoxon test. This pattern is consistently observed across the three sub-periods (untabulated). Based on year-by-year results, the t-test (similar to the Fama-MacBeth test) also indicates that the absolute difference in V/P ratios of extreme B/P quintiles is significantly lower for our model relative to the CAPM.[23]

Panel B of Table 4 reports the V/P ratios of size quintiles. Based on the CAPM risk

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[23]These results are consistent with Cohen, Polk, and Vuolteenaho (2003) who use the Feltham-Ohlson valuation framework to decompose the variance of the market-to-book ratio. In an ex-post analysis, they show that when risk is measured by "cash flow" covariances, the variance share of mispricing of value and growth stocks is negligible. While their variance decomposition approach arrives at the same conclusion as we do in terms of value-growth mispricing, they do not tackle the problem of implementing fundamental risk adjustment to obtain firm value in a practical setting.

adjustment, we observe that the smallest-sized firms have higher V/P ratios consistent with prior evidence of the size effect. Although the monotonic trend is clear across quintiles, the difference is not large in magnitude, probably because our sample is dominated by large *I/B/E/S* firms. Relative to the CAPM, the difference between the highest and lowest quintiles (reported in the last row) is significantly lower for our model for the portfolio- and industry-level estimations, but not for the firm-level estimation (based on the Wilcoxon test). Analysis by sub-periods reveals that our results are driven mainly by the latest sub-period, 1998-2005, when CAPM-adjusted differences in V/P ratios between size quintiles are very large (untabulated). The difference in V/P ratios of the highest and lowest size quintiles is small for both models in the first two sub-periods. Consistent with this, the Fama-MacBeth-type t-test, which is based on yearly differences, rejects the hypothesis of lower difference in V/P ratios of extreme quintiles for our model relative to the CAPM.

Why does the CAPM risk adjustment fail to capture the higher risk of high B/P (value) stocks relative to low B/P (growth) stocks, while the fundamental risk adjustment in our model does? We examine some primitive variables of these portfolios that may shed light on this question.[24] Table 5 shows that the volatility of residual earnings of value stocks is 63% higher than the volatility of residual earnings of growth stocks (0.070 versus 0.043). On the other hand, the return volatility of value stocks is only 3% higher than the return volatility of growth stocks (0.090 versus 0.087). Thus, it appears that the high fundamental risk (arising from high earnings volatility) of value stocks is not reflected in the variation in returns nor in the market beta. This is consistent with the findings of Campbell and Vuolteenaho (2004) that value stocks have higher "cash flow" betas which carry a higher risk premium than discount-rate

[24]We do not conduct a similar examination for size portfolios since the size effect in our sample is not substantial.

betas.[25] They show that the CAPM risk adjustment fails to explain the B/P effect because the CAPM beta does not differentiate the cash flow beta from the discount-rate beta.

Overall, it appears that our fundamental risk measurement captures some aspects of risk reflected in the B/P ratio and firm size. The marginal differences in V/P ratios from our model across B/P and size quintiles suggests that the prior observation of excess returns to trading strategies based on B/P and size can be explained by risk mismeasurement rather than mispricing. These results confirm that our estimation procedure measures an essential element of risk that is not captured by models with standard risk adjustment like the CAPM. A more general issue for future inquiry relates to identifying characteristics of firms (such as the quality of book value or earnings) for which our risk adjustment obtains more accurate value estimates relative to those using CAPM.

5. Concluding Remarks

The valuation literature typically uses returns-based measures of risk to price securities. While some attempts have been made to trace the source of risk captured by returns-based measures to economic fundamentals, fundamentals-based risk adjustment in valuation remains a theoretical ideal. In this paper, we derive a simplified covariance risk adjustment based on accounting variables. The residual income valuation model provides a setting in which expected payoffs are adjusted for risk in the numerator of the valuation formula and the risk adjustment takes the form of covariance of residual earnings with market-wide factors. We use the covariance of excess ROE with market excess ROE (accounting beta), and with ROE of

[25]Campbell and Vuolteenaho (2004) decompose the CAPM beta into two betas, one reflecting news about the market's future cash flows and the other reflecting news about the market's discount rate; the former carries a higher price of risk than the latter.

size and book-to-market factors as accounting-based risk measures and estimate covariance risk for a firm out of sample.

