Using earnings forecasts to simultaneously estimate firm-specific cost of equity and long-term growth

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Abstract

A growing body of literature in accounting and finance relies on implied cost of equity (COE) measures. Such measures are sensitive to assumptions about terminal earnings growth rates. In this paper we develop a new COE measure that is more accurate than existing measures because it incorporates endogenously estimated long-term growth in earnings. Our method extends Easton, Taylor, Shroff, and Sougiannis' (2002) method of simultaneously estimating *sample average* COE and growth. Our method delivers COE (growth) estimates that are significantly positively associated with future realized stock returns (future realized earnings growth). The predictive ability of our COE measure subsumes that of other commonly used COE measures and is incremental to known risk determinants.

1. Introduction

In this study, we propose a new firm-specific measure of implied cost of equity capital (COE) that is more accurate than existing measures because it incorporates *endogenously* estimated long-term growth in earnings.

Implied COE measures are internal rates of return that equate a firm's current stock price to the sum of discounted future payoffs. Payoffs beyond the short-term horizon are assumed to grow at a certain constant long-term growth rate, which makes growth an important input in COE estimation.[1] Any error in the growth estimate feeds directly into the implied COE. In particular, the more positive (negative) is the error in the long-term growth rate, the more upwardly (downwardly) biased is the implied COE.[2]

Extant implied COE measures assume the same long-term growth rate across all firms (Claus and Thomas 2001; Gode and Mohanram 2003).[3] This assumption is unlikely to hold in practice, however, because a number of factors influence a firm's terminal growth rate, such as the firm's degree of accounting conservatism and expected growth in investment (Feltham and Ohlson 1995; Zhang 2000). Existing measures of implied COE therefore systematically over- or understate growth, which can lead to spurious inferences

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[1] This growth rate is often referred to as the terminal growth rate or the growth rate in perpetuity. Throughout the paper we use the terms long-term growth, terminal growth, and growth in perpetuity interchangeably.

[2] Valuation textbooks emphasize that firm valuation can be highly sensitive to the assumed terminal growth rate of earnings (Penman 2009; Whalen et al. 2010). For example, Damodaran (2002) states that "of all the inputs into a discounted cash flow valuation model, none can affect the value more than the stable growth rate."

[3] Another commonly used COE measure developed by Gebhardt et al. (2001) assumes a convergence in profitability to an industry benchmark over twelve years with constant zero growth thereafter. But as Easton (2006) point out, this approach creates systematic biases to the extent that firms with certain characteristics have other expected growth patterns.

(Easton 2006, 2007). Our measure of COE helps avoid such spurious inferences by taking into account a firm's growth rate as *implied by the data*.[4]

Our estimation method builds upon the pioneering work of Easton, Taylor, Shroff, and Sougiannis (2002) (hereafter, ETSS). ETSS develop a method to simultaneously estimate the *average* COE and *average* earnings growth rate for a given portfolio of firms. Despite this method's conceptual and practical appeal, however, it cannot be used in many research settings because it only allows one to estimate the *average* COE and growth rate for a given sample of firms. In this paper we extend the ETSS approach to allow for estimation of COE and expected earnings growth for individual firms. Our approach is motivated by the industry practice of using firm peers when valuing privately-held companies. Practitioners often compare a given firm against firms with similar characteristics to determine an appropriate COE and/or growth rate (Pratt and Niculita 2007; Damodaran 2002). Accordingly, our method estimates a firm's COE (growth) as the sum of the COE (growth) typical of firms with the same risk-growth profile plus a firm-specific component. Empirically, COE and growth are estimated by

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[4] Developing a more accurate and less biased implied COE measure is important given the increasing use of implied COE measures in accounting and finance literature. Implied COE measures have been used to shed light on the equity premium puzzle (Claus and Thomas 2001; Easton et al. 2002), the market's perception of equity risk (Gebhard et al. 2001), risk associated with accounting restatements (Hribar and Jenkins 2004), dividend taxes (Dhaliwal et al. 2005), accounting quality (Francis et al. 2004), legal institutions and regulatory regimes (Hail and Leuz 2006), and quality of internal controls (Ogneva et al. 2007), as well as to test intertemporal CAPM (Pastor et al. 2008), international asset pricing models (Lee et al. 2009), and the pricing of default risk (Chava and Purnanandam 2010).

regressing the ratio of forecasted earnings to book value of equity on the market-to-book ratio and a set of observable risk and growth characteristics.[5]

We test the accuracy of our COE estimates by examining their ability to explain future stock returns for a sample of 7,631 firms with *I/B/E/S* forecasts over the 1980 to 2007 period. This analysis uses unadjusted earnings forecasts as well as forecasts adjusted for predictable analyst biases as in Gode and Mohanram (2009). We find that using either raw earnings forecasts (unadjusted measure) or earnings forecasts adjusted for predictable biases (adjusted measure), our implied COE measure surpasses conventional implied COE measures (hereafter referred to as benchmark COE measures) in predicting future realized stock returns. More specifically, when we sort stocks into quintiles based on COE, the return spread between the top and bottom quintiles is 6.5% (9.3%) per annum using our unadjusted (adjusted) measure, whereas this spread does not exceed 5.0% (7.1%) per annum using the benchmark unadjusted (adjusted) COE measures.

Multivariate regression analyses further suggests that our implied COE measure has incremental predictive ability relative to the benchmark COE measures and commonly used risk proxies (CAPM beta, size, book-to-market, and past twelve-month stock returns). Specifically, our measure remains significantly positively related to future realized stock returns even after controlling for either the benchmark COE measures or

[5] Specifically, we use the CAPM beta, size, book-to-market, and momentum as the observable risk characteristics, and we use analysts' long-term growth forecast, the difference between the firm's and the industry's target ROE, and the ratio of R&D expenses to sales as the observable growth characteristics. We take the part of COE (growth) that is not explained by these observable risk (growth) characteristics to be due to unobservable risk (growth) factors. Examples of unidentified risk factors may include the risk of increased competition and extreme weather, credit risk, and litigation risk as perceived by market participants but not fully captured by the set of observable risk characteristics that we consider.

the commonly used risk proxies. In contrast, none of the benchmark COE measures is significantly related to future stock returns after controlling for our measure. Additional tests that rely on Easton and Monahan's (2005) methodology suggest that our implied COE measure delivers the lowest measurement error compared to the benchmark COE estimates.

To examine the accuracy of our long-term growth estimates, we test their predictive ability with respect to future earnings growth rates. Specifically, we estimate the realized growth in aggregate four-year cum-dividend earnings from years *t*+1 to *t*+4, to years *t*+5 to *t*+8. We find that our implied growth estimates are significantly associated with future earnings growth: when we sort stocks into quintiles based on predicted growth, the annualized growth spread between the top and bottom quintiles is between 2.5% and 10.4% (5.5% and 8.6%) per annum using our unadjusted (adjusted) measure. In multivariate regression analysis, however, the growth spread is no longer statistically significant after we control for analysts' long-term growth forecasts,[6] the difference between the firm's and the industry's return on equity, and the ratio of R&D expenses to sales. We therefore conclude that the significant predictive of our implied growth measure can be attributed to these observable growth characteristics.[7]

[6] Note that analysts' long-term growth forecasts are based on 3- to 5-year forecasts, while our implied long-term growth rate corresponds to the rate of growth in perpetuity.

