

# Fundamentals-Based Risk Measurement in Valuation

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**ABSTRACT:** We propose a methodology to incorporate risk measures based on economic fundamentals directly into the valuation model. Fundamentals-based risk adjustment in the residual income valuation model is captured by the covariance of ROE with market-wide factors. 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. We show how the covariance risk estimate can be transformed to obtain the fundamentals-based cost of equity. Our empirical analysis shows that value estimates based on fundamental risk adjustment produce significantly smaller deviations from price relative to the CAPM or the Fama-French three-factor model. We further find that our single-factor risk measure, based on the accounting beta alone, captures aspects of risk that are indicated by the book-to-market factor, largely accounting for the “mispricing” of value and growth stocks. Our study highlights the usefulness of accounting numbers in pricing risk beyond their role as trackers of returns-based measures of risk.

**Keywords:** *covariance risk; accounting beta; cost of capital; value-growth anomaly.*

**Data Availability:** *All data are obtained from publicly available sources.*

## I. 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

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captured by a non-primitive variable such as returns. If firm value is determined by more primitive or fundamental variables, then it seems logical that risk also arises from those primitives or fundamentals. In general, 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, then it would make sense to measure risk directly from fundamentals.

As far back as the seventies, Beaver et al. (1970) 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) examined 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 study, we propose a methodology that incorporates risk measures based on economic fundamentals *directly* into 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 estimated from returns using single- or multi-factor asset-pricing models?

We use the residual income valuation model to analytically derive a simplified risk adjustment that equals the covariance between a firm’s return on book equity (ROE) and economy-wide risk factors.<sup>1</sup> We then identify accounting risk factors based on theory and empirical observation and use these factors to provide reasonable predictions of the risk adjustment term to obtain firm value. We compare how this value deviates from price relative to the value derived by discounting expected payoffs by a returns-based cost of equity.

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*), i.e., 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 valuation 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.<sup>2</sup> We strive to adhere to the dictates of theory by using ROE *betas* rather than *ad hoc* measures such as the *magnitude* of size and book-to-market ratios, earnings volatility, or return volatility. However, since theory leaves the stochastic discount factor undefined, our choice of market-wide risk factors remains *ad hoc*.

Although we believe that illustrating how accounting risk measures map into firm value is a contribution in itself, from a practical standpoint it is important to determine if our risk adjustment is empirically valid. We compare valuation errors from our model with those

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<sup>1</sup> The residual income valuation model 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; Feltham and Ohlson 1995). Residual income is income minus a charge for the use of capital measured by the beginning book value times the cost of capital.

<sup>2</sup> Analogous to the market beta, the accounting beta is the covariance of a firm’s return on equity (ROE) with the market’s ROE. 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).

from benchmark models that are also estimated using the residual income model with the same inputs, but where payoffs are discounted by a returns-based cost of equity. Our empirical findings show that the mean and median valuation errors (absolute deviation of value estimate from price) are significantly lower when firm value is estimated using fundamental risk based on firm-specific betas of three *earnings-based* factors (market, size, and book-to-market) as compared to that using the Fama-French three-factor model. 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. Median valuation errors of the benchmark model are more than twice the magnitude of those that result from our model, when we use betas averaged at the portfolio and industry levels.<sup>3</sup>

We further find that 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 percent. We find this to be noteworthy 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 make this a desirable model and particularly useful in practical valuation.

We establish the empirical validity of our fundamental risk estimates by examining their association with *ex ante* firm characteristics that have either been suggested as proxies for firm-specific risk or are observed to be correlated with realized returns, namely market beta, leverage, information asymmetry, firm size, book-to-market ratio (B/M), and expected earnings growth (similar to Gebhardt et al. [2001] and Botosan and Plumlee [2005]). We find that our fundamental risk measure (one-factor and three-factor) and various risk proxies are consistently and significantly correlated in the predicted direction.

We further explore whether our fundamentals-based risk adjustment captures risk that is unexplained by measures based on the CAPM, such as the risk of value and 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 value (high B/M) stocks are underpriced and growth (low B/M) stocks are overpriced, then this pattern should be evident from the difference between our value estimate and price. Using our one-factor (i.e., accounting beta) model, we find that the difference in the ratio of value to price of the extreme B/M portfolios is insignificant. We also estimate excess returns of extreme B/M portfolios where the expected return is measured as the fundamentals-based cost of equity derived from our covariance risk adjustment. We find that the difference in excess returns of the extreme B/M portfolios is insignificant and significantly lower than the difference based on CAPM risk adjustment. Overall, our fundamental risk measure captures a significant portion of the risk reflected in book-to-market ratios and to a large extent explains the “mispricing” of value and growth stocks.<sup>4</sup>

The conceptual antecedent of our price-level risk adjustment can be traced to the theoretical work by Rubinstein (1976). In turn, Baginski and Wahlen (2003) estimate risk implicit in stock price as the difference between *RFPV* and price. These authors find that

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<sup>3</sup> Note that for portfolio- and industry-level estimations, the risk-adjustment term is estimated for each firm with all *firm-level* variables except the betas.

<sup>4</sup> These results are consistent with the findings of Cohen et al. (2009). Based on a variance decomposition of the market-to-book ratio, these authors find that the mispricing component of the variance is insignificant when risk is measured as “cash flow” covariances (where cash flow is measured by the ROE).

this measure of priced risk is significantly associated with accounting risk measures (accounting beta and earnings volatility) and other risk proxies (size, B/M, and market beta). Our research goes beyond a within-sample explanation of priced risk. First, based on valuation theory, we develop a methodology to estimate fundamental risk *out of sample* and incorporate it directly into the valuation formula. Second, we establish the superiority of our out-of-sample covariance risk adjustment in terms of low valuation errors relative to returns-based risk adjustments. Third, we validate our covariance risk adjustment with known proxies for firm risk. Fourth, while the price-level fundamental risk adjustment is a necessary starting point in our analysis, we demonstrate how one can easily convert it to a return-level measure, the fundamentals-based cost of equity.

We acknowledge that risk adjustment based on fundamentals may be more complex to implement than the returns-based cost of equity. However, we propose that the empirical validity of the one-factor (accounting beta) model and the fact that its estimation requires few additional inputs commend its use in practical valuation. In particular, our methodology can be applied to obtain value estimates of unlisted or newly listed companies for which returns-based risk measures cannot be estimated. Our measure of fundamentals-based cost of equity can be easily incorporated into any standard valuation formula used by analysts/investors (e.g., the discounted cash flow model). Our results suggest that our risk measure would provide better risk assessment, leading to improved stock selection and portfolio management decisions.

In sum, this study contributes by incorporating accounting measures of risk directly into the valuation model both theoretically and practically. To our knowledge, this is the first study 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 as risk adjustments in valuation is appealing. While this study 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 margin, asset turnover, and leverage.<sup>5</sup>

Section II presents the theoretical development of the covariance risk adjustment. Section III describes the data, sample selection, and research design. Section IV reports empirical results and discusses practical applications of our risk adjustment. Concluding remarks follow in Section V.

## II. THEORETICAL DEVELOPMENT

### Covariance Risk Adjustment

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. Assuming the clean surplus relation (i.e., the change in book value equals earnings minus dividends), the residual income model is equivalent to the dividend discount model (Ohlson 1995; Feltham and Ohlson 1995). Besides the important fact that risk adjustment using fundamentals emerges theoretically in the residual income model, the model

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<sup>5</sup> 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 (see Nekrasov 2008). The current study is perhaps the first response to Penman's call for a shift in focus from returns-based risk to fundamental risk estimation.

has some advantages over the dividend discount model and the discounted cash flow model (DCF) in terms of covariance risk estimation. Covariance of dividends as payoffs is unlikely to provide a good measure of risk because dividend policies tend to be arbitrary and do not vary much over time. Covariance based on earnings rather than free cash flows is likely to provide a better indication of risk since earnings capture economic performance better over short horizons (see discussions by Penman and Sougiannis [1998] and Dechow and Schrand [2004]).<sup>6</sup>

We begin with a general representation of the dividend discount formula:

$$V_t = E_t \sum_{j=1}^{\infty} \tilde{m}_{t,t+j} \tilde{d}_{t+j} \tag{1}$$

where  $V_t$  = value of equity at date  $t$ ,  $d_t$  = dividends at date  $t$ ,  $\tilde{m}_{t,t+j}$  equals the  $j$ -period stochastic discount factor, and  $1/E_t[\tilde{m}_{t,t+j}] = R_{t,t+j}^f = (1 + r_{t,t+j}^f)$  equals 1 plus the risk-free return from date  $t$  to  $t+j$ .<sup>7</sup> 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  $x_{t+j}^a = x_{t+j} - r_{t+j-1,t+j}^f B_{t+j-1}$ , we can express the residual income valuation model as:

$$V_t = B_t + E_t \sum_{j=1}^{\infty} \tilde{m}_{t,t+j} \tilde{x}_{t+j}^a \tag{2}$$

Separating the expected residual earnings component and the risk component and substituting  $E_t[\tilde{m}_{t,t+j}] = 1/R_{t,t+j}^f$ , we obtain:

$$V_t = \left( B_t + \sum_{j=1}^{\infty} \frac{E_t[\tilde{x}_{t+j}^a]}{R_{t,t+j}^f} \right) + \left( \sum_{j=1}^{\infty} Cov_t[\tilde{m}_{t,t+j}, \tilde{x}_{t+j}^a] \right) \equiv RFPV + Risk\ Adjustment \tag{3}$$

where *RFPV* or the “risk-free present value” is assumed to converge. *RFPV* equals current book value of equity plus the present value of expected future residual earnings discounted at the risk-free rate. *Risk Adjustment* in Equation (3) is a negative number and, in contrast with standard practice, modifies expected payoffs in the numerators rather than modifying

<sup>6</sup> Although a number of theoretical studies (e.g., Lambert et al. 2007) define risk as the covariance of free cash flows with the market-wide factor, to empirically capture risk based on finite horizon information, studies like Cohen et al. (2009) use earnings instead of cash flows in their analysis.