Our empirical results indicate that valuation errors obtained from value estimates based on fundamental risk adjustment are significantly lower than those from benchmark models that use risk-adjusted cost of equity to discount expected payoffs (such as the CAPM and the Fama-French three factor model). Moreover, we find that even a parsimonious model with the accounting beta as the only risk measure obtains lower valuation errors relative to the CAPM, especially when betas are estimated at the portfolio and industry levels. More importantly, we find that the difference in value-to-price ratios of extreme size and B/P quintiles using fundamentals-based risk adjustment is significantly lower relative to the difference in value-to-price ratios using the CAPM risk adjustment. Thus, fundamentals-based risk adjustment provides a risk measurement that largely explains the "mispricing" attributed to the size and B/P effects.

The paper contributes to the valuation literature by developing a methodology for implementing fundamentals-based risk adjustment in a practical valuation exercise. We propose that the one-factor accounting beta-based risk adjustment can be implemented without undue complexity and can be used in practical valuation when market measures of risk are not available. Of course, fundamental risk adjustment comes at a cost – risk measures are noisier than returns-based measures due to the short time-series of earnings data available for estimation. Efforts to reduce noise in beta estimation (other than portfolio/industry level estimation) can further improve risk estimation at the firm level relative to commonly used alternatives. Perhaps using a deseasonalized quarterly earnings series may produce more reliable beta estimates. Whether value estimates based on fundamental risk adjustment can identify mispriced stocks is an issue for future inquiry and forms part of our on-going research.

Appendix 1

Derivation of Covariance Risk Adjustment

This appendix derives a simplified expression for the covariance risk adjustment term:

$$\text{Risk Adjustment}_t = \sum_{j=1}^{\infty} Cov_t[m_{t,t+j}, x^a_{t+j}] \tag{1A}$$

The derivation that follows assumes an arbitrary but non-stochastic dividend payout policy, $\{k_{t+j}\}_{j=1}^{\infty}$. Replacing the first period's residual earnings with excess ROE times beginning book value, we get

$$Cov_t[m_{t,t+1}, x^a_{t+1}] = B_t Cov[m_{t,t+1}, EROE_{t+1}] \equiv B_t Cov[m, EROE] \tag{2A}$$

For the second period's residual earnings, we split the stochastic discount factor into two parts (i.e. $m_{t,t+2} = m_{t,t+1} m_{t+1,t+2}$), and express the covariance of excess ROE_{t+1} with the contemporaneous discount factor, $m_{t+1,t+2}$.

$$\begin{aligned} Cov_t[m_{t,t+2}, x^a_{t+2}] &= Cov_t[m_{t,t+1} m_{t+1,t+2}, B_{t+1} EROE_{t+2}] \\ &= \frac{E_t[B_{t+1}]}{(1+r^f)} Cov[m, EROE] \\ &\quad + B_t(1-k_{t+1}) Cov[m, ROE]\left(Cov[m, EROE] + \frac{E_t[EROE_{t+2}]}{1+r^f} \right) \end{aligned} \tag{3A}$$

Equation (3A) is derived by assuming that $Cov_{t+j-1}[m_{t+j-1,t+j}, EROE_{t+j}] = Cov[m, EROE]$ and $Cov_{t+j-1}[m_{t+j-1,t+j}, ROE_{t+j}] = Cov[m, ROE]$. This assumption is consistent with constant betas over time as commonly used in empirical estimations of the cost of equity. Further, for ease of implementation in an empirical setting, we ignore the relatively small second term on the RHS of (3A), and obtain

$$Cov_t[m_{t,t+2}, x^a_{t+2}] \approx \frac{E_t[B_{t+1}]}{(1+r^f)} Cov[m, EROE] \tag{4A}$$

Based on the data in this study, we find that, on average, the magnitude of the second term that is omitted in equation (4A) amounts to 0.19% of the magnitude of the first term, suggesting that this is a good approximation in practice. Based on the same assumptions, we obtain for any *j*,

$Cov_t[m_{t,t+j}, x^a_{t+j}] \approx \frac{E_t[B_{t+j-1}]}{(1+r^f)^{j-1}} Cov[m, EROE]$.