[7] Although observable growth characteristics appear to explain the predictive ability of our growth measure, our measure contains information that is incremental to a simple statistical forecast based on such characteristics. To demonstrate, we use a simple cross-sectional prediction model that first regresses past growth on past growth characteristics and then applies the resulting coefficients to current growth characteristics to arrive at a growth forecast. We find that such simple forecasts, even when positively associated with future realized growth rates, never fully subsume the predictive ability of our implied growth measure.

In addition to examining COE and growth rates for individual firms, we revisit ETSS' findings with respect to the market-wide levels of COE and earnings growth. As we discuss in detail in Section 2, explicitly incorporating risk and growth characteristics as we do in our model may improve estimates of *sample average* COE and growth rates. For instance, using our method, we obtain estimates of average implied COE and equity risk premia that are significantly lower than those obtained from the ETSS model. Further, unlike ETSS, our method also delivers risk premia that are consistent with theoretically derived equity risk premia (Mehra and Prescott 1985).[8]

Our paper is related to earlier work by Huang et al. (2005), who use ETSS' method to estimate firms' COE and growth based on the *time series* of monthly stock prices and earnings forecasts. However, our method differs from that proposed by Huang et al. along several dimensions. First, their method assumes that a firm's risk exposure and expected earnings growth do not change over the estimation period (36 months), which limits the practical appeal of the resulting measures (i.e., they cannot be used to examine changes in risk over short horizons). In contrast, we provide point-in-time COE estimates. Second, their estimation pairs monthly stock prices with annual book values of equity, which implicitly assumes that the book value of equity does not change within a given fiscal year. Our method relies on annual stock prices corresponding to annual book values of equity. Finally, by using monthly analyst forecasts and stock prices, their method assumes that forecasts and prices are simultaneously updated to reflect new

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[8] Note that this market-wide analysis is subject to an important caveat: the actual expected returns may be somewhat higher than the implied COE estimates when interest rates are stochastic (Hughes et al. 2009).

information on a timely basis, which is inconsistent with prior research documenting significant sluggishness in analyst forecasts (Guay et al. 2005).

Our paper contributes to the literature in three ways. First, we expand the literature on COE estimation by developing an implied COE measure that relies on endogenously determined long-term earnings growth rates. By taking into account a firm's growth rate as implied by the data, our implied COE measure mitigates the potential bias that arises due to incorrect assumptions about growth rates. Second, we complement the literature on forecasting long-term firm performance by developing and validating an implied earnings growth measure that has economically significant predictive ability with respect to future long-term earnings growth.[9] To the best of our knowledge, this is the first paper to propose an implied growth measure that can predict future long-term earnings growth. Finally, we contribute to the equity premium literature by providing a measure that delivers firm-level equity risk premia consistent with theoretically justified low implied market-wide risk premia.

The rest of the paper is organized as follows. Section 2 discusses our estimation of firm-level COE and growth. Section 3 describes the data and variable estimation. In Section 4 we present the empirical results. Section 5 provides concluding remarks.

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[9] While we are not aware of any papers that estimate terminal growth rates, a few papers forecast earnings over horizons beyond two years. For example, Chan et al. (2003) forecast earnings growth over the next five years, while Hou et al. (2010) forecast three-year-ahead earnings.

2. Estimation of firm-level cost of equity and growth

In this section, we develop a method to simultaneously estimate firms' cost of equity (COE) and expected earnings growth rate using stock prices, book values of equity, and earnings forecasts. Our method extends Easton, Taylor, Shroff, and Sougiannis (2002) (ETSS), who simultaneously estimate *average* COE and expected earnings growth for a given sample of firms.

Similar to ETSS, our approach is based on the residual income model (e.g. Ohlson 1995), which expresses firm value as the reported book value plus the discounted sum of expected residual earnings: [10]

$$P_0^i = B_0^i + \sum_{t=1}^{\infty} \frac{E_t^i - r^i B_{t-1}^i}{(1+r^i)^t} \tag{1}$$

where P_0^i is the market value of equity, B_0^i is the book value of equity, E_t^i is expected earnings for year t given information at t=0, and r^i is the COE (unless specifically stated otherwise, the terms COE and expected return are used interchangeably throughout the paper).

Following ETSS, we re-write the valuation equation using finite (four-year) horizon forecasts and define g^i as the perpetual annual growth rate such that:

$$P_0^i = B_0^i + \frac{X_{cT}^i - (R^i - 1)B_0^i}{R^i - G^i} \tag{2}$$

[10] The residual income model is equivalent to the discounted dividend model assuming the clean surplus relation, i.e. the book value of equity at the end of year t+1 is equal to the book value of equity at the end of year t plus net income for year t+1 minus dividends for year t+1.

where $G^i = (1+g^i)^4$ is one plus the expected rate of growth in four-year residual income, $R^i = (1+r^i)^4$ is one plus the four-year expected return, $X^i_{cT} = \sum_{t=1}^{4} E_t + \sum_{t=1}^{3}((1+r)^{4-t}-1)d_t$ is expected aggregate four-year cum-dividend earnings, and d_t is expected dividends in year *t* given information at *t*=0.

In order to estimate COE and growth, ETSS re-arrange the valuation equation (2) as:

$$X^i_{cT} / B^i_0 = G^i + (R^i - G^i)MB^i \tag{3a}$$

ETSS further observe that the sample average *R* and *G* in equation (3a) can be estimated from the intercept and the slope in a cross-sectional regression of the ratio of cumulative earnings to book value on the market-to-book ratio:

$$X^i_{cT} / B^i_0 = \gamma_0 + \gamma_1 MB^i + \varepsilon^i \tag{3b}$$

where $\gamma_0 = \overline{G} - 1, \gamma_1 = \overline{R} - \overline{G}$, and $\varepsilon^i = \varepsilon^i_G(1 - MB^i) + \varepsilon^i_R MB^i$. The $\overline{R}$ and $\overline{G}$ are the sample means of R^i and G^i respectively, and $\varepsilon^i_R = R^i - \overline{R}$ and $\varepsilon^i_G = G^i - \overline{G}$ are the firm-specific deviations of R^i and G^i from their sample means.

Estimating regression (3b) using OLS obtains the sample means of COE and growth as $\overline{R} = \gamma_0 + \gamma_1 + 1$ and $\overline{G} = \gamma_0 + 1$, but leaves the firm-specific components of *R* and *G* unidentified.

Our approach to estimating firm COE and growth rates introduces two innovations to the ETSS method. First, consistent with a large body of extant research, we explicitly recognize that COE and growth rates are associated with certain firm characteristics. Each individual R^i (G^i) can therefore be expressed as the average $\overline{R}$ ($\overline{G}$) plus components due to observable and unobservable risk (growth) factors:

$$R^i = \overline{R} + \boldsymbol{\lambda}_{\mathbf{R}}{}'\mathbf{x}_{\mathbf{R}}^{\mathbf{i}} + \varepsilon_R^i$$
$$G^i = \overline{G} + \boldsymbol{\lambda}_{\mathbf{G}}{}'\mathbf{x}_{\mathbf{G}}^{\mathbf{i}} + \varepsilon_G^i$$

where $\overline{R}$ ($\overline{G}$) is the sample mean of R^i (G^i) in the estimation year t, $\mathbf{x}_{\mathbf{R}}^{\mathbf{i}}$ ($\mathbf{x}_{\mathbf{G}}^{\mathbf{i}}$) is a vector of observable firm risk (growth) drivers (the drivers are demeaned to ensure that $\overline{R}$ and $\overline{G}$ can be interpreted as sample means) [11], $\boldsymbol{\lambda}_{\mathbf{R}}$ ($\boldsymbol{\lambda}_{\mathbf{G}}$) is a vector of premia on the observable risk (growth) drivers, and ε_R^i (ε_G^i) is a firm-specific component of R^i (G^i) that is due to some unobservable risk (growth) factors.[12]