<sup>7</sup>  $m_{t,t+j}$  is a set of contingent claims prices scaled by state probabilities, also referred to as state-price density. In a two-date economy with no arbitrage, the value of an asset can be expressed as  $V = \sum_s d_s R_s = \sum_s d_s m_s \pi_s = E[\tilde{m}\tilde{d}] = E[\tilde{m}]E[\tilde{d}] + Cov[\tilde{m},\tilde{d}]$ , where  $R_s$  is the implicit price of a claim to one unit of dividends in state  $s$ ,  $\pi_s$  is the objective (true) probability of state  $s$ , and  $m_s = R_s/\pi_s$  (see Cochrane 2001).

discount factors in the denominators of the valuation model.<sup>8,9</sup> To simplify the model, we assume a flat and nonstochastic risk-free rate and express *RFPV* as a finite period calculation with a terminal value at horizon  $t+T$ :

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

where  $FEROE_{t+j} = E_t[\tilde{x}_{t+j}]/E_t[\tilde{B}_{t+j-1}] - r^f =$  forecasted excess return on equity (forecasted *EROE*),  $(1+r^f)^j = R_{t,t+j}^f$  (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.

Implementation of the risk adjustment in Equation (3) poses a difficulty. Equation (3) requires us to estimate an infinite set of covariances, which is not 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 that can be estimated from historical data. Expressing residual earnings in the form of a rate of return, as excess ROE, allows us to make the assumption of constant covariance, which is a less reasonable assumption for the nonstationary earnings series.

Appendix A derives a simplification of the risk-adjustment term in Equation (3) as:

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

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 standard estimations of the CAPM. The expression for risk adjustment in Equation (5) is a result of further simplification achieved by omitting a complex term whose relative effect is negligible under alternative assumptions about excess ROE dynamics (see Appendix A). Assuming the same terminal value growth rate as in Equation (4), we obtain:

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

where  $K_t = \left[ \sum_{j=0}^{T-1} \frac{E_t(B_{t+j})}{(1+r^f)^j} + \frac{E_t(B_{t+T})}{(1+r^f)^{T-1}(r^f-g)} \right]$ . Assuming a linear factor model,  $m = a - \sum_l \lambda_l f_l$ , where  $f_l =$  an economy-wide risk factor, we can re-write Equation (3) as:

<sup>8</sup> Assuming convergence, Equation (3) is equivalent to the residual income valuation function in Feltham and Ohlson (1999), although our notation is slightly different. These authors express the valuation function as  $V_t = B_t + \sum_{j=1}^{\infty} (R_{t,t+j}^f)^{-1} (E_t[\tilde{x}_{t+j}^a] + Cov_t[\tilde{x}_{t+j}^a, \tilde{Q}_{t,t+j}])$  where  $\tilde{Q}_{t,t+j} =$  risk-adjustment index  $= \tilde{m}_{t,t+j} R_{t,t+j}^f$ .  
<sup>9</sup> The stochastic discount factor in consumption-based models is the marginal rate of substitution,  $\tilde{m}_{t,t+j} = \beta u'(\tilde{c}_{t+j})/u'(c_t)$ , where  $\beta$  is the subjective discount factor,  $c_t$  is consumption at date  $t$ , and  $u(c)$  denotes an investor's utility function. Thus,  $m_{t,t+j}^s$  is the rate at which an investor is willing to substitute consumption at date  $t+j$ , state  $s$ , for consumption at date  $t$ . Since the utility function  $u(c)$  is concave for risk-averse investors, the marginal utility  $u'(\tilde{c}_{t+j})$  and the stochastic discount factor,  $\tilde{m}_{t,t+j}$ , are decreasing in future consumption,  $\tilde{c}_{t+j}$ . 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.

$$(RFPV_t - V_t) = -Risk\ Adjustment = K_t \sum_i \lambda_i Cov[EROE, f_{it}] \quad (7)$$

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.

### Relation between Price-Level Risk Measure and Cost of Equity

The risk adjustment in Equation (7) is an aggregate price-level measure rather than a return-level measure. The standard asset-pricing framework (e.g., CAPM or Arbitrage Pricing Theory) derives the cost of equity by using factor betas and factor premia estimated from returns. There is no theoretical analog for the standard asset-pricing model in which the cost of equity is derived by using accounting variables (or fundamentals) to estimate betas and premia. Although we cannot directly incorporate accounting-based betas in the standard cost of equity formula, we can accommodate fundamental variables in the covariance risk adjustment at the price level as shown in Equation (7). Further, we can convert the covariance risk adjustment (a price-level measure) to a fundamentals-based risk-adjusted cost of equity (a return-level measure); however, this equivalence arises only as a special case. Under the assumption that expected residual earnings grow at a constant rate  $g$  after period  $t+1$ , and scaling Equation (7) by  $P_t$ , we obtain:

$$K_t \sum_i \lambda_i Cov[EROE, f_{it}] / P_t = Covariance\ Risk / P_t = (E(r) - r^f) / (r^f - g). \quad (8)$$

Equation (8) is intuitive, as the (price-scaled) covariance risk is expressed as the capitalized value of the firm's risk premium. Expressing Equation (8) in terms of the cost of equity, i.e.,  $E(r)$ , we obtain:

$$E(r) = r^f + (r^f - g)[Covariance\ Risk / P_t]. \quad (9)$$

Thus, the firm's cost of equity,  $E(r)$ , equals the risk-free rate plus the (price-scaled) covariance risk times the capitalization factor,  $(r^f - g)$ .<sup>10</sup> In the next section, we define variables used in the empirical analysis and describe the covariance risk-estimation procedure.

### III. DATA AND RESEARCH DESIGN

Our sample includes firms with required data on Compustat, CRSP, and I/B/E/S databases. We include only firms with a December fiscal year-end.<sup>11</sup> 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 firm value estimates, we use the per share beginning-of-year book value, analysts' EPS forecasts for the subsequent

<sup>10</sup> Analogously, one can show that the price-level market premium equals the capitalized value of the return-level market premium, that is,  $(RFPV_M - P_M) / P_M = E(r^M - r^f) / (r^f - g)$ , where  $g$  is the constant growth rate of expected residual earnings after period  $t+1$ .

<sup>11</sup> Similar to other valuation studies, we exclude non-December fiscal year-end firms so that (1) betas as well as priced risk are estimated at the same point in time for each firm-year observation, and (2) portfolios can be formed on the basis of characteristics that are measured at the same point in time for all firms.

five years, and the yield on ten-year U.S. government bonds as the risk-free rate.<sup>12</sup> We use the I/B/E/S mean consensus analysts' EPS forecasts in the month of April for one and two years ahead and apply the forecasted long-term growth rate 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 a 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.

Next we explain how we separately estimate the two components of firm value: (1) *RFPV* as the current book value plus the present value of expected future residual earnings discounted at the risk-free rate, and (2) the risk-adjustment term in Equation (7).

### Estimation of *RFPV*

To estimate *RFPV* from Equation (4), we make assumptions that are standard in the literature on earnings-based valuation (e.g., Frankel and Lee 1998; Claus and Thomas 2001; Gebhardt et al. 2001; Easton et al. 2002; Baginski and Wahlen 2003). Book value per share for subsequent years is forecasted using the clean surplus relation, i.e.,  $B_t = B_{t-1} + \text{forecasted EPS}_t - \text{forecasted dividend per share}_t$ . 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 percent of total assets (a proxy for normal earnings based on the historical long-run return on assets for U.S. companies).

### Growth-Rate Assumptions

We use several terminal growth-rate assumptions to estimate the terminal value in the *RFPV* calculation, including zero growth, a 3 percent 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  $t+12$  and residual income remains constant thereafter (see Gebhardt et al. 2001). For *RFPV* to converge, the assumed terminal growth rate must be less than  $r^f$ . This is not a concern when we assume zero terminal growth or use the fade rate to forecast future ROE up to date  $t+12$  and assume zero terminal growth thereafter. The convergence of *RFPV* could be a concern when we assume a 3 percent terminal growth rate, but we find that  $r^f$  is greater than 3 percent in all years of our sample period.<sup>13</sup> 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).

### 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  $P_t$ :

<sup>12</sup> Yields on ten-year U.S. government bonds are obtained from Federal Reserve Bulletins (Table 1.35) for the month of April of each year.

<sup>13</sup> In three years of the latest subperiod of the 24-year sample period,  $r^f$  is quite low, ranging from 4 percent to 5 percent. This results in a small denominator in the terminal value calculation, which may unduly influence our value estimates. To ensure that our results are not affected by the small denominator problem, we winsorize ( $r^f - g$ ) at 2 percent in these three years. Our results are not sensitive to the winsorization.

$$\frac{(RFPV_t - P_t)}{P_t} = \sum_i \lambda_i \frac{K_i \text{Cov}[EROE, f_i]}{P_t} \quad (10)$$

and separately estimate the two components of the risk-adjustment term: factor sensitivity,  $K_i \text{Cov}[EROE, f_i]/P_t$ , and factor premium,  $\lambda_i$ . Note that factor sensitivity is a firm-specific measure that equals the sum of discounted future book values of the firm ( $K_i$ ) times the covariance of excess ROE with the specific market factor,  $f_i$ , scaled by  $P_t$ . The factor premium,  $\lambda_i$ , is a market-wide measure.