Summing terms in (1A), we obtain

$$\text{Risk Adustment}_t \approx \sum_{j=0}^{\infty} \frac{E_t[B_{t+j}]}{(1+r^f)^j} \; Cov[m, EROE] \tag{5A}$$

Observation 1: Formula (5A) holds exactly in the case of a full dividend payout policy, $k_{t+j} = 1$, all *j*.

Observation 2: Under the assumption of non-stochastic growth in book values, the formula (5A) holds exactly.

Observation 3: One can derive the exact expression (as opposed to an approximation) for the risk adjustment term under the assumption that $B_{t+j} = B_t(1+g+\varepsilon_{t+j})^j$, $\varepsilon_{t+j} \sim i.i.d.$ Risk adjustment then equals

$$\text{Risk Adustment}_t = \sum_{j=0}^{\infty} \frac{E_t[B_{t+j}]}{(1+r^f)^j} \; Cov[m, EROE] + \Omega \tag{6A}$$

where

$$\Omega = \frac{(1-k)Cov[m, ROE](1+r^f)}{r^f - g - (1-k)Cov[m, ROE](1+r^f)} \sum_{j=0}^{\infty} \frac{E_t[B_{t+j}]}{(1+r^f)^j} \left(Cov(m, EROE) + \frac{E(EROE)}{1+r^f} \right)$$

Based on the data in this study, the average magnitude of $\Omega / \sum_{j=0}^{\infty} \frac{E_t[B_{t+j}]}{(1+r^f)^j} \; Cov[m, EROE]$

equals 0.045. Thus, even for the infinite sum, our approximation of $\Omega=0$ is reasonable in practice and at the same time facilitates implementation.[26]

[26]Note that our derivation does not explicitly include the risk in investment growth. However, if payout k is assumed to be non-stochastic, then the risk in investment growth will be fully captured by the risk in ROE. We thank Stephen Penman for drawing our attention to this point.

Appendix 2

Explanatory Power of Accounting Risk Measures for Priced Risk

From a within-sample analysis, we first determine the risk factors that exhibit explanatory power for priced risk and then use these risk factors to estimate covariance risk out of sample, as explained in Section 3.2. We estimate the cross-sectional regression (12) with intercept separately for each year of our sample period,

$$\frac{(RFPV_t - P_t)}{P_t} = c_0 + c_1 Cov_{ACCT} + c_2 Cov_{ESMB} + c_3 Cov_{EHML} + v_t$$

The dependent variable is the discount for risk implicit in price (priced risk) and the independent variables are accounting risk measures: Cov_{ACCT}, Cov_{ESMB}, and Cov_{EHML}, which reflect the sum of covariances of a firm's residual earnings with the market, size and book-to-market factors in earnings, respectively.[27] The cross-sectional regression is estimated each year and coefficient means across years are reported along with the Fama-MacBeth t-statistics.

From Table A1, Cov_{ACCT}, has significant explanatory power for priced risk and has significant incremental explanatory power over the earnings-based size and book-to-market risk measures. The coefficient estimates of the earnings-based size measure (Cov_{ESMB}) and book-to-market measure (Cov_{EHML}) are both significant in the univariate regressions, but reduce in significance (to the 5% level) in the presence of Cov_{ACCT}. Results of year-wise multivariate regressions show that the risk measure based on the accounting beta has significant explanatory power (5% level or lower) in 22 of 24 years, in contrast with the earnings-based size and book-to-market measures which obtain significance only in 7 and 4 (out of 24) years, respectively (untabulated). Overall, it appears that the three risk measures each have some explanatory

[27]For the cross-sectional analysis, we winsorize excess ROE betas at the upper and lower 1% tails of the distribution to reduce noise.

power for priced risk, with the measure based on the accounting beta exhibiting the strongest association. In the out-of-sample estimation of covariance risk we use all three measures and also the accounting beta alone and examine how value estimates based on the three-factor model versus the one-factor model compare with price.