Incorporating the observable risk and growth drivers serves two purposes. First, it provides estimates of firm COE and growth rate conditional on the observable firm characteristics related to risk and growth. Second, it helps to obtain more accurate estimates of *average* COE and growth rates. To see this, note that the estimates of average COE and growth rate ($\overline{R}$ and $\overline{G}$) are derived from the intercept and slope estimates in (3b). The residuals in (3b) are a linear function of firm-specific components of COE and growth rate ($\varepsilon^i = \varepsilon_G^i(1-MB^i) + \varepsilon_R^i MB^i$). The residuals are therefore likely to be correlated with firm COE and growth rates, which are in turn correlated with the independent variable in regression (3b) − the market-to-book ratio (e.g. Fama and French

[11] Empirically, we use the CAPM beta, size, book-to-market ratio, and momentum as observable risk drivers, and we use the analyst long-term growth forecast and the difference between the firm and industry target ROE as observable growth drivers.

[12] The component due to unobservable risk (growth) factors is defined as the part of COE (growth) that is not explained by the observable risk (growth) drivers. For example, unidentified risk factors may include the risk of increased competition, liquidity risk, credit risk, litigation risk, and political risk as perceived by market participants but not fully captured by the above observable risk drivers.

1993; Penman 1996). Note, that because the residuals in (3b) are a complex function of the firm-specific COE, growth rate, and market-to-book ratio, it is unclear whether such correlations represent a source of bias in the regression coefficients. Explicitly incorporating observable risk and growth factors in equation (3b) mitigates any concerns regarding the possible bias and may lead to more accurate estimates of average COE and growth rates.[13]

As our second innovation, we decompose the residuals ε^i in the cross-sectional regression (3b) into the COE component (ε_R^i) and expected growth component (ε_G^i). We perform this decomposition by jointly minimizing the components due to unknown risk and growth factors, ε_R^i and ε_G^i. For this purpose we set up the following minimization program:

$$\begin{cases} \underset{\bar{R},\bar{G},\lambda_R,\lambda_G,\varepsilon_R^i,\varepsilon_G^i}{Min} \sum_i w_1^i(\varepsilon_R^i)^2 + w_2^i(\varepsilon_G^i)^2 \\ R^i = \bar{R} + \boldsymbol{\lambda}_\mathbf{R}{}'\mathbf{x}_\mathbf{R}^\mathbf{i} + \varepsilon_R^i \\ G^i = \bar{G} + \boldsymbol{\lambda}_\mathbf{G}{}'\mathbf{x}_\mathbf{G}^\mathbf{i} + \varepsilon_G^i \end{cases} \qquad (4)$$

where w_1^i and w_2^i are some predetermined non-negative weights (with at least one of the two weights being positive), and the other variables are as defined above.

Intuitively, the minimization function in (4) represents a loss (cost) function that increases with the magnitude of the unexplained components of COE and growth. Introducing cost due to unexplained components reflects the idea akin to Occam's razor principle – everything else being equal, estimates that can be explained by known factors

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[13] The analysis that follows leads to such extended regression relation (equation (5a) below).

are preferred to estimates that appeal to some unobservable factors. The weights w_1^i and w_2^i reflect the relative cost of the components due to unobservable risk and growth factors respectively. For example, the assumption that the growth rate does not vary across firms beyond the variation implied by the known growth factors, $G^i = \bar{G} + \boldsymbol{\lambda}_{\mathbf{G}}'\mathbf{x}_{\mathbf{G}}^{\mathbf{i}}$, is a special case with $w_1^i = 0$.

The appendix shows that our minimization program (4) is equivalent to the following minimization program that can be estimated using a weighted least squares (WLS) regression:[14]

$$\begin{cases} \underset{\varepsilon^i, \gamma_0, \gamma_1, \lambda_R, \lambda_G}{Min} \sum_i w^i (v^i)^2 \\ \text{s.t.} \quad X_{cT}^i / B_0^i = \gamma_0 + \gamma_1 MB^i + \boldsymbol{\lambda}_{\mathbf{R}}'\mathbf{x}_{\mathbf{R}}^{\mathbf{i}} MB^i + \boldsymbol{\lambda}_{\mathbf{G}}'\mathbf{x}_{\mathbf{G}}^{\mathbf{i}}(1 - MB^i) + v^i \end{cases} \tag{5a}$$

where the weights w^i are equal to $w_1^i w_2^i / \left(w_1^i (1 - MB^i)^2 + w_2^i (MB^i)^2 \right)$.[15]

Using the coefficient and residual estimates (γ_0, γ_1, $\boldsymbol{\lambda}_{\mathbf{R}}$, $\boldsymbol{\lambda}_{\mathbf{G}}$, and ε^i) from the WLS regression (5a), firm COE (R^i) and growth rate (G^i) are determined as follows (see the derivation in the appendix):

$$\begin{aligned} R^i &= \bar{R} + \boldsymbol{\lambda}_{\mathbf{R}}'\mathbf{x}_{\mathbf{R}}^{\mathbf{i}} + \varepsilon_R^i \\ G^i &= \bar{G} + \boldsymbol{\lambda}_{\mathbf{G}}'\mathbf{x}_{\mathbf{G}}^{\mathbf{i}} + \varepsilon_G^i \end{aligned} \tag{5b}$$

where

[14] Regression (5a) assumes that independent variables are exogenous, i.e. $E[\varepsilon^i \mid MB^i, MB^i x_R^i, (1 - MB^i) x_G^i] = 0$. A sufficient but not necessary condition for the exogeneity is the assumption that ε_R^i and ε_G^i are independent of MB^i, x_R^i, and x_G^i.

[15] Note that the WLS regression restricts neither the magnitudes nor the signs of risk and growth premia, λ_R and λ_G, which are determined endogenously based on earnings forecasts and stock prices.

$$\overline{G} = \gamma_0 + 1$$
$$\overline{R} = \gamma_1 + \gamma_0 + 1$$
$$\varepsilon_R^i = v^i \frac{w_2^i MB^i}{w_1^i (MB^i - 1)^2 + w_2^i (MB^i)^2} \tag{5c}$$
$$\varepsilon_G^i = v^i \frac{w_1^i (1 - MB^i)}{w_1^i (MB^i - 1)^2 + w_2^i (MB^i)^2}$$

To summarize, our method allows simultaneously estimating implied COE and growth rates by incorporating known risk and growth drivers in the estimation procedure and by minimizing the components due to unknown risk and growth factors.

Estimation procedure

We estimate firms' COE and growth rates in two steps detailed below.