### **Estimation of Factor Sensitivities (Betas) and Factor Risk Premia**

To estimate  $\text{Cov}[EROE, f_i]$ , we use three fundamentals-based risk measures, namely, the accounting beta, beta of the size factor *in earnings*, and beta of the book-to-market factor *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. Thus, the accounting beta measures nondiversifiable risk as the co-movement of a firm's ROE with that of the market, which is analogous to the market beta using a firm's accounting rate of return instead of its market return. Fama and French (1992) argue that, if stocks are priced rationally, higher returns to small firms and high book-to-market stocks arise because these variables proxy for unnamed risk factors in expected returns.<sup>14</sup> 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, we use the return on *book* equity for the market, and size and book-to-market factors in *earnings* as (accounting) risk factors.

For each firm, we estimate betas or the sensitivity of a firm's excess ROE to (1) the market's excess ROE (*MKT.EROE*), (2) ROE of the SMB (small minus big) portfolio (*SMB.ROE*), and (3) 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 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 percent 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 20 years preceding the valuation year  $t$  ( $\tau = t-21, \dots, t-1$ ):

$$EROE_\tau = \alpha + \beta_{ACCT} \text{MKT.EROE}_\tau + \varepsilon_\tau \quad (11)$$

$$EROE_\tau = \alpha' + \beta_{ESMB} \text{SMB.ROE}_\tau + \varepsilon'_\tau \quad (12)$$

$$EROE_\tau = \alpha'' + \beta_{EHML} \text{HML.ROE}_\tau + \varepsilon''_\tau \quad (13)$$

where  $\beta_{ACCT}$  is the accounting beta,  $\beta_{ESMB}$  is the beta of the size factor in earnings, and  $\beta_{EHML}$  is the beta of the book-to-market factor in earnings.<sup>15</sup>

To estimate factor premia, we run the cross-sectional regression based on Equation (10) using data from year  $t-1$  relative to the valuation year  $t$ :

<sup>14</sup> 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 prices and high B/M ratios, have higher expected returns (they are penalized with higher costs of capital) than firms with strong prospects.

<sup>15</sup> We estimate betas by winsorizing excess ROE at  $\pm 0.50$ ; results are insensitive to alternative winsorization.

$$\frac{(RFPV_{t-1} - P_{t-1})}{P_{t-1}} = c_1 Cov_{ACCT} + c_2 Cov_{ESMB} + c_3 Cov_{EHML} + v_{t-1}, \quad (14)$$

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  $v_{t-1}$  is the error term.  $\hat{\beta}_{ACCT}$ ,  $\hat{\beta}_{ESMB}$ , and  $\hat{\beta}_{EHML}$  are the slope coefficients estimated from Regressions (11), (12), and (13) for each firm. Note that the independent variables reflect the sum of covariances of *residual earnings* with the respective market factor scaled by  $P_{t-1}$ ; however, to estimate the independent variables, we break down residual earnings into two components, excess ROE and book value, to obtain more reliable estimates of covariances.<sup>16</sup> 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*.<sup>17</sup>

We obtain the predicted value of  $(RFPV_t - V_t)/V_t$  by first multiplying the estimated coefficients from Regression (14),  $\hat{c}_1$ ,  $\hat{c}_2$ , 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 (i.e., we take the fitted value of Regression (14)). Using this estimate of risk adjustment and our estimate of  $RFPV$ , we obtain the estimate of firm value,  $V$ .

Our use of the three earnings-based risk factors (market, size, and book-to-market) to estimate firm value is supported by our finding that these factors have significant explanatory power for priced risk in the cross-section (see Appendix B 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, as  $\hat{\beta}_{ACCT} = 1$ , the factor premium equals  $(RFPV_{M_t} - P_{M_t})/K_{M_t}$ , or the market's priced risk scaled by the aggregate (capitalized) book value of the market portfolio—an accounting analog of market risk premium. Thus, the risk-adjustment term equals  $[(RFPV_{M_{t-1}} - P_{M_{t-1}})/K_{M_{t-1}}]Cov_{ACCT}$  for the one-factor model, where  $Cov_{ACCT}$  is estimated for each firm  $i$  in the previous year  $t-1$ .

### Portfolio- and Industry-Level Estimation

Since the estimation of firm-specific betas is noisy due to the relatively small number of observations in the estimation period (at least ten and up to 20 annual observations), we also estimate betas at the portfolio and industry levels.<sup>18</sup> We construct 25 size-B/M portfolios of sample firms by first forming quintiles of firm size and then, within each size quintile, forming five portfolios based on the book-to-market ratio (B/M). Firm size equals market value of equity at the end of April of each year. B/M is measured as book value of equity at the end of the previous year (i.e., December 31) divided by market value of equity at the end of April of each year. We estimate portfolio betas as the portfolio means

<sup>16</sup> 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. In estimating Regression (14), we replace  $V_{t-1}$  in Equation (7) by  $P_{t-1}$ , because  $V_{t-1}$  is unobservable.

<sup>17</sup> 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.

<sup>18</sup> For out-of-sample estimation, firm-specific accounting betas are winsorized at 0 and +3 and size and book-to-market betas at  $\pm 3$ . Results are substantially similar when we winsorize accounting betas at 0 and +5 and size and book-to-market betas at  $\pm 5$ .

of firm-specific betas ( $\hat{\beta}_{ACCT}$ ,  $\hat{\beta}_{ESMB}$ , and  $\hat{\beta}_{EHML}$ ), and obtain factor premia by estimating Regression (14) for the previous year  $t-1$  relative to the valuation year  $t$ . Regression (14) 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/M portfolios.

### Estimation of Benchmark Models

We estimate firm value from different benchmark models using the same data within the forecasting horizon, the same risk-free rate, and the same terminal growth-rate assumption that we use to obtain our estimate of firm value. The benchmark models are also based on the residual income valuation formula, but these models incorporate risk in the cost of equity used 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 of 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 averages from 1926 until April of the valuation year.<sup>19</sup>

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. *Ex ante*, it is unclear whether the fundamental risk measure would capture risk better than the CAPM or the Fama-French three-factor model. First, as argued by Campbell and Vuolteenaho (2004), returns are derived from primitives, namely cash flows/earnings and discount rates, and the aggregation of these primitives into returns may lose information related to risk. Second, returns-based risk measures estimate betas using high frequency data from the market. If markets are even slightly inefficient, mispricing could contaminate not only average returns, but also measures of risk, as argued by Brainard et al. (1991) and Cohen et al. (2009). In view of these differences in returns-based versus earnings-based risk factors, whether the fundamental risk adjustment captures risk better than the benchmark CAPM and Fama-French three-factor model is an empirical question that we address.

### Empirical Validation of Fundamental Risk Measures

We validate our risk measures using different approaches. First, we emphasize the price-level criterion to evaluate our risk estimation method by comparing value estimates with the observed price. Cohen et al. (2009) argue that asset-pricing models should be evaluated

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<sup>19</sup> Monthly data of the three factors is obtained from Kenneth French's website, for which we are grateful. Our use of the average factor risk premia from 1926 up to the valuation date assumes insignificant variation in factor premia over time. In case this assumption is not true (as suggested by Fama and French [1997]), we also estimate the benchmark models with factor premia averaged over rolling windows of 30, 20, 10, and 5 prior years. We find that shorter rolling windows in fact produce larger valuation errors for both the CAPM and the Fama-French models (untabulated).

by the closeness of value estimates derived from the model to the current stock price. This price-level criterion is appropriate in the context of long-term investment decisions and in tests of market efficiency. Similar to Penman and Sougiannis (1998), we compare valuation errors, measured as value estimate minus current price, of models with fundamental risk adjustment to those obtained from benchmark models.

Second, in addition to assessing the point accuracy of the average value estimate, we examine the cross-sectional relation between the fundamentals-based covariance risk estimates and the cost of equity implied by the current price. The implied cost of equity is estimated by inverting the residual income model using the observed price and the same inputs as used in the calculation of *RFPV*. In this approach, we validate our risk estimation method by comparing the correlation of the implied cost of equity with fundamentals-based risk estimates and with the benchmark CAPM and Fama-French cost of equity. However, we prefer the price-level criterion as a validation approach, because price is an observed variable, whereas the implied cost of equity is an estimated value that may be subject to noise and bias.<sup>20</sup>

Third, Botosan and Plumlee (2005) evaluate the reliability of alternative estimates of the implied cost of equity (or risk premium) by examining their association with known proxies for firm-specific risk, namely market beta, leverage, information asymmetry, firm size, and growth.<sup>21</sup> Similarly, we test whether the association between our covariance risk measure (or the equivalent fundamentals-based cost of equity) and various risk proxies is significant and in the predicted direction.<sup>22</sup>

#### IV. EMPIRICAL RESULTS

Table 1 reports descriptive statistics of our sample firms over three subperiods: 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 increase over the three subperiods, while the mean and median book value per share remain more or less stable. The mean (median) book-to-market ratio declines from a high of 0.75 (0.71) in 1982–89 to 0.52 (0.45) in 1998–2005, reflecting the effect of the bull market over this time period. The mean (median) dividend payout ratio declines steadily from 45 percent (41 percent) in the earliest subperiod to 29 percent (24 percent) in the latest subperiod. Analysts' expectations of ROE for the subsequent one and two years trend slightly upward compared to the reported ROE; this upward trend is discernible in all subperiods. The risk-free rate (ten-year government bond rate) declines significantly over our sample period from a mean of 10 percent in 1982–89 to a mean of 5 percent in 1998–2005. A similar declining trend is visible in the cost of equity estimates based on the CAPM and the Fama-French three-factor model.

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<sup>20</sup> We examine cross-sectional correlations rather than deviations of risk estimates from implied cost of equity because the latter method can lead to inference problems due to biases in the implied cost of equity and the risk estimates from different models.