Table A1
Results of cross-sectional regression of priced risk on accounting risk measures estimated over each year of the sample period

$$\frac{(RFPV_t - P_t)}{P_t} = c_0 + c_1 Cov_{ACCT} + c_2 Cov_{ESMB} + c_3 Cov_{EHML} + \nu_t$$

Dependent variable is priced risk (RFPV-P)/P

Intercept	**Cov_{ACCT}**	**Cov_{ESMB}**	**Cov_{EHML}**	**Adj R^2**
1.0712	0.0047			6.73%
(8.4240)***	(7.2042)***			
1.1224		0.0018		3.62%
(8.9127)***		(3.8643)***		
1.1394			0.0015	2.32%
(9.2707)***			(3.7987)***	
1.0681	0.0044	0.0006	0.0005	7.82%
(8.4073)***	(7.6628)***	(2.1198)**	(2.0131)**	

***, ** denote significance at the 1% and 5% levels, respectively.

Means of coefficient estimates from year-wise regressions are reported. Fama-MacBeth t-statistics are reported below the mean coefficient estimates in parentheses. RFPV is the risk-free present value that is derived from the residual income model using current book value, forecasted ROEs, forecasted book values, and the risk-free rate as laid out in equation (4). Cov_{ACCT}, Cov_{ESMB} and Cov_{EHML} equal K_t times β_{ACCT}, β_{ESMB} and β_{EHML} respectively (scaled by price), where K_t is defined in equation (6). β_{ACCT}, β_{ESMB} and β_{EHML} are the estimated slope coefficients from the firm-by-firm regression of a firm's excess ROE on market excess ROE, excess ROE of the SMB portfolio (small minus large) and excess ROE of the HML portfolio (high minus low book-to-market), respectively [equations (9), (10) and (11)].

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Table 1
Descriptive statistics of sample firms over three sub-periods: 1982-89, 1990-97, and 1998-2005

	1982-1989		**1990-1997**		**1998-2005**	
Variable	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**
Panel A: Valuation Model Inputs						
Price	20.55	15.19	22.87	18.56	30.82	25.81
Book Value Per Share	14.41	10.43	12.02	9.50	13.43	10.91
Book-to-Price Ratio	0.75	0.71	0.57	0.54	0.52	0.45
Dividend Payout	44.70%	40.55%	39.77%	37.04%	28.96%	24.00%
ROE	13.40%	14.24%	13.50%	13.50%	13.21%	13.63%
FROE-1-yr ahead	15.99%	15.03%	16.52%	14.38%	16.43%	14.54%
FROE-2-yr ahead	17.17%	15.74%	17.30%	15.34%	17.02%	15.19%
Long-Term Growth Rate	11.69%	11.50%	11.69%	11.00%	13.32%	12.00%
Risk-free Rate	9.92%	9.18%	7.13%	6.97%	4.90%	5.14%
Cost of Equity (CAPM)	15.87%	15.73%	13.35%	13.40%	11.88%	11.55%
Cost of Equity (Fama-French)	18.13%	17.68%	15.70%	14.95%	15.83%	15.45%
Panel B: Valuation Model Outputs						
Priced Risk	13.10	7.11	22.77	15.70	49.22	38.31
Risk-free Present Value (RFPV)	33.65	23.55	45.64	35.28	80.04	66.18
Priced Risk/RFPV	0.34	0.34	0.46	0.47	0.59	0.61
Priced Risk/Price	0.63	0.50	1.05	0.89	1.81	1.56
No. of observations	4664	4664	6093	6093	7238	7238

Notes:
Means and medians of variables are calculated for firm-years over each sub-period.
Variable definitions:
Book value is the book value of common equity at the beginning of the year. Price is the price per share at the end of April of each year. Dividend payout equals the annual dividend per share divided by actual earnings per share (both from *I/B/E/S*). ROE is the return on equity calculated as EPS (before extraordinary items) divided by beginning-of-year book value per share. FROE-1-yr ahead (2-yr ahead) is the *I/B/E/S* consensus analysts' one-year (two-years) ahead EPS forecast in April of each year divided by forecasted beginning-of-year book value per share. Forecasted book value per share is derived from the clean surplus relation. Long-term growth rate is the median *I/B/E/S* estimate of long-term growth in EPS. Risk-free rate is the yield on 10-year U.S. government bonds. Cost of equity (CAPM) is estimated using CAPM. Cost of equity (Fama-French) is estimated using the Fama and French (1993) three-factor model. Risk-free present value (RFPV) is derived from the residual income model using current book value, forecasted ROEs, forecasted book values, and the risk-free rate as laid out in equation (4). Priced risk is the discount for risk implicit in price and is estimated by subtracting the security price from the risk-free value (RFPV–P).