Step 1: In each sample year, we estimate the following cross-sectional regression using WLS with the weights equal to $1/((1-MB^i)^2 + (MB^i)^2)$:[16]

$$X_{cT}^i / B_0^i = \gamma_0 + \gamma_1 MB^i + \underbrace{(\lambda_{Beta} Beta^i + \lambda_{Size} LogSize^i + \lambda_{MB} MB^i + \lambda_{ret} ret_{-12}^i)}_{\boldsymbol{\lambda}_\mathbf{R}'\mathbf{x}_\mathbf{R}^\mathbf{i}} MB^i$$
$$+ \underbrace{(\lambda_{Ltg} Ltg^i + \lambda_{dROE} dIndROE^i + \lambda_{RdSales} RdSales^i)}_{\boldsymbol{\lambda}_\mathbf{G}'\mathbf{x}_\mathbf{G}^\mathbf{i}}(1 - MB^i) + v^i \tag{6}$$

where the vector of risk characteristics, $\mathbf{x}_\mathbf{R}^\mathbf{i}$, corresponds to the three-factor Fama-French model augmented with Carhart (1997) momentum factor: the CAPM beta (*Beta*), market value of equity (*LogSize*), market-to-book ratio (*MB*), and past twelve months stock

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[16] These weights assume equal weighting of the COE and growth components due to unknown factors in (4), that is $w_1^i = w_2^i = 1$. As a robustness check, we vary the ratio of the weights (w_1^i / w_2^i) from 0.5 to 2. Our inferences are robust to these variations.

return (*ret*$_{12}$).[17] The vector of growth characteristics, $\mathbf{x}^{\mathbf{i}}_{\mathbf{G}}$, consists of the analysts' long-term growth forecast (*Ltg*), the difference between the industry ROE and the firm forecasted ROE (*dIndROE*), which serves as a proxy for the mean-reversion tendency in ROEs, and the ratio of R&D expenses to sales (*RdSales*). The latter characteristic serves a dual purpose as a proxy for the extent of accounting conservatism, which affects terminal growth rate in residual income (Zhang 2000), and as one of the known predictors of the long-term growth in earnings (Chan et al. 2003).[18]

The calculation of X^i_{cT} requires a COE estimate, r^i, which is not known. We use an iterative procedure similar to that described in ETSS to estimate both X^i_{cT} and r^i. Namely, we first set r^i equal to 10% for all firms and calculate the initial values of X^i_{cT}. We then use obtained X^i_{cT} to estimate the WLS regression, which produces revised estimates of r^i. We then re-calculate X^i_{cT} using the revised estimates of r^i and again re-estimate the WLS regression. The procedure is repeated until the mean (across all firms) of absolute change in r^i from one iteration to the next is less than 10^{-7}. The estimation is robust to using other initial values of r^i and in most cases involves less than 10 iterations.[19]

[17] Leverage is another characteristic associated with equity risk. We do not include leverage in the estimation because Fama and French (1992) show that the predictive power of leverage with respect to future stock returns is subsumed by the beta, size, and book-to-market ratio.

[18] In our sensitivity tests, we have also included other growth predictors suggested in Chan et al. (2003), including past sales growth, earnings-to-price ratio, and alternative conservatism proxies used in Penman and Zhang (2000). Our results are not sensitive to including them in the estimation, and we opt for a parsimonious set of variables to avoid additional sample restrictions.

[19] Note that numerical estimation of implied COE is typical in models that assume different short-term and long-term growth rates in earnings (e.g. Gebhardt et al. 2001, Claus and Thomas 2001). The method proposed here is not more computationally complex than the extant COE estimation methods.

Step 2: Using the intercept and the slope on the market-to-book ratio from the regression estimated in Step 1, we calculate the mean $\overline{R}$ and $\overline{G}$ as $\overline{R} = \gamma_1 + \gamma_0 + 1$ and $\overline{G} = \gamma_0 + 1$. We use the residuals from the same regression to calculate the firm-specific components of *R* and *G*, as $\varepsilon_R^i = v^i MB^i / ((MB^i - 1)^2 + (MB^i)^2)$ and $\varepsilon_G^i = v^i (1 - MB^i) / ((MB^i - 1)^2 + (MB^i)^2)$. The total firm *R* and *G* are calculated by combining the mean $\overline{R}$ and $\overline{G}$ estimates and the residuals ε_R^i and ε_G^i with the estimates of $\boldsymbol{\lambda}_{\mathbf{R}}'\mathbf{x}_{\mathbf{R}}^{\mathbf{i}}$ and $\boldsymbol{\lambda}_{\mathbf{G}}'\mathbf{x}_{\mathbf{G}}^{\mathbf{i}}$ from regression (6), so that $R^i = \overline{R} + \boldsymbol{\lambda}_{\mathbf{R}}'\mathbf{x}_{\mathbf{R}}^{\mathbf{i}} + \varepsilon_R^i$ and $G^i = \overline{G} + \boldsymbol{\lambda}_{\mathbf{G}}'\mathbf{x}_{\mathbf{G}}^{\mathbf{i}} + \varepsilon_G^i$.

3. Data and Variable Estimation

Our sample consists of December fiscal-year end firms available in *I/B/E/S*, *Compustat*, and *CRSP* from 1980 to 2007. The one- and two-year-ahead analyst earnings forecasts, long-term growth forecasts, realized earnings, stock prices, dividends, and number of shares outstanding are obtained from *I/B/E/S*; book values of common equity are obtained from *Compustat*; CAPM betas, as well as past and future buy-and-hold stock returns are estimated using monthly stock returns from CRSP. We exclude firm-years with negative two-year-ahead earnings forecasts, book-to-market ratios less than 0.01 or greater than 100, or stock prices below one dollar. Our final sample includes 7,631 firms, with the by-year number of observations ranging from 761 in 1980 to 2,447 in 2007.

Inputs to Simultaneous Estimation of COE and Growth

As discussed in detail in the previous section, our method requires estimating the following cross-sectional regression using WLS:

$$\begin{aligned} X^i_{cT} / B^i_0 = \gamma_0 + \gamma_1 MB^i + (\lambda_{Beta} Beta^i + \lambda_{Size} LogSize^i + \lambda_{MB} MB^i + \lambda_{ret} ret^i_{-12}) MB^i x^i_R \\ + (\lambda_{Ltg} Ltg^i + \lambda_{dROE} dIndROE^i + \lambda_{RdSales} RdSales^i)(1 - MB^i) x^i_G + v^i \end{aligned} \quad (6)$$

where

X_{cT} = expected four-year cum-dividend earnings, $\sum_{t=1}^{4} E_t + \sum_{t=1}^{3}((1+r)^{4-t} - 1) d_t$, where E_1 and E_2 are one- and two-year-ahead consensus earnings per share forecasts from *I/B/E/S* reported in June of year t+1; E_3 and E_4 are three- and four-year-ahead earnings per share forecasts computed using the long-term growth rate from *I/B/E/S* as: $E_3 = E_2(1+Ltg)$ and $E_4 = E_3(1+Ltg)$;[20] d_1 to d_3 are expected dividends per share calculated assuming a constant dividend payout ratio from fiscal year t;

B_0 = book value of equity from *Compustat* at the end of year t divided by the number of shares outstanding from *I/B/E/S*;

MB = market-to-book ratio, calculated as stock price from *I/B/E/S* as of June of year t+1, divided book value of equity per share estimated as previously described;

Beta = CAPM beta estimated using sixty monthly stock returns preceding June of year t+1 (with at least twenty four non-missing returns required);

LogSize = the log of the market value of equity calculated as stock price from *I/B/E/S* as of June of year t+1 multiplied by shares outstanding from *I/B/E/S*;

ret_{-12} = the twelve-month buy-and-hold stock return preceding June of year t+1;

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[20] When the long-term growth forecast is missing, we use the growth implied by E_1 and E_2. Values of *Ltg* greater than 50% are winsorized.