<sup>21</sup> Gebhardt et al. (2001) also examine the association of their measure of implied risk premium with risk proxies that capture market volatility, leverage, liquidity and information environment, and earnings variability.

<sup>22</sup> An asset-pricing model can also be evaluated by examining how well the expected returns estimated from the model map into realized future returns—typically returns of the next year. Similar to Vuolteenaho (2002), Easton and Monahan (2005) note that realized returns are noisy measures of expected returns because they incorporate “information surprises.” Consistent with this argument, they find weak empirical correlation between expected and realized future returns. Due to this concern, we do not use the realized future returns criterion to evaluate the overall validity of our fundamental risk measure. Note that model evaluation using the realized-return criterion could be inconsistent with that based on valuation errors due to noise in realized returns and differences in investing horizons of the two approaches (one future year versus infinite).

**TABLE 1**  
**Descriptive Statistics of Sample Firms over Three Subperiods: 1982–1989, 1990–1997, and 1998–2005**

**Panel A: Model Inputs**

| Variables                    | 1982–1989 |        | 1990–1997 |        | 1998–2005 |        |
|------------------------------|-----------|--------|-----------|--------|-----------|--------|
|                              | Mean      | Median | Mean      | Median | Mean      | Median |
| 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-Market 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 One-Year-Ahead          | 15.99%    | 15.03% | 16.52%    | 14.38% | 16.43%    | 14.54% |
| FROE Two-Years-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: Model Outputs**

| Variables                               | 1982–1989 |        | 1990–1997 |        | 1998–2005 |        |
|---|-----------|--------|-----------|--------|-----------|--------|
|   | Mean      | Median | Mean      | Median | Mean      | Median |
| Priced Risk                             | 13.10     | 7.11   | 22.77     | 15.70  | 49.22     | 38.31  |
| Risk-Free Present Value ( <i>RFPV</i> ) | 33.65     | 23.55  | 45.64     | 35.28  | 80.04     | 66.18  |
| Priced Risk/Price                       | 0.63      | 0.50   | 1.05      | 0.89   | 1.81      | 1.56   |
| Implied Cost of Equity                  | 12.69%    | 12.13% | 10.56%    | 10.22% | 9.20%     | 8.75%  |
| No. of Observations                     | 4,664     | 4,664  | 6,093     | 6,093  | 7,238     | 7,238  |

**Panel C: Out-of-Sample Estimates**

| Variables                            | 1982–1989 |        | 1990–1997 |        | 1998–2005 |        |
|--------------------------------------|-----------|--------|-----------|--------|-----------|--------|
|                                      | Mean      | Median | Mean      | Median | Mean      | Median |
| Covariance Risk (one-factor)/Price   | 0.58      | 0.49   | 0.84      | 0.75   | 1.28      | 1.17   |
| Covariance Risk (three-factor)/Price | 0.43      | 0.34   | 0.63      | 0.50   | 1.06      | 0.87   |
| Expected Return (one-factor)         | 13.08%    | 12.50% | 10.51%    | 10.26% | 8.77%     | 8.52%  |
| Expected Return (three-factor)       | 12.16%    | 11.53% | 9.66%     | 9.31%  | 8.11%     | 7.56%  |
| No. of Observations                  | 3,625     | 3,625  | 5,554     | 5,554  | 6,337     | 6,337  |

Means and medians of variables are calculated for firm-years over each subperiod. 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 one-year-ahead (two-year-ahead) is the I/B/E/S consensus analysts' one-year- (two-years-) ahead EPS forecast in the month of 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 ten-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

(continued on next page)

TABLE 1 (continued)

by subtracting the security price from the risk-free value ( $RFPV - P$ ). Implied Cost of Equity is estimated by inverting the residual income model with the same inputs as used in the calculation of  $RFPV$ . Covariance Risk (one-factor) is the firm-specific out-of-sample estimate of covariance risk using the earnings-based market factor (accounting beta). Covariance Risk (three-factor) is the firm-specific out-of-sample estimate of covariance risk based on three earnings-based factors: market, size, and book-to-market. Expected Returns (one-factor and three-factor) are derived from the firm-specific covariance risk estimates using Equation (9).

Panel B of Table 1 presents the mean and median estimates of the risk-free present value ( $RFPV$ ), priced risk, and implied cost of equity. Although we use alternative terminal growth-rate assumptions to estimate  $RFPV$ , we only report results based on a 3 percent rate. Given that we are primarily interested in *relative* valuations, our conclusions are generally insensitive to the growth-rate assumption. From Panel B,  $RFPV$  increases steadily over time. The increasing trend in  $RFPV$  is consistent with declining risk-free rates over this time period. The mean Priced Risk/Price increases over the three subperiods, while the mean implied cost of equity declines over the three subperiods.<sup>23</sup> Overall, the implied cost of equity is in line with values reported by prior studies—for example, Claus and Thomas (2001)—report mean implied cost of equity of 12.4 percent over 1985–89 and 10.3 percent over 1990–98.

In Panel C of Table 1, we report means and medians of our fundamental risk adjustment (i.e., covariance risk) and expected return (i.e., fundamentals-based cost of equity) estimated out of sample. The sample size declines due to additional data requirements for the out-of-sample estimation and the exclusion of 1982, the first year of the sample period. Consistent with the within-sample estimates of Priced Risk/Price, the out-of-sample estimates of Covariance Risk/Price steadily increase over the three subperiods for both the one-factor and three-factor models. On the other hand, consistent with the within-sample estimates of implied cost of equity, the out-of-sample estimates of expected return (based on Equation (9)) decline over the three subperiods. The opposite trends in Covariance Risk/Price and expected return mirror the within-sample trends in Priced Risk/Price and implied cost of equity reported in Panel B.

### Comparison of Valuation Errors

In Table 2, we report valuation errors of the residual income model with fundamental risk adjustment 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 model (based on accounting beta) and the CAPM are reported in Panel A, and those from the three-factor model (based on accounting beta, and earnings-based size and book-to-market betas) and the Fama-French model are reported in Panel B. We report (1) percentage absolute errors measured as the absolute difference between the value estimate ( $V$ ) and price ( $P$ ), divided by price,<sup>24</sup> and (2) 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 (thus obtaining a variable that ranges from 0 to 1). We report rank errors because they are less susceptible to outliers and biases. Both panels report valuation

<sup>23</sup> These trends are similar to those reported in Baginski and Wahlen (2003). The decline in implied cost of equity is not inconsistent with the increase in Priced Risk/Price, since  $\text{Priced Risk/Price} = (E(r) - r^f)/(r^f - g)$ , and  $r^f$  is decreasing over time.

<sup>24</sup> To mitigate the effect of outliers on our results, we winsorize percentage absolute errors at 100 percent.

**TABLE 2**  
**Comparison of Valuation Errors of Model with Fundamental Risk Adjustment with Those of Benchmark Models**

**Panel A: Deviations of Estimated Value from Price (Valuation Errors) of One-Factor Models**

|                         | % Lower Error (1) | Fundamental Risk |            | CAPM     |            | t-test (p-values) | Med. Test (p-values) |
|-------------------------|-------------------|------------------|------------|----------|------------|-------------------|----------------------|
|                         |                   | Mean (2)         | Median (3) | Mean (4) | Median (5) |                   |                      |
| <b>%Absolute Errors</b> |                   |                  |            |          |            |                   |                      |
| Firm-specific           | 50.3%             | 41.25%           | 32.76%     | 38.32%   | 35.91%     | (0.9999)          | (< 0.0001)           |
| Portfolio-level         | 63.1%*            | 26.32%           | 20.51%     | 31.59%   | 30.94%     | (< 0.0001)        | (< 0.0001)           |
| Industry-level          | 63.9%*            | 27.69%           | 21.52%     | 34.09%   | 32.93%     | (< 0.0001)        | (< 0.0001)           |
| <b>Rank Errors</b>      |                   |                  |            |          |            |                   |                      |
| Firm-specific           |                   | 0.156            | 0.109      | 0.145    | 0.111      | (0.9999)          | (0.1349)             |
| 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: Deviations of Estimated Value From Price (Valuation Errors) of Three-Factor Models**

|                         | % Lower Error (1) | Fundamental Risk |            | Fama-French |            | t-test (p-values) | Med. Test (p-values) |
|-------------------------|-------------------|------------------|------------|-------------|------------|-------------------|----------------------|
|                         |                   | Mean (2)         | Median (3) | Mean (4)    | Median (5) |                   |                      |
| <b>%Absolute Errors</b> |                   |                  |            |             |            |                   |                      |
| Firm-specific           | 56.6%*            | 45.36%           | 36.71%     | 48.50%      | 49.89%     | (< 0.0001)        | (< 0.0001)           |
| Portfolio-level         | 83.0%*            | 26.47%           | 19.99%     | 48.69%      | 50.00%     | (< 0.0001)        | (< 0.0001)           |
| Industry-level          | 77.2%*            | 29.22%           | 21.36%     | 48.02%      | 50.36%     | (< 0.0001)        | (< 0.0001)           |
| <b>Rank Errors</b>      |                   |                  |            |             |            |                   |                      |
| Firm-specific           |                   | 0.120            | 0.080      | 0.159       | 0.118      | (< 0.0001)        | (< 0.0001)           |
| Portfolio-level         |                   | 0.092            | 0.064      | 0.092       | 0.064      | (0.4487)          | (0.3223)             |
| Industry-level          |                   | 0.096            | 0.066      | 0.123       | 0.092      | (< 0.0001)        | (< 0.0001)           |

\* Denotes significance at the 1 percent level using a binomial test.

The table compares valuation errors of the one-factor (three-factor) fundamental risk-adjustment model with valuation errors of the CAPM (Fama-French three-factor model) for different levels of beta estimation. 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 betas (25 size-B/M portfolios) and industry-level betas (48-industries) 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  $|(V - P)|/P$ , 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 (in column 1) 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.