Table 2
Valuation errors of our model with fundamental risk adjustment and of benchmark models

Panel A: Valuation errors of one-factor models

	% lower error	**Fundamental Risk**		**CAPM**			
		Mean	**Median**	**Mean**	**Median**	**T-test** (p-values)	**Med. test** (p-values)
%Absolute errors:							
Firm specific	50.3%	55.20%	32.76%	42.01%	35.91%	(<0.0001)	(<0.0001)
Portfolio-level	63.1%*	27.81%	20.51%	32.37%	30.94%	(<0.0001)	(<0.0001)
Industry-level	63.9%*	29.59%	21.52%	35.32%	32.93%	(<0.0001)	(<0.0001)
Rank errors:							
Firm specific		0.156	0.109	0.145	0.111	(<0.0001)	(0.2697)
Portfolio-level		0.095	0.066	0.107	0.076	(<0.0001)	(<0.0001)
Industry-level		0.102	0.070	0.125	0.099	(<0.0001)	(<0.0001)

Panel B: Valuation errors of three-factor models

	% lower error	**Fundamental Risk**		**Fama-French**			
		Mean	**Median**	**Mean**	**Median**	**T-test** (p-values)	**Med. test** (p-values)
%Absolute errors:							
Firm specific	56.6%*	57.90%	36.71%	50.30%	49.89%	(<0.0001)	(<0.0001)
Portfolio-level	83.0%*	28.19%	19.99%	48.84%	50.00%	(<0.0001)	(<0.0001)
Industry-level	77.2%*	31.95%	21.36%	48.28%	50.36%	(<0.0001)	(<0.0001)
Rank errors:							
Firm specific		0.120	0.080	0.159	0.118	(<0.0001)	(<0.0001)
Portfolio-level		0.092	0.064	0.092	0.064	(0.8973)	(0.6446)
Industry-level		0.096	0.066	0.123	0.092	(<0.0001)	(<0.0001)

* denotes significance at the 1% level.

Firm-specific, portfolio-level, and industry-level valuation errors are based on value estimates where covariance risk is measured using firm-specific betas, portfolio-level (25 size-B/P portfolios) betas and industry-level (48-industries) betas for the fundamental risk adjustment; cost of equity is estimated at the firm-specific, portfolio, and industry levels for the CAPM and the Fama-French model. Percentage absolute error equals the |(V-P)|/P, where V equals estimated value and P equals price. Rank error is calculated by first ranking firms each year on V and P separately and dividing the rank by the number of sample firms in that year; absolute rank errors are then calculated as $|(V_R-P_R)|$, where V_R is the rank of V and P_R is the rank of P. % lower error equals the percentage of firms for which the absolute error using fundamental risk adjustment is strictly lower than the absolute error using the benchmark model risk adjustment.

Table 2 continued…

Panel A: Columns (1) and (2) present valuation errors based on the residual income model with fundamental risk adjustment based on excess ROE market beta (accounting beta). Value is derived by separately estimating the risk-free present value and the covariance risk adjustment as described in the text. Columns (3) and (4) present valuation errors of the residual income model with denominator risk adjustment using the risk-adjusted CAPM cost of equity. Panel B: Columns (1) and (2) present valuation errors based on the residual income model with fundamental risk adjustment using excess ROE beta of three factors, market, size and book-to-market. Columns (3) and (4) present valuation errors of the residual income model with denominator risk adjustment using the risk-adjusted cost of equity based on the Fama-French three-factor model. In both panels, we present p-values of the matched-pair t-test (column 5) and the 2-sample median test (column 6) of the difference between valuation errors from the model using fundamental risk adjustment and those from the benchmark (CAPM or Fama-French three-factor) model.

Table 3
Fundamentals-based risk estimates of selected industries

	Energy	Utility	Auto	Banking	All Firms
CovRisk/P: 1-factor	0.907	0.789	1.878	1.103	1.016
CovRisk/P: 3-factor	0.726	0.641	1.429	0.959	0.832

CovRisk is the out-of-sample estimate of covariance risk as discussed in section 3. CovRisk is estimated at the industry level using one-factor (accounting beta) and three factors (accounting beta, and earnings-based size and book-to-market betas). CovRisk/P is CovRisk scaled by price at the end of April of the valuation year. Median CovRisk/P for each industry is calculated each year and averaged across sample years. The four industry groups are based on the following 4-digit SIC codes: energy, 1310-1389, 2900-2911, 2990-2999; utility, 4900-4999; auto, 2296, 2396, 3010-3011, 3537, 3647, 3694, 3700-3716, 3790-3792, and 3799; and banking, 6000-6199. The industry groups are as defined in Fama and French (1997).