Ltg = the long-term growth consensus forecast from *I/B/E/S* as of June of year *t*+1;

dIndROE = the industry ROE (income before extraordinary items divided by the average book value of equity) minus the firm average forecasted ROE over fiscal years *t+1* to *t+4*. Industries are defined using the Fama and French (1997) 48-industry classification. Industry ROE is calculated as a ten-year moving median ROE after excluding loss firms (Gebhardt et al. 2001);

RdSales = the ratio of R&D expenses to sales.

All variables are calculated as the difference between the firm value and the sample mean in the estimation year.

COE from Benchmark Models

We compare performance of our COE measure with three COE measures derived using an *assumed* long-term earnings growth rate. The first implied COE measure, r_{zero}, is derived as an internal rate of return from the residual income valuation model assuming a zero residual earnings growth rate after year t=4:

$$P_0 = B_0 + \sum_{\tau=1}^{3} \frac{E_\tau - r_{zero} B_{\tau-1}}{(1+r_{zero})^t} + \frac{E_4 - r_{zero} B_3}{r_{zero}(1+r_{zero})^3} \qquad (r_{zero})$$

where P_0 is the stock price as of June of year t=1 from *I/B/E/S*; B_0 is the book value of equity at the end of year $t=0$ from *Compustat* divided by the number of shares outstanding from *I/B/E/S;* E_τ is expected earnings for year τ; B_τ is the expected per-share book values of equity estimated using the clean surplus relation ($B_{t+1} = B_t + E_{t+1} - d_{t+1}$).

The second implied COE measure, r_{GLS}, is developed by Gebhardt et al. (2001) and is frequently used in both accounting and finance studies. It is derived using explicit earnings forecasts for years t=1 and t=2, and assumes that return on equity fades to the industry median ROE from year t=3 to year t=12. A zero growth in residual earnings is assumed afterwards. The measure is estimated as an internal rate of return from the following valuation equation:

$$P_0 = B_0 + \sum_{\tau=1}^{11} \frac{(ROE_\tau - r_{GLS})B_{\tau-1}}{(1+r_{GLS})^t} + \frac{(IndROE - r_{GLS})B_{11}}{r_{GLS}(1+r_{GLS})^{11}} \qquad (r_{GLS})$$

where ROE_τ is expected future return on equity calculated as earnings per share forecast (E_τ) divided by the book value of equity per share at the end of the previous year ($B_{\tau\text{-}1}$); ROE_1 and ROE_2 are calculated using one- and two-year-ahead consensus earnings per share forecasts from *I/B/E/S* reported in June of year t+1; ROE_3 is computed by applying the long-term growth rate from *I/B/E/S* to the two-year-ahead consensus earnings per share forecast; beyond year t+3 ROE are assumed to fade to industry median ROE (*IndROE*) by year t+12.

The third implied COE measure, $r_{PEG,}$, is taken from Gode and Mohanram (2009). It is based on the abnormal earnings growth model (Ohlson and Juettner-Nauroth 2005) and assumes a zero abnormal earnings growth beyond year t+2. The measure is calculated as:

$$r_{PEG} = \sqrt{\frac{E_1}{P_0} g_2}, \quad g_2 = \frac{(E_2 / E_1 - 1) + Ltg}{2} \qquad (r_{PEG})$$

where P_0 is the stock price as of June of year t+1 from *I/B/E/S*; E_1 and E_2 are one- and two-year-ahead consensus earnings per share forecasts from *I/B/E/S* reported in June of year t+1; *Ltg* is the long-term earnings growth forecast from *I/B/E/S* reported in June of year t+1. This measure is a modified version of the Easton (2004) PEG measure, which assumes g_2=E_2/E_1.

Adjusting Analysts' Forecasts for Predictable Errors

Prior literature shows that analyst short-term earnings forecasts are systematically biased, with the direction and the extent of the bias correlated with various firm-year characteristics (e.g. Guay et al. 2005, Hughes et al. 2008). Using biased earnings forecasts as inputs in the valuation equation inevitably produces biased implied COE estimates (Easton and Sommers 2005). To mitigate the effect of the bias, we follow Gode and Mohanram (2009) and first adjust analyst forecasts for predictable errors and then re-compute the implied COE measures using the adjusted forecasts.[21,22]

We obtain predictable errors in earnings forecasts by first regressing realized forecast error in *k*-year-ahead earnings scaled by price ($FERR_k$, k = 1, 2, 3, and 4) on the forward earnings-to-price ratio, *EP*, long-term growth forecast, *Ltg*, change in gross PP&E, *CH_PPE*, trailing twelve-month stock return, Ret_{-12}, and the revision of one-year-ahead earnings forecast from the forecast made three months earlier, *REV*. The regressions are estimated annually based on the hold-out sample lagged by *k* years. The obtained coefficients are combined with variables in year *t* to estimate the predictable bias in *k*-year-ahead earnings forecasts. We then correct earnings forecasts for the

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[21] We would like to thank Partha Mohanram for sharing his forecast error adjustment codes with us.

[22] Hughes et al. (2008) suggest that the trading strategy based on exploiting predictable analyst forecast errors does not produce statistically significant returns, which is consistent with the market not being subject to the same biases as analysts. However, it is possible that in some instances the stock prices may incorporate earnings expectations biased in the same direction as analyst earnings forecasts. If this is the case, adjusting earnings forecasts for such predictable errors leads to implied COE estimates that do not represent the market's expectations of future returns, but instead are equal to the market's expectation of future returns plus the predictable return due to subsequent correction of the mispricing. The adjusted COE measure then represents the total COE that the firm faces due to both risk and mispricing. In our empirical analyses, we do not distinguish between the two interpretations of the implied COE.

predictable bias and calculate the adjusted COE and growth rate based on the corrected forecasts. The obtained COE and growth rates are labeled as "*adjusted*".

4. Empirical Analyses

Descriptive Statistics

Table 1, Panel A, reports descriptive statistics for our sample firms.[23] Consistent with other studies that use *I/B/E/S* analyst earnings forecasts, the firms in our sample are relatively large with the mean (median) market capitalization of $3,631 (541) million. The mean CAPM beta is 1.04 which is comparable to the beta of one for the market value-weighted portfolio.

The mean (median) of our COE estimate, r_{SE} (where *SE* stands for simultaneous estimation), is 8.4% (8.9%) and the mean (median) of our growth estimate, g_{SE} , is 0.5% (0.3%). Our COE estimates are somewhat lower than those based on the model with zero growth rate, GLS model, and PEG model (means 9.5%, 10.4%, and 11.1% respectively). When earnings forecasts are corrected for analyst forecast biases, COE estimates for all models decline suggesting that earnings forecasts were on average adjusted downwards to correct for the overall optimistic forecast bias.

Panel B of Table 1 presents means of by-year correlations among the COE estimates. The average correlations between unadjusted (adjusted) r_{SE} and r_{zero}, r_{GLS}, and r_{PEG} are 0.84, 0.71, and 0.53 (0.79, 0.61, and 0.43), respectively. The high correlation

[23] To avoid the influence of extreme observations, we winsorize all variables except future realized returns at the 1st and 99th percentiles.

between r_{SE} and r_{zero} reflects the fact that these COE measures are based on the same valuation model with identical inputs, except the terminal growth rate. Overall, correlations among all COE measures are positive and significant in all sample years, suggesting that they capture the same underlying construct.