Panel A: Columns (2) and (3) present valuation errors based on the residual income model with fundamental risk adjustment based on excess ROE market beta (i.e., accounting beta). Value is derived by separately estimating  $RFPV$  and the covariance risk adjustment as described in the text. Columns (4) and (5) present valuation errors of the residual income model with risk adjustment in the discount factors using the risk-adjusted CAPM cost of equity. Panel B: Columns (2) and (3) 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 (4) and (5) present valuation errors of the residual income model with risk adjustment in the discount factors using the risk-adjusted cost of equity based on the Fama-French three-factor model. In the last two columns of both panels, we present p-values of the one-tailed matched-pair t-test and the two-sample median test of lower valuation errors from the model using fundamental risk adjustment relative to those from the benchmark model (CAPM or Fama-French).

errors of our model with betas estimated at the firm level, portfolio level (25 size-B/M portfolios) and industry level (48 industries), and of the CAPM and the Fama-French model estimated at the firm, portfolio, and industry levels.

From Table 2, Panel A, column (1), based on portfolio-level (industry-level) estimation, 63.1 percent (63.9 percent) of firms have lower absolute valuation error using the one-factor fundamental risk adjustment relative to the CAPM. The one-factor model obtains significantly lower mean and median 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.<sup>25</sup> Median errors at the firm, portfolio, and industry levels are lower than CAPM median errors by 8.8 percent, 33.7 percent, and 34.6 percent, respectively. When accounting beta is estimated at the firm level, while the median valuation error is lower than that of the CAPM, the mean error is higher. Note that, in the case of CAPM errors, the portfolio-/industry-level estimation does not achieve substantial improvement over firm-specific estimation. Results of rank errors follow a similar pattern.

From Panel B of Table 2, our model with risk estimated using three factors obtains significantly lower mean and median valuation errors at all levels of beta estimation compared to the Fama-French three-factor model.<sup>26</sup> Median errors at the firm, portfolio, and industry levels are lower than benchmark-model median errors by 26.4 percent, 60 percent, and 57.6 percent, 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 B), 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 (comparison of Panel A and Panel B). The performance of the standard benchmark models in fact reverses—CAPM valuation errors are consistently *lower* than those from the Fama-French three-factor model.<sup>27</sup> Analysis by subperiods (1982–89, 1990–97, and 1998–2005) 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 subperiods (untabulated).

Overall, the improvement achieved by our model is significant in magnitude when risk is estimated using three accounting factors. Notably, 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. It should be noted 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 betas. Thus, overall risk estimates are obtained for each firm separately, even when we report them as “portfolio” or “industry” level.

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<sup>25</sup> The magnitude of the median valuation error based on the industry-level CAPM cost of equity is close to the median valuation error of 30 percent obtained by Francis et al. (2000).

<sup>26</sup> When t-statistics are corrected for clustering of standard errors by firm and by year (see Petersen 2009), the differences in mean valuation errors obtained from industry- and portfolio-level estimations for both one-factor and three-factor models remain significant; for firm-level estimation, the mean valuation error from the three-factor model becomes insignificantly different from that of the Fama-French model (untabulated).

<sup>27</sup> While multiple risk factors improve risk estimation *within sample* (Fama and French 1993), it is interesting to note that the Fama-French three-factor model leads to higher deviations of value from price relative to the CAPM when risk is estimated *out of sample*, most likely due to the additional noise in estimating multiple betas and factor premia. This is consistent with Fama and French (1997) who show that standard errors of industry cost of equity from the CAPM model are consistently lower than those from the three-factor model under a variety of assumptions about the precision of estimates of factor loadings and risk premia.

## Sensitivity Analysis

Since equity valuation inherently relies on estimates and assumptions with respect to various parameters, such as the risk-free rate, market risk premium, and growth rate, we analyze the sensitivity of our value estimates to alternative assumptions.

### *Alternative Cost of Equity Estimates for Benchmark Models*

For the CAPM and Fama-French model, we estimate the cost of equity using the ten-year government bond rate to be consistent with the risk-free rate used in our model. To ensure that our results are not due to our choice of the risk-free rate, we use the one-year T-bill rate as the risk-free rate for all models to conform to standard practice in finance. When we use this alternative risk-free rate, the average valuation errors are lower for our model relative to benchmark models (untabulated).

The CAPM and Fama-French estimates of cost of equity reported in Table 1, Panel A, are upward biased relative to the *implied* cost of equity (reported in Panel B). This result is consistent with the findings of Claus and Thomas (2001), Gebhardt et al. (2001), and Easton and Sommers (2007) that the implied market risk premium is significantly lower than the historical premium. In contrast, the expected return based on fundamental risk (in Table 1, Panel C) does not exhibit systematic bias relative to the implied cost of equity. To address the concern of biased benchmark estimates, we replace the historical average market premium of 6.5 percent (relative to the ten-year government bond rate) by 5 percent or 3 percent in estimating the cost of equity using the CAPM and Fama-French three-factor model. Our (untabulated) results based on the lower market premium show that the average valuation errors for the benchmark models in general decrease, but are still significantly higher than those from our fundamental risk model.

### *Alternative Residual Income Growth Assumptions for Benchmark Models*

The assumption of a constant growth in residual income (say 3 percent) can have a different effect on value estimates based on our model versus the CAPM or the Fama-French model, because residual income is measured differently in these models.<sup>28</sup> If the firm is not in steady state at the end of the forecast horizon, then growth rates for the two residual income measures will differ. We therefore conduct sensitivity analysis by maintaining the 3 percent growth assumption for our model but varying the growth rate between 0 percent and 6 percent for benchmark models.<sup>29</sup> Valuation errors under varying growth-rate assumptions remain significantly lower for our model at all levels of estimation (untabulated). In fact, the changes in benchmark model valuation errors induced by varying growth rates are very slight, supporting the robustness of results with respect to terminal growth-rate assumptions.

## Relation between Alternative Risk Measures and Implied Cost of Equity

In addition to evaluating the deviations of value from price for alternative risk-adjustment methods, we also examine the cross-sectional correlation between the *implied* cost of equity and out-of-sample estimates of alternative risk measures: fundamental risk (Covariance Risk/Price) and the CAPM and Fama-French cost of equity. Recall that the

<sup>28</sup> While residual income in our model is measured as  $[x_{t+j} - r^f B_{t+j-1}]$  (i.e., using the risk-free rate), when applying the CAPM or Fama-French model, residual income is measured as  $[x_{t+j} - r B_{t+j-1}]$  (i.e., using the risk-adjusted cost of equity).

<sup>29</sup> Note that the differential effect is relatively minor when we assume a “fade” rate since the fading growth rate is applied to *FROE* (and not to residual income) up to date  $t+12$ ; the differential effect arises only due to the zero residual income growth assumption beyond the horizon  $t+12$ , which is minor after discounting.

implied cost of equity is estimated by inverting the residual income model using the observed price and the same inputs used in estimating other models. In Table 3, we report means of yearly Pearson correlations and test whether the correlation of implied cost of equity with fundamental risk is higher than that with benchmark risk measures using the binomial test. Based on portfolio and industry beta estimation, our results indicate significantly higher correlations of implied cost of equity with the fundamental risk measures (both one- and three-factor) relative to those with the CAPM and Fama-French cost of equity. When fundamental risk is measured based on firm-specific betas, the correlation is significantly higher relative to the CAPM but is indistinguishable from that of the Fama-French three-factor model. Overall, our estimates of fundamental risk map well into the market's expected cost of equity relative to benchmarks.

### Association of Fundamental Risk Adjustment with Known Risk Proxies

Table 4 reports results examining the relation between fundamentals-based Covariance Risk/Price and commonly used proxies for firm-specific risk used by Gebhardt et al. (2001) and Botosan and Plumlee (2005) to validate alternative estimates of implied cost of equity. We use market beta, size (log of market value of equity), B/M ratio, leverage, analyst forecast dispersion, and expected long-term earnings growth as proxies for firm-specific risk. Consistent with prior literature, we expect covariance risk to be negatively correlated with firm size and positively correlated with market beta, leverage, and B/M. Leverage is measured as long-term debt divided by market value of equity at the end of the previous fiscal year. Dispersion in analysts' forecasts serves as a proxy for information asymmetry and is expected to be positively correlated with covariance risk. Forecast dispersion is measured as the log of the standard deviation of one-year-ahead EPS forecasts obtained from the I/B/E/S Summary file in April of each year, divided by price. Prior empirical evidence suggests a positive association between expected earnings growth and risk (e.g., La Porta 1996). We use the I/B/E/S long-term earnings growth forecast as a risk proxy.

**TABLE 3**  
**Correlation between Out-of-Sample Estimates of Alternative Risk Measures and Implied Cost of Equity**

| <u>One-Factor Model</u>   | <u>Fundamental Risk</u> | <u>CAPM</u>        | <u>p-value<sup>a</sup></u> |
|---------------------------|-------------------------|--------------------|----------------------------|
| Firm                      | 0.230                   | 0.076              | (< 0.0001)                 |
| Portfolio                 | 0.336                   | -0.063             | (< 0.0001)                 |
| Industry                  | 0.292                   | 0.056              | (< 0.0001)                 |
| <u>Three-Factor Model</u> | <u>Fundamental Risk</u> | <u>Fama-French</u> | <u>p-value<sup>a</sup></u> |
| Firm                      | 0.248                   | 0.231              | (0.3388)                   |
| Portfolio                 | 0.345                   | 0.250              | (0.0173)                   |
| Industry                  | 0.321                   | 0.211              | (0.0003)                   |

The table reports means of yearly Pearson correlations between the implied cost of equity and estimates of (1) fundamentals-based Covariance Risk/Price (one-factor and three-factor); (2) CAPM cost of equity; and (3) cost of equity based on the Fama-French three-factor model. Implied cost of equity is estimated by inverting the residual income model with the same inputs as used in the calculation of *RFPV*.