Table 4
Value-to-price (V/P) ratios of B/P and Size quintiles

Panel A: V/P ratios of B/P quintiles

	Fundamental Risk Adj			CAPM		
Quintiles	**Firm**	**Portfolio**	**Industry**	**Firm**	**Portfolio**	**Industry**
Q1	1.045	1.009	1.016	0.618	0.583	0.598
Q2	1.057	0.999	0.993	0.725	0.688	0.698
Q3	1.064	0.989	0.993	0.843	0.789	0.803
Q4	1.087	0.963	1.003	0.987	0.861	0.944
Q5	1.122	0.946	0.966	0.958	0.880	0.954
Q5-Q1	0.077	-0.064	-0.050	0.340	0.297	0.356
Wilcoxon (Diff)[a]				(<0.0001)	(<0.0001)	(<0.0001)
T-test (Diff)[b]				(<0.0001)	(<0.0001)	(<0.0001)

Panel B: V/P ratios of Size quintiles

	Fundamental Risk Adj			CAPM		
Quintiles	**Firm**	**Portfolio**	**Industry**	**Firm**	**Portfolio**	**Industry**
Q1	1.161	0.978	0.978	0.866	0.804	0.813
Q2	1.101	0.974	0.968	0.850	0.771	0.780
Q3	1.074	0.996	1.001	0.802	0.766	0.785
Q4	1.063	0.977	0.999	0.784	0.751	0.785
Q5	1.036	0.992	1.016	0.748	0.711	0.708
Q5-Q1	-0.125	0.013	0.039	-0.119	-0.093	-0.105
Wilcoxon (Diff)[a]				(0.9999)	(<0.0001)	(0.0140)
T-test (Diff)[b]				(0.9580)	(0.4421)	(0.2658)

[a]P-value of one-tailed test of difference in |Q5-Q1| between fundamental risk adjustment and CAPM.
[b]P-value of one-tailed t-test (similar to the Fama-MacBeth test) of difference in |Q5-Q1| between fundamental risk adjustment and CAPM over sample years.

V/P ratio equals value estimate divided by price at the end of April of each year. Median V/P ratios are calculated each year for each quintile and then averaged across years. Firm, portfolio, and industry V/P ratios are based on value estimates where covariance risk is measured using firm-specific betas, portfolio-level (25 size-B/P portfolios) betas and industry-level (48-industries) betas for the fundamental risk adjustment; cost of equity is estimated at the firm-specific, portfolio, and industry levels for the CAPM and the Fama-French model. Columns 1-3 present V/P ratios based on the residual income model with fundamental risk adjustment based on one factor -- excess ROE market beta (accounting beta).

Table 4 continued…

Columns (4-6) present V/P ratios based on the residual income model with denominator risk adjustment using the risk-adjusted CAPM cost of equity. B/P and Size quintiles are formed at the end of April of each year. B/P ratio is calculated as book value of common equity as of the beginning of the valuation year divided by price at the end of April of the valuation year. Size is measured by the market capitalization (price times common shares outstanding) at the end of April of each year. (Q5-Q1) reported in the last row of each panel is the difference between V/P ratios of the fifth and the first quintiles.

Table 5
Covariances and standard deviations of extreme B/P quintiles

Quintiles	$Cov(RE_i/P_i, EROE_m)$	$Cov(R_i, R_m)$	$SD(RE_i/P_i)$	$SD(R_i)$
L B/P	0.336	0.951	0.043	0.087
H B/P	0.630	0.843	0.070	0.090

Means of covariances and standard deviations across firms in the lowest (L) and highest (H) B/P quintiles are reported. Covariances and standard deviations are calculated over a period of at least ten years (up to 20 years) preceding the valuation year. $Cov(RE_i/P_i, EROE_m)$ is the covariance of price-scaled residual earnings and the market's excess ROE, $Cov(R_i,R_m)$ is the market beta, $SD(RE_i/P_i)$ is the standard deviation of price-scaled residual earnings, and $SD(R_i)$ is the standard deviation of returns.