Correlations between Implied COE and Firm Characteristics

In the approach following Botosan and Plumlee (2005) we verify that COE measures exhibit predictable associations with risk-related firm characteristics. Prior literature (e.g. Fama and French 1992, Carhart 1997) proposes several proxies for firm risk, including the CAPM beta (*Beta*), debt-to-equity ratio (*Leverage*), firm size (*LogSize*), book-to-market ratio (*B/M*), and momentum (prior twelve-month return, Ret_{-12}). It is worth noting that the validity of most of these risk characteristics is itself derived from their empirical associations with future realized returns, with ex-post rationalizations relying on modified asset-pricing models.[24] Therefore, we treat the evidence presented in this subsection as more descriptive in nature.

In addition to risk proxies, we examine the implied COE's association with the volatility of expected returns and cash flows. Hughes et al. (2009) show that, when expected returns are stochastic, the implied COE estimates deviate from expected returns. These deviations depend on the volatility of expected returns and cash flows. The lower is COE estimate's correlation with these volatilities – the lower the estimate's deviation from expected returns. We use analyst forecast dispersion in one-year-ahead earnings

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[24] The exceptions are the CAPM beta, which is derived from the equilibrium asset-pricing theory, and debt-to-equity ratio, which proxies for the differences is equity riskiness due to the degree of financial leverage (e.g. Hamada 1972). Note that if the CAPM represents a valid description of the world and the CAPM beta is measured without error, the explanatory power of leverage should be subsumed by the CAPM beta.

scaled by stock price, *Disp*, as a proxy for expected cash flow volatility, and the standard error of the estimate of the CAPM beta, σ_β, as a proxy for expected return volatility.[25]

Table 2 reports the results of pooled regressions of COE estimates on firm characteristics. The regressions include year fixed effects, and standard errors are clustered by firm and year (Petersen 2009). The associations between the benchmark COE measures and *Beta*, *Leverage*, *Size*, *B/M*, and *Disp* are generally consistent with those reported by Botosan and Plumlee (2005). Notably, all unadjusted COE measures are negatively related to past returns consistent with the sluggishness in analyst forecasts (Guay et al. 2005).[26] The adjusted COE measures, on the other hand, correlate positively with past returns reflecting the momentum effect in stock returns. The relation between our COE measure and firm characteristics is similar to those of other COE measures with the following exceptions. The relation between r_{SE} and *Beta* is negative, which is inconsistent with the single-period CAPM, but is in line with the negative insignificant coefficient in asset-pricing tests that use realized returns (Fama and French 1992; Petkova 2006; Core et al. 2008).[27] Both adjusted and unadjusted implied COE measures are correlated either with our proxy for the volatility of future cash flows, *Disp*, or with the proxy for the variability of future expected returns, σ_β. This result confirms the cautionary

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[25] In Hughes et al. (2009), the volatility of expected returns is reflected by the volatility of the firm's forward-looking beta, which we proxy by the standard error of the firm's historical beta.

[26] When analyst forecasts are sluggish, they do not incorporate the recent positive (negative) earnings news and are therefore biased downward (upward) following recent positive (negative) stock returns. The bias in forecasts mechanically leads to downwardly (upwardly) biased implied COE estimates following positive (negative) stock returns.

[27] The insignificant relation between the CAPM beta and stock returns was a key motivation for more elaborate asset-pricing models (Merton 1973; Jagannathan and Wang 1996; Lettau and Ludvigson 2001).

statement in Hughes et al. (2009) that it is important to control for the volatility measures in the empirical studies that use implied COE measures.

Overall, we find that our measure, r_{SE}, generally exhibits similar correlations with the risk characteristics when compared to benchmark implied COE measures. The results however need to be interpreted with caution because they depend on the construct validity of the risk characteristics.

Implied COE and Future Realized Returns

In this subsection, we employ a different approach to validating the implied COE measures by documenting their association with future realized returns (Guay et al. 2005; Easton and Monahan 2005; Gode and Mohanram 2009).

We first verify the out-of-sample predictive ability of the COE measures with respect to future stock returns by sorting sample firms into quintiles of the implied COE distribution at the end of June of each year. For each portfolio, we calculate the mean of buy-and-hold returns for the next twelve months. We then calculate hedge returns - the difference in returns between the top (Q5) and bottom (Q1) quintiles of implied COE. Their significance is evaluated using Fama-MacBeth *t*-statistics with the Newey-West autocorrelation adjustment.

Figure 1 plots the time-series means of portfolio returns. The numbers next to the 'Q5-Q1' labels refer to the magnitude of hedge returns. Panel A reports returns by portfolios based on unadjusted COE measures. Our measure, r_{SE} , exhibits a strong monotonic relation with future realized returns. The difference in returns between the top and bottom quintiles, Q5-Q1, is equal to 6.5% (statistically significant at the 5% level). In contrast, the predictive ability of r_{GLS} and r_{PEG} is weak. The hedge returns, Q5-Q1, are only 3.8% (0.01%) for r_{GLS} (r_{PEG}) and not statistically significant. Predictive ability of the benchmark zero-growth measure, r_{zero}, is weaker than that of our measure, producing a marginally significant hedge return of 5%.

Panel B reports returns by portfolios based on COE measures adjusted for forecast errors. Performance of all COE measures is markedly improved, with our measure still performing best. The hedge return, Q5-Q1, increases to 9.3%, 7.1%, 6.8%, and 4.5% for r_{SE}, r_{zero}, r_{GLS}, and r_{PEG} respectively, and is uniformly statistically significant at least at the 5% level. Overall, our COE measure produces more significant return differences than the benchmark models both with and without adjustments for analyst forecast errors.

Having established that our measure has significant predictive ability with respect to future stock returns at the portfolio level, we turn to regression analysis to, first, explore its predictive ability at the individual firm level, second, establish whether its predictive ability is incremental to that of other COE measures, and third, shed some light on the source of its predictive ability.

First, we investigate return predictive ability of individual COE measures at the firm level. Panel A of Table 3 reports the results of cross-sectional regressions of future one-year stock returns on the COE measures. Each slope coefficient has two corresponding *t*-statistics reflecting how significantly different the coefficient is from zero and one. The slope on a valid COE measure should be significantly different from zero, and not significantly different from one. Consistent with the evidence from Figure 1, our measure, r_{SE}, is significantly related to future stock returns, and the regression coefficient is statistically indistinguishable from one. None of the other measures unadjusted for analyst forecast biases performs as well – their slopes are not statistically significant. After the forecast bias adjustment, the slopes increase for all measures and become (remain) significantly positive and indistinguishable from one for r_{zero} and r_{GLS} (r_{SE}). The slope on r_{PEG}, although positive, is still not significant, which is in contrast to portfolio-level tests from Figure 1.

Next, we examine the incremental explanatory power of r_{SE} and the benchmark COE measures relative to each other by regressing future realized returns on the pairs of COE measures. Although we continue to report two sets of *t*-statistics for the slope coefficients, we no longer expect the coefficient on r_{SE} to be statistically indistinguishable from one. The results are reported in Panel B of Table 3. Both unadjusted and adjusted r_{SE} have significant explanatory power after controlling for r_{zero}, r_{GLS}, or r_{PEG}. However, neither of the benchmark COE is significant after controlling for r_{SE}. Therefore, it appears that r_{SE} subsumes the predictive power of other COE measures.