<sup>a</sup> p-value relates to the one-tailed binomial test of significance of the number of sample years in which the correlation between implied cost of equity and fundamental risk is higher than the correlation between implied cost of equity and the benchmark-model cost of equity (i.e., CAPM and Fama-French).

**TABLE 4**  
**Association of Fundamentals-Based Risk Estimates with Known Risk Proxies**

**Panel A: Correlation between Out-of-Sample Estimates of Covariance Risk (Divided by Price) and Risk Proxies**

| Variables | Pred. Sign | One-Factor Model |                  |                  | Three-Factor Model |                  |                  |
|-----------|------------|------------------|------------------|------------------|--------------------|------------------|------------------|
|           |            | Firm             | Portfolio        | Industry         | Firm               | Portfolio        | Industry         |
| Beta      | +          | 0.176<br>(21/0)  | 0.068<br>(8/1)   | 0.215<br>(22/0)  | 0.189<br>(20/0)    | 0.076<br>(7/1)   | 0.185<br>(19/0)  |
| Ln(Size)  | -          | -0.146<br>(0/20) | -0.335<br>(0/22) | -0.274<br>(0/22) | -0.175<br>(0/22)   | -0.336<br>(0/23) | -0.272<br>(0/22) |
| Leverage  | +          | 0.119<br>(13/0)  | 0.328<br>(22/0)  | 0.184<br>(18/0)  | 0.124<br>(15/0)    | 0.296<br>(22/0)  | 0.216<br>(19/0)  |
| Ln(Disp)  | +          | 0.289<br>(23/0)  | 0.374<br>(23/0)  | 0.387<br>(23/0)  | 0.303<br>(23/0)    | 0.360<br>(23/0)  | 0.380<br>(23/0)  |
| B/M       | +          | 0.234<br>(22/0)  | 0.571<br>(23/0)  | 0.475<br>(23/0)  | 0.250<br>(22/0)    | 0.538<br>(23/0)  | 0.505<br>(23/0)  |
| Growth    | +          | 0.049<br>(8/1)   | -0.064<br>(1/9)  | 0.038<br>(7/1)   | 0.064<br>(11/0)    | -0.041<br>(1/7)  | 0.005<br>(6/5)   |

**Panel B: Results of Multivariate Cross-Sectional Regressions of Covariance Risk Estimates on Risk Proxies<sup>a</sup>**

| Variables                   | Pred. Sign | One-Factor Model   |                    |                    | Three-Factor Model |                    |                    |
|-----------------------------|------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
|                             |            | Firm               | Portfolio          | Industry           | Firm               | Portfolio          | Industry           |
| Intercept                   | ?          | 2.247<br>(0.0001)  | 1.819<br>(0.0001)  | 2.080<br>(0.0001)  | 1.227<br>(0.0001)  | 1.663<br>(0.0001)  | 1.606<br>(0.0001)  |
| UBeta                       | +          | 0.297<br>(0.0002)  | 0.052<br>(0.0550)  | 0.237<br>(0.0009)  | 0.156<br>(0.0003)  | 0.046<br>(0.0701)  | 0.163<br>(0.0093)  |
| Ln(Size)                    | -          | -0.036<br>(0.0016) | -0.054<br>(0.0001) | -0.040<br>(0.0273) | -0.030<br>(0.0005) | -0.055<br>(0.0018) | -0.033<br>(0.0220) |
| Leverage                    | +          | 0.215<br>(0.0009)  | 0.138<br>(0.0008)  | 0.082<br>(0.0193)  | 0.122<br>(0.0024)  | 0.105<br>(0.0017)  | 0.103<br>(0.0005)  |
| Ln(Disp)                    | +          | 0.196<br>(0.0001)  | 0.038<br>(0.0007)  | 0.074<br>(0.0001)  | 0.103<br>(0.0001)  | 0.033<br>(0.0003)  | 0.076<br>(0.0001)  |
| B/M                         | +          | 0.299<br>(0.0001)  | 0.401<br>(0.0001)  | 0.415<br>(0.0001)  | 0.158<br>(0.0001)  | 0.299<br>(0.0001)  | 0.425<br>(0.0001)  |
| Growth                      | +          | 0.017<br>(0.0143)  | 0.009<br>(0.0001)  | 0.016<br>(0.0004)  | 0.010<br>(0.0003)  | 0.008<br>(0.0001)  | 0.013<br>(0.0003)  |
| Average Adj. R <sup>2</sup> |            | 15.5%              | 40.1%              | 34.4%              | 16.9%              | 36.5%              | 33.6%              |

<sup>a</sup> Dependent variable is the out-of-sample estimate of covariance risk divided by price.

Panel A reports the means of Pearson correlations across sample years. The numbers in parentheses indicate the number of years in which the correlation is significantly positive/negative.

Panel B reports means of coefficient estimates from cross-sectional regressions estimated yearly over the sample period. The last row reports the adjusted R<sup>2</sup> of yearly regressions averaged over the sample period. p-values in parentheses relate to Newey-West autocorrelation adjusted t-statistics.

Firm, portfolio, and industry relate to covariance risk measured using firm-specific betas, portfolio-level betas (25 size-B/M portfolios) and industry-level betas (48-industries) to obtain the fundamental risk adjustment. Beta is the firm's market beta estimated using monthly returns over the preceding 60 months. UBeta is the firm's unlevered beta, which equals the market beta divided by 1 plus the ratio of long-term debt to shareholders' equity at the end of the previous fiscal year. Ln(Size) is firm size calculated as the log of market value of equity at the end of April of each year. Leverage is measured as long-term debt divided by market value of equity at

*(continued on next page)*

TABLE 4 (continued)

the end of the previous fiscal year. Ln(Disp) is the dispersion in analysts' forecasts measured as the log of the standard deviation of one-year-ahead EPS forecasts obtained from the I/B/E/S summary file in April of each year, divided by price. B/M is the book-to-market ratio measured as the book value of common equity at the end of the previous fiscal year divided by market value of equity at the end of April of each year. Growth equals expected earnings growth proxied by the I/B/E/S analysts' long-term earnings growth forecast.

All risk proxies are winsorized at the upper and lower 1 percent tails of the distribution to mitigate the effect of outliers.

Table 4, Panel A, reports means of yearly correlations between estimates of Covariance Risk/Price and risk proxies. The univariate results indicate that our estimates of covariance risk (both one- and three-factor) are significantly related to the risk proxies. The correlations are in general consistent across sample years in terms of predicted direction and significance except for that with forecasted earnings growth, which is significant in less than half the sample years.<sup>30</sup> Panel B reports the mean coefficient estimates of yearly multivariate cross-sectional regressions together with p-values of the Newey-West autocorrelation adjusted t-statistics.<sup>31</sup> In the multivariate analysis, we use the unlevered CAPM beta rather than the levered beta because the levered beta captures both leverage risk and market risk and thus could obscure the explanatory power of the leverage variable. We expect Covariance Risk/Price to be positively correlated with the unlevered CAPM beta and leverage. Unlevered beta is calculated as the market beta divided by 1 plus the ratio of long-term debt to shareholders' equity as described in standard finance textbooks. The regression results in Panel B show significant coefficient estimates for all risk proxies in the predicted direction for all levels of risk estimation—firm-specific, portfolio, and industry.<sup>32,33</sup> Forecasted earnings growth is also positive and significant as predicted in the multivariate analysis in contrast with its weak significance in Panel A. Overall, the consistently significant association of covariance risk with common proxies for firm risk validates our fundamental risk measurement.

### Value-to-Price Ratios and Subsequent Excess Returns for Value and Growth Stocks

While the earnings-based covariance risk 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 significant correlation of fundamental risk with the book-to-market ratio reported in Table 4 leads us to inquire whether our risk measure can explain the persistent high returns to value (high B/M) stocks and low returns to growth (low B/M) stocks, the

<sup>30</sup> Contrary to expectation, the correlation of covariance risk with earnings growth is negative for the portfolio beta estimation, because earnings growth has a high negative correlation with B/M, the variable on the basis of which portfolios are formed. In the multivariate analysis, we obtain a positive coefficient on earnings growth after including B/M as an independent variable.

<sup>31</sup> Consistent with standard practice for Newey-West estimation, we use a lag length equal to the smallest integer greater than  $T^{.25}$  (Greene 2003, 267), which in our case equals 3. Lag lengths of 1 and 2 yield substantially similar results.

<sup>32</sup> The results are substantially similar to those reported in Table 4 when we use covariance risk divided by *RFPV* (instead of price) or the estimated cost of equity (based on Equation (9)) as the dependent variable.

<sup>33</sup> We also use panel data methods to estimate the regression with year fixed effects and obtain t-statistics corrected for clustering of standard errors by firm and by year, following the procedure in Petersen (2009). The results are consistent with those reported in Table 4, except that the estimated coefficient on size (unlevered beta) becomes insignificant when the dependent variable is covariance risk estimated from the one-factor (three-factor) model.

so-called value-growth anomaly.<sup>34</sup> If high book-to-market stocks are underpriced and low book-to-market stocks are overpriced, then we should observe a high value-to-price ratio (V/P) for high B/M stocks and a low V/P ratio for low B/M 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.

Panel A of Table 5 reports V/P ratios of B/M 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. We also report the V/P ratio from the CAPM for comparison.<sup>35</sup> Note that V/P ratios based on CAPM risk adjustment are less than 1 for all portfolios, consistent with the upward bias in the CAPM cost of equity discussed earlier in the sensitivity analysis section. Consistent with prior research, V/P ratios based on CAPM are substantially higher for the highest B/M quintile relative to the lowest B/M quintile at all levels of estimation (Table 5, Panel A). In contrast, the difference in V/P ratios of extreme quintiles is relatively small and statistically insignificant for the one-factor fundamentals-based model. Moreover, the Wilcoxon test shows that the absolute difference in V/P ratios between the highest and lowest quintiles is significantly lower for our model relative to the CAPM. This pattern is consistently observed across the three subperiods (untabulated). The Newey-West autocorrelation-adjusted t-statistic calculated over sample years also indicates that the absolute difference in V/P ratios of extreme B/M quintiles is significantly lower for our model relative to the CAPM.

We also find that, relative to the CAPM, the absolute difference in V/P ratios between the highest and lowest *size* quintiles is significantly lower for our model for the portfolio- and industry-level estimations (untabulated). We do not emphasize these results, however, since the size effect is quite small in our sample, likely because the sample consists of large I/B/E/S firms.

In addition to our price-level analysis in Panel A of Table 5, we also examine excess returns earned by value-growth strategies in the 12 months beginning in the month of May of the valuation year. In contrast with significant excess returns with CAPM risk adjustment, we expect to observe insignificant excess returns to value-growth strategies when expected returns are based on fundamental risk. We estimate excess returns as realized returns minus the expected fundamentals-based (one-factor) cost of equity (from Equation (9)). From column (1) of Table 5, Panel B, subsequent one-year *raw* returns are substantially lower for the lowest B/M quintile relative to the highest B/M quintile. Consistent with the book-to-market effect, excess returns based on the CAPM risk adjustment are substantially lower for the first B/M quintile (growth stocks) relative to the fifth B/M quintile (value stocks) for all estimation levels. When expected returns are calculated based on fundamentals-based (one-factor) cost of equity, we find that the difference in excess returns of the extreme B/M quintiles is insignificant and significantly lower than the difference based on CAPM risk adjustment.

Overall, the “mispricing” of value and growth stocks appears to be negligible when excess returns are calculated based on fundamental risk adjustment (either price-level risk or expected cost of equity). To understand why the CAPM risk adjustment fails to capture

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<sup>34</sup> Note that significant correlation of the risk measure with the book-to-market ratio does not ensure that there is no bias in value estimates of extreme B/M portfolios.

<sup>35</sup> We do not report results based on the Fama-French three-factor model because we expect the difference in V/P ratios of extreme B/M quintiles to be indistinguishable, given that the model is designed to capture this difference by explicitly incorporating the book-to-market effect.

**TABLE 5**  
**Estimated Value-to-Price (V/P) Ratios and Future Excess Returns**  
**of Book-to-Market (B/M) Quintiles**

**Panel A: V/P Ratios of B/M Quintiles**

| B/M Quintiles                | Fundamental Risk |           |          | CAPM       |            |            |
|------------------------------|------------------|-----------|----------|------------|------------|------------|
|                              | Firm             | Portfolio | Industry | Firm       | Portfolio  | Industry   |
| Q1 (Growth)                  | 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 (Value)                   | 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) <sup>a</sup> |                  |           |          | (< 0.0001) | (< 0.0001) | (< 0.0001) |
| t-test (Diff) <sup>b</sup>   |                  |           |          | (< 0.0001) | (< 0.0001) | (< 0.0001) |

**Panel B: Subsequent-Year Excess Returns ( $ER_{t+1}$ ) of B/M Quintiles**

| B/M Quintiles                | $R_{t+1}$ | $ER_{t+1}$ : Fundamental Risk |           |          | $ER_{t+1}$ : CAPM |            |            |
|------------------------------|-----------|-------------------------------|-----------|----------|-------------------|------------|------------|
|                              |           | Firm                          | Portfolio | Industry | Firm              | Portfolio  | Industry   |
| Q1 (Growth)                  | 0.1065    | 0.0048                        | 0.0047    | 0.0057   | -0.0315           | -0.0338    | -0.0338    |
| Q2                           | 0.1006    | -0.0153                       | -0.0122   | -0.0148  | -0.0368           | -0.0382    | -0.0363    |
| Q3                           | 0.1301    | 0.0090                        | 0.0116    | 0.0129   | 0.0038            | -0.0020    | -0.0001    |
| Q4                           | 0.1490    | 0.0317                        | 0.0274    | 0.0283   | 0.0269            | 0.0212     | 0.0257     |
| Q5 (Value)                   | 0.1439    | 0.0146                        | 0.0125    | 0.0130   | 0.0176            | 0.0117     | 0.0167     |
| Q5 – Q1                      | 0.0374    | 0.0099                        | 0.0078    | 0.0073   | 0.0491*           | 0.0454*    | 0.0505*    |
| Wilcoxon (Diff) <sup>a</sup> |           |                               |           |          | (< 0.0001)        | (< 0.0001) | (< 0.0001) |
| t-test (Diff) <sup>b</sup>   |           |                               |           |          | (< 0.0001)        | (< 0.0001) | (< 0.0001) |

\*, \*\* Denote significance of the Newey-West autocorrelation adjusted t-statistic at the 5 percent and 1 percent level, respectively.

<sup>a</sup> p-value of one-tailed test of lower (Q5 – Q1) for fundamental risk adjustment compared to that for CAPM.

<sup>b</sup> p-value of one-tailed t-test (similar to the Fama-MacBeth test with Newey-West autocorrelation adjustment) of lower (Q5 – Q1) for fundamental risk adjustment compared to that for CAPM over sample years.

B/M quintiles are formed at the end of April of each year. B/M 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.

In Panel A,  $V/P$  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 betas (25 size-B/M portfolios) and industry-level betas (48-industries) for the fundamental risk adjustment; cost of equity is estimated at the firm-specific, portfolio, and industry levels for the CAPM. In Panel A, columns (1) to (3) present  $V/P$  ratios where value is estimated from the residual income model with fundamental risk adjustment based on one factor: excess market ROE. Columns (4) to (6) present  $V/P$  ratios where value is estimated from the residual income model using the risk-adjusted CAPM cost of equity as the discount factor. (Q5 – Q1) is the difference between  $V/P$  ratios of the fifth and the first quintiles.

In Panel B,  $R_{t+1}$  equals buy-and-hold (raw) returns for the period of 12 months beginning in the month of May of the valuation year averaged across years (column 1).  $ER_{t+1}$  equals one-year excess returns calculated as realized returns,  $R_{t+1}$ , minus expected returns. For columns (2) to (4), expected returns are calculated based on fundamental risk adjustment, as  $[r^f + \text{Covariance Risk}/P * (r^f - g)]$ , where covariance risk is estimated at the firm-specific, portfolio, and industry levels. For columns (5) to (7), expected returns are calculated based on the CAPM, where beta is estimated at the firm-specific, portfolio, and industry levels. (Q5 – Q1) is the difference in excess returns of the fifth and the first quintiles.

the risk differences of value-growth stocks while the fundamental risk adjustment does, we examine some primitive variables of these portfolios. Untabulated results show that the volatility of residual earnings of value stocks is 63 percent higher than the volatility of residual earnings of growth stocks (standard deviation: 0.070 versus 0.043). On the other hand, the return volatility of value stocks is only 3 percent higher than that of growth stocks (0.090 versus 0.087). Hence, it appears that the high fundamental risk (arising from high earnings volatility) of value stocks is not reflected in the variation in returns.

Our results indicate that risk measurement based on residual earnings captures some aspects of risk reflected in the B/M ratio, suggesting that the value-growth “anomaly” indicates risk mismeasurement rather than mispricing. We acknowledge that these results can be attributed to the use of book value as an input in the estimation of the residual income covariance risk. However, the fact that book value arises theoretically as a component of the risk term is more appealing than an *ad hoc* addition of the book-to-market factor in multi-factor models. Thus, our analysis provides a theoretical rationale for the significance of the book-to-market ratio in risk assessment that heretofore has remained unexplained.

### ***Link with Related Studies***

Our results are consistent with recent findings in the finance literature explaining the “mispricing” of value and growth stocks. Campbell and Vuolteenaho (2004) decompose the CAPM beta into two betas: one reflecting news about the market’s discount rate and the other about the market’s future cash flows. From a regression of average portfolio excess returns on the two estimated betas, they find that the cash flow beta carries a higher price of risk than the discount rate beta. Their main finding is that, relative to growth stocks, value stocks have higher cash flow betas (“bad” betas) with a higher risk premium that explains the higher returns to these stocks. They conclude that CAPM risk adjustment fails to explain the B/M effect because the CAPM beta does not differentiate cash flow beta from discount rate beta. Note, however, that Campbell and Vuolteenaho (2004) estimate cash flow betas as residuals from returns after controlling for proxies of discount rate news. In our analysis, we *explicitly* estimate “cash flow” risk from fundamentals and obtain results consistent with their explanation of the value-growth anomaly.

Cohen et al. (2009) address the issue of cash flow risk from a different perspective. They use the Feltham-Ohlson residual income valuation framework and decompose the cross-sectional variance of the market-to-book ratio into two components, one due to risk-adjusted fundamental value and the other due to mispricing. In an *ex post* analysis, they show that when risk is measured by “cash flow” covariances (measured by ROE covariances), the variance share of mispricing of value and growth stocks is negligible. While Cohen et al. (2009) arrive at the same conclusion as we do in terms of value-growth mispricing, their procedure relies on within-sample estimation using a long time-series of data (72 years), which precludes firm-level estimation for most firms. As such, they do not tackle the problem of implementing fundamental risk adjustment to obtain firm value in a practical setting.