Finally, we provide evidence on the relative importance of the two information sources underlying our measure, r_{SE}. Recall that r_{SE} is estimated to (1) most accurately fit the risk profile (i.e. risk characteristics) of the company, and (2) minimize the residual COE that is due to unobservable risk sources. Next, we control for the observable risk characteristics to assess the validity of our measure beyond proxying for the risk profile of the company.[28] Panel C of Table 3 regresses realized returns on COE proxies after

[28] In supplementary analyses, we verify that the risk and growth drivers combined in a simple statistical prediction model do not predict future returns. Specifically, we estimate cross-sectional regressions of one-year stock returns on the lagged risk and growth drivers for a one-year holdout period *t*-1. The obtained coefficients are combined with risk and growth drivers at time *t* to come up with a statistical forecast of *t*+1 realized returns. The results (untabulated) suggest that such simple statistical return prediction model is unable to forecast future returns. When realized returns are regressed on the statistical forecasts, the coefficients on the statistical forecasts are not statistically significant.

controlling for *Beta*, Size, *B/M*, and past stock returns. The results show that the slopes on both adjusted and unadjusted r_{SE} remain statistically significant. That confirms the construct validity of our measure beyond simply capturing the observable risk profile of the company.[29]

Overall, the results in Figure 1 and Table 3 demonstrate that our COE measure is significantly positively associated with future realized returns. Furthermore, it contains information about firms' expected returns that is not captured by the CAPM beta, firm size, book-to-market ratio, past stock returns, as well as other implied COE measures.

Implied Growth Rates and Future Realized Earnings Growth

In this subsection, we validate the implied growth rates by documenting their association with future realized growth in earnings.

From Section 3, the implied growth rate captures expected growth in four-year cum-dividend residual earnings from period *t*+4 onwards. The direct validation test would involve correlating the implied growth rates with earnings growth from *t*+4 to perpetuity. Such test is infeasible in practice. Accordingly, we estimate growth in four-year cum-dividend earnings[30] from [*t*, *t*+4] to [*t*+5, *t*+8] as:

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[29] In additional analyses (untabulated), we find that our COE measure, both before and after adjustment for analyst forecast errors, remains significantly positively associated with future realized returns even when both the benchmark COE measures and risk characteristics are included as control variables..

[30]A more direct validation requires estimating realized growth in residual earnings. We choose not to use growth in residual earnings in our main tests for two reasons. First, if our implied growth and COE estimates are correlated, using our COE estimate to calculate realized residual earnings may cause the latter to be spuriously correlated with our implied growth estimate. Second, when we use risk-free rates to calculate realized residual earnings, over 50% of cumulative residual earnings before extraordinary items (EBEI) over the first four years are negative and thus cannot be used as a base to estimate growth. Percentage of negative observations is lower when operating income before depreciation (OI) is used to

$$GR_{t+4,t+8} = X_{t+8}^{cumd} / X_{t+4}^{cumd} - 1,$$

where $X_T^{cumd} = \sum_{t=T-3}^{T} E_t + \sum_{t=T-3}^{T-1} ((1+r)^{4-t} - 1)d_t$, E_t is realized earnings for year *t*, d_t is dividends declared in year *t*, and *r* is the rate of return at which the dividends are reinvested. For the rate of return, we use the risk-free rate at period *t*.[31] The realized earnings are either earnings before extraordinary items (*EBEI*), or operating income before depreciation (*OI*). Earnings before extraordinary items corresponds more directly to earnings underlying our predicted long-term growth, however it is frequently negative or small causing problems when used in the denominator. Calculating growth using operating income before depreciation mitigates this problem.

Table 4, Panel A contains the descriptive statistics for the growth rates in four-year cum-dividend earnings growth rates. The mean (median) growth rates are 0.48 (0.30) for *EBEI* and 0.52 (0.32) for *OI*. These growth rates can be interpreted as a geometric average growth over four years, and they correspond to annualized rates of 10% (7%) for *EBEI* and 11% (7%) for *OI*.[32]

Figure 2, Panel A plots mean growth rates by quintiles of implied growth measure. Casual observation suggests a positive association between the implied and

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estimate residual earnings. Accordingly, we replicate analyses presented in this subsection using growth in residual OI, and produce a similar set of results (untabulated).

[31] By using a risk-free rate we avoid spurious correlations with implied growth rates that could arise had we used previously estimated implied COE estimates. The results are robust to using a uniform 10% rate as in Penman (1996), or a 0% rate that assumes no reinvestment of dividends.

[32] We do not use annualized growth rates in the analysis because we cannot annualize four-year growth rates that are less than negative 100%.

realized growth rates, with the exception of unadjusted implied growth being used to predict growth in *OI*.

This observation is formally confirmed in regression analysis. Specifically, we regress realized growth rates on the quintile rank of unadjusted (adjusted) implied growth rate. The regressions use a pooled sample, with time fixed effects and standard errors clustered by firm and year. The results are reported in Panels B and C of Table 4. The coefficients on the ranks of unadjusted (adjusted) implied growth rate are 0.122 (0.098) and 0.026 (0.060) when predicting growth in *EBEI* and growth in *OI*, respectively. These slope coefficients multiplied by four can be interpreted as average differences in four-year earnings growth between the extreme quintiles of implied growth. The differences in four-year growth rates are, therefore, 48.8% (39.2%) and 10.4% (24%). On the annualized basis, these differences in growth rates correspond to 10.4% (8.6%) and 2.5% (5.5%), respectively. All slope coefficients, except the slope in the regression of *OI* growth on unadjusted implied growth, are statistically significant at the 1% level. Overall, we find that our implied growth measure is a statistically and economically significant predictor of future growth in earnings.

Next, we investigate whether the implied growth rates retain the ability to predict future realized growth after controlling for the growth drivers used in the estimation of implied growth. For that purpose, we regress future realized growth rates on the quintile rank of implied growth estimates, $R(g_{SE})$, and control variables – analysts' predicted earnings growth, *Ltg*, deviation of firm's ROE from industry's ROE, *dIndROE*, and a ratio of R&D expenses to sales, *RdSales*. The results reported in Panels B and C of Table 4 suggest that predictive ability of the implied growth measure derives entirely from the growth drivers – none of the coefficients on ranked implied growth remains statistically significant after controlling for growth characteristics.

Given that the growth drivers (ex post) fully explain the implied growth's predictive ability, we next investigate whether a simple statistical model based on the same growth drivers is equally successful in predicting earnings growth. Each year *t*, we use a hold-out sample lagged by eight years to regress past realized four-year cum-dividend earnings growth rates ($GR_{t\text{-}4,t}$) on the earnings growth drivers (*Ltg*, *dIndROE*, and *RdSales*) from year *t*-8. We then combine the obtained coefficients with growth drivers from year *t* to calculate a statistical predictor of future growth in four-year cum-dividend earnings ($pGR_{t+4,\ t+8}$).

Panels D and E of Table 4 report regressions of realized growth rates on the quintile ranks of both implied and statistically predicted growth. Figure 3 plots average realized growth rates by quintiles of statistically predicted growth. Due to the hold-out sample requirements, these regressions are based on the 1987 – 2001 sample period. For this period, the implied growth measure exhibits a stronger predictive ability – the coefficients on $R(g_{SE})$ are higher than in Panels B and C of Table 4, and significant at least at the 1% level. The implied growth measure retains incremental predictive ability after controlling for the statistical predictors. Moreover, it subsumes predictive ability of the latter with respect to future growth in *EBEI*. Importantly, statistical predictors of growth seem to be "fitted" to a specific earnings measure. Namely, statistically predicted growth in *OI* (*EBEI*) has no power in predicting growth in *EBEI* (*OI*). The above evidence, combined, suggests that while it is possible to predict future realized growth in earnings statistically, the statistical growth measures need to be "fitted" to a specific earnings metric and they do not perform as well as the implied growth at predicting growth in bottom-line earnings. The implied growth measure, on the other hand, provides universal predictive ability, regardless of earnings definition, and contains information beyond simple statistical predictors.

Overall, the implied growth rates are predictive of future long-term growth in earnings. Although the predictive ability of implied growth is derived entirely from the growth drivers, estimating implied growth rate from our model is superior to combining growth drivers using a simple statistical model. The analyses in this subsection are, however, subject to an inherent survivorship bias, which is unavoidable when measuring growth over long horizons. We further investigate the effects of the bias in our robustness check section (Section 5).

Comparison between Our Measure and GLS Measure

Results in Tables 3 and 4 show that our COE measure surpasses the benchmark COE measures in predicting future returns over a broad cross-section of firms. A natural question then arises: when does our measure perform especially well relative to commonly used measures, such as r_{GLS}?[33] In other words, when does r_{GLS} fail to predict future returns but our measure succeeds. A key assumption of the GLS model is that the firm's ROE converges to the industry average ROE. For firms where this assumption is a good approximation of expected growth, the GLS model is expected to perform well. In contrast, for firms that are so different from other firms in the industry that their ROE is not expected to converge to the industry ROE, the GLS model is expected to perform

[33] Although, both r_{GLS} and r_{PEG} are widely used in the literature, we chose to examine r_{GLS} because the predictive ability of this measure significantly exceeds that of the r_{PEG} in our sample.

relatively poorly. One of the well known predictors of future firm ROE, besides the industry ROE, is the book-to-market ratio. Firms with high book-to-market ratios tend to have low future ROE, while firms with low book-to-market – high future ROE (Fairfield 1994; Fama and French 1995). If a firm's book-to-market ratio is very different from that of the industry, the industry ROE may not be a good predictor of the firm's future ROE. Therefore, we expect r_{GLS} to perform relatively poorly when the difference between the firm and industry book-to-market ratios is large.

Table 7 examines the association between r_{GLS} and future stock returns for portfolios based on the difference between the firm's and industry's *B/M* ratios. The difference in stock returns between the top and bottom quintiles of r_{GLS} is significant only for the middle (third and fourth) quintiles, and insignificant for the top and bottom quintiles. Therefore, as predicted, r_{GLS} has a strong association with future returns only when the firm's *B/M* is relatively close to the industry's *B/M*, and fails to predict future returns when the difference between the firm's and the industry's *B/M* is relatively large. In contrast to GLS, our COE measure is a significant predictor of future returns across all quintiles of the difference between the firm's and the industry's ROEs. Therefore, the results in Table 5 confirm that our measure is more accurate than the GLS measure when the long-term growth rates assumed in the GLS model are likely to be inaccurate.

Comparison with ETSS: Average COE and Growth Rate

As discussed in Section 2, the ETSS method allows simultaneously estimating *average* COE and expected growth rates for the cross-section of firms. One of the main findings in ETSS is that their average COE estimate is significantly higher than the average COE estimates from the prior models. As mentioned in Section 2, our *average*

COE and long-term growth estimates may deviate from those in ETSS because our model explicitly incorporates the known risk and growth drivers. In this subsection, we document the average levels of the implied COE and long-term growth rates obtained using our model.

Table 6 compares the average estimates produced by our model to those produced by ETSS model. Panel A reports by-year means of the COE and expected earnings growth, *Gearn*, estimates as well the average of the yearly means.[34] Our model yields notably lower COE and earnings growth estimates than the ETSS model. When using the ETSS model, the average COE is 11.7% (9.7%) and growth rate is 9.7% (7.4%) before (after) correction for analyst forecast errors. The corresponding values produced by our model are 9% (7.6%) and 6.7% (5.2%) before (after) adjustment for analyst forecast errors. Both our and ETSS' growth estimates are greater than the average historical earnings growth rate for the US market of around 3.2% per annum[35], with our estimates being closer to the historical rate.

Using the average risk-free rate (proxied by the yield on five-year government *t*-Bonds) of 7.22% for our sample period, the average implied risk premium from ETSS model is 4.43% (2.50%) compared to 2.50% (0.34%) from our model before (after) correction for analyst forecast errors.[36] Although the average risk premium for our model

[34] To obtain growth in earnings from growth in residual earnings, we use the formula derived in the appendix in ETSS. Since we assume a constant future dividend payout while ETSS assume constant future dividends, we adjust the formula to make it consistent with our assumption.

[35] The estimate of the average historical rate is based on the data for aggregate nominal earnings of the S&P 500 firms from 1871 to 2009 provided by Robert Shiller at http://www.econ.yale.edu/~shiller/data/ie_data.xls.

[36] Risk premia are often measured relative to the rate on one-month treasury bill. Based on this measure of the risk free rate, the average implied risk premium from ETSS model is 5.82% (3.89%) compared to 3.89% (1.17%) from our model before (after) correction for analyst forecast errors.

is significantly lower than the historical premium based on realized returns, it is consistent with the low implied risk premia documented by prior studies (Claus and Thomas 2001; Gebhardt et al. 2001). Moreover, lower estimates of COE are consistent the finding in Hughes et al. (2009) that, under stochastic expected returns, the implied COE is lower than the expected return.[37]

Overall, the results provide evidence consistent with our modifications to the ETSS method improving the accuracy of average implied COE and growth measures. These results, however, need to be interpreted with caution given the lack of reliable benchmarks of market risk premia and expected earnings growth rates against which model estimates can be judged.

5. Robustness Tests

Easton and Monahan Tests of Construct Validity of COE measures

A valid COE proxy should be positively associated with future *expected* stock returns. Our validation tests based on realized returns implicitly assume that realized stock returns on average are equal to expected returns. This assumption may not hold in finite data samples. For example, Elton (1999) argues that historical realized returns deviate from expected returns over long periods of time due to non-cancelling cash flow or discount rate shocks.

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[37] Hughes et al. (2009) provide a ball-park estimate of the difference between expected returns and implied cost of capital of 2.3%. They note that the actual difference can be larger.

To address this limitation of realized returns-based tests, Easton and Monahan (2005) propose a method that directly evaluates the association of COE measures with future expected returns by controlling for future cash flow and discount rate shocks in the realized returns – COE regressions.[38]

In this subsection, we conduct the Easton and Monahan tests for our implied COE measures. The tests consist of two parts. The first part involves regressing the log of one-year-ahead stock returns on the log of the COE measure (proxy for expected return) and the log of proxies for cash flow news and discount rate news received over the following year. The coefficient on the valid COE measure should not statistically differ from one. The second part involves calculating implied measurement errors for the COE estimates, using a modified Garber and Klepper (1980) approach.

Table 7 reports the results of Easton and Monahan tests, where Panel A (Panel B) pertains to unadjusted (adjusted) COE measures. To avoid spurious over-time correlations between the realized returns and COE measures, as well as inflated *t*-statistics, we use Fama-MacBeth approach and estimate cross-sectional regressions by year. The mean of the by-year regression coefficients on the valid expected return proxy (*LOG_ER*) should be statistically