### **Practical Applications**

Our approach to risk estimation can be used in the practical valuation of securities. First, one can estimate the cost of equity based on the accounting beta using the formula in Equation (9) and apply it as a discount factor in any valuation model, residual income or DCF. Fundamentals-based cost of equity can lead to better risk assessment for stock selection and portfolio management decisions. Since industry betas produce superior value

estimates relative to firm-specific betas, analysts/investors can estimate the fundamentals-based cost of equity with a parsimonious set of inputs using an industry-specific accounting beta.

Second, our risk estimation approach can potentially be used even when the past history of returns is not available for a firm, for example, in the case of initial public offerings or companies that are privately held or thinly traded. However, while our approach does not require stock return history, it does require adjustment when applied to companies for which the *stock price* is not available, for example, unlisted companies. In such cases, we propose estimating covariance risk as a proportion of *RFPV* of the previous period.<sup>36</sup> Although theoretically not an ideal alternative, when *RFPV* instead of price is used as the deflator, valuation errors are statistically indistinguishable between our one-factor model and the CAPM and significantly lower for our three-factor model relative to the Fama-French model (untabulated).

We validate our risk adjustment by using the valuation-error criterion, which implicitly assumes that the market correctly values the security. By relaxing this assumption when valuing individual securities, one could potentially use our approach to identify mispriced stocks. If our fundamental risk measure captures information about risk that is missed by a returns-based measure, then alpha technologists can construct trading strategies that buy (short) stocks for which risk is overestimated (underestimated) by returns-based measures relative to fundamental measures.

## V. CONCLUDING REMARKS

The emphasis in valuation has been gradually shifting to valuation based on fundamentals as evidenced by the gaining popularity of EVA<sup>®</sup>-type models. Empirical applications of valuation based on fundamentals include studies of market risk premium, effect of accounting disclosures on cost of equity (e.g., Botosan 1997), and corporate finance issues (e.g., D'Mello and Shroff 2000). Thus, researchers and practitioners increasingly measure payoffs using fundamentals, but continue to measure risk from returns when valuing 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 study, we derive a simplified covariance risk adjustment and the equivalent cost of equity based on accounting variables.

Our empirical results indicate that valuation errors obtained from value estimates based on fundamental risk adjustment are significantly lower than those from returns-based benchmark models. We validate the fundamental risk estimates by demonstrating their significant and consistent association with known proxies for firm-specific risk. Further, we find that the fundamentals-based risk adjustment provides a risk measurement that largely accounts for the “mispricing” attributed to the book-to-market effect.

Our research 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

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<sup>36</sup> Recall that we estimate covariance risk as a proportion of value in the previous period and then use this estimate to obtain the out-of-sample covariance risk as a proportion of value in the current period. Since “value” is unobservable, we use the previous year’s price as a proxy for value in our estimation procedure.

available for estimation. Efforts to reduce noise in beta estimation (perhaps using a deseasonalized quarterly earnings series) can further improve risk estimation at the firm level relative to commonly used alternatives. Our analysis leads us to several related issues for future inquiry, in particular, examining whether value estimates based on fundamental risk can identify mispriced stocks, and establishing a linkage with other studies that use properties of accounting earnings such as accruals quality and earnings predictability as measures of information risk (e.g., Francis et al. 2004, 2005).

**APPENDIX A  
DERIVATION OF COVARIANCE RISK ADJUSTMENT**

A general representation of the present value of expected dividends formula is expressed as  $V_t = E_t \sum_{j=1}^{\infty} \tilde{m}_{t,t+j} \tilde{d}_{t+j}$  (Equation (1)).<sup>37</sup> In Section II, we assume the clean surplus relation, and rewrite Equation (1) as  $V_t = B_t + E_t \sum_{j=1}^{\infty} \tilde{m}_{t,t+j} \tilde{x}_{t+j}^a = \left( B_t + \sum_{j=1}^{\infty} \frac{E_t[\tilde{x}_{t+j}^a]}{R_{t,t+j}^f} \right) + \left( \sum_{j=1}^{\infty} Cov_t[\tilde{m}_{t,t+j}, \tilde{x}_{t+j}^a] \right)$ .

This Appendix derives a simplified expression for the covariance risk term:

$$Risk\ Adjustment_t = \sum_{j=1}^{\infty} Cov_t[\tilde{m}_{t,t+j}, \tilde{x}_{t+j}^a]. \tag{1A}$$

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

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

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<sub>t+1</sub> with the contemporaneous discount factor,  $m_{t+1,t+2}$ :

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

Equation (3A) is derived by assuming that  $Cov_{t+j-1}[m_{t+j-1,t+j}, EROE_{t+j}] = Cov[m, EROE]$ , all  $j$ . This assumption is consistent with the common practice in empirical estimations of cost of equity where beta is estimated using contemporaneous market factors and assumed

<sup>37</sup> In all our analyses, our expectation,  $E[.]$ , is based on objective (true) probabilities and not risk-neutral probabilities.

to be constant over time. Further, for ease of implementation in an empirical setting, we ignore the relatively small term that appears within the braces on the RHS of Equation (3A), and obtain:

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

While fewer assumptions will result in a more general risk adjustment, our goal is to obtain a theoretically sound risk measure that can be practically implemented with relative ease. Based on the data in this study, we find that, on average, the magnitude of the term within braces in Equation (3A) that is omitted in Equation (4A) ranges from 0.19 percent to 1.7 percent of the magnitude of the first term on the RHS of Equation (3A), suggesting that this is a good approximation in practice. The range of possible values of the omitted term is established by employing the following alternative assumptions: (i)  $E_{t+1}[EROE_{t+2}] = E_t[EROE_{t+2}]$ , which obtains 0.19 percent; (ii)  $E_{t+1}[EROE_{t+2}] = E_t[EROE_{t+2}] + \varepsilon_t$ , which obtains 1.7 percent; and (iii)  $E_{t+1}[EROE_{t+2}] = a + bE_t[EROE_{t+2}] + \varepsilon_t$ , which obtains 1.3 percent. Assumption (i) implies that the expectation of excess ROE remains constant over time; (ii) assumes that the expectation follows a random walk; and (iii) assumes an autoregressive process. The estimates of the intercept ( $a$ ) and slope coefficient ( $b$ ) in assumption (iii) are obtained from a regression of one-year-ahead excess ROE forecast of analysts issued in period  $t+1$  on the two-year-ahead excess ROE forecast issued in period  $t$  (our estimates of the average intercept and slope coefficient equal 0.006 and 0.91, respectively). Based on the same assumptions that derive (4A), we obtain for any  $j$ ,  $Cov_t[m_{t,t+j}, x_{t+j}^a]$

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

Summing terms in (1A), we obtain:

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

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

**Observation 2:** Under the assumption of nonstochastic 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:

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

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

Based on the data in this study, the average magnitude of the second term relative to the first term on the RHS of Equation (6A), that is,  $\Omega / \sum_{j=0}^{\infty} \frac{E_t[B_{t+j}]}{(1+r^f)^j} Cov[m, EROE]$ , 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.<sup>38</sup>

**APPENDIX B**  
**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 III. We estimate the cross-sectional regression (14) with intercept separately for each year of our sample period:

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

**TABLE A1**  
**Results of Cross-Sectional Regression of Priced Risk on Accounting Risk Measures Estimated over Each Year of the Sample Period**

| <u>Intercept</u>   | <u>Cov<sub>ACCT</sub></u> | <u>Cov<sub>ESMB</sub></u> | <u>Cov<sub>EHML</sub></u> | <u>Avg. Adj. R<sup>2</sup></u> |
|--------------------|---------------------------|---------------------------|---------------------------|--------------------------------|
| 1.0712<br>(0.0001) | 0.0047<br>(0.0003)        |                           |                           | 6.73%                          |
| 1.1224<br>(0.0001) |                           | 0.0018<br>(0.0308)        |                           | 3.62%                          |
| 1.1394<br>(0.0001) |                           |                           | 0.0015<br>(0.0326)        | 2.32%                          |
| 1.0681<br>(0.0001) | 0.0044<br>(0.0001)        | 0.0006<br>(0.0274)        | 0.0005<br>(0.0458)        | 7.82%                          |

Dependent variable is priced risk  $(RFPV - P)/P$ .  
 p-values of Newey-West autocorrelation adjusted (Fama-MacBeth) t-statistics are reported in parentheses.  
 Means of coefficient estimates from year-wise regressions are reported.  
 Variable Definitions:

$RFPV$  = 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  $Cov_{EHML}$  =  $K_t$  times  $\beta_{ACCT}$ ,  $\beta_{ESMB}$  and  $\beta_{EHML}$  respectively (scaled by price), where  $K_t$  is defined in Equation (6); and  
 $\beta_{ACCT}$ ,  $\beta_{ESMB}$ , and  $\beta_{EHML}$  = estimated slope coefficients from the firm-by-firm regression of a firm's excess ROE on market excess ROE, ROE of the SMB portfolio (small minus large) and ROE of the HML portfolio (high minus low book-to-market), respectively (Equations (11), (12), and (13)).

<sup>38</sup> We thank Stephen Penman for pointing out that our derivation does not explicitly include the risk in investment growth. While in general this risk should be estimated separately, under our assumption of nonstochastic payout  $k$ , the risk in investment growth is fully captured by the risk in ROE.

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.<sup>39</sup> The cross-sectional regression is estimated each year and coefficient means across years are reported in Table A1 along with the Fama-MacBeth t-statistics with Newey-West autocorrelation adjustment.

$Cov_{ACCT}$  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 also significant in both univariate and multivariate regressions. Results of year-wise multivariate regressions show that the risk measure based on the accounting beta has significant explanatory power ( $\leq 5$  percent level) 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 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.

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<sup>39</sup> For the cross-sectional analysis, we winsorize excess ROE betas at the upper and lower 1 percent tails of the distribution to reduce noise.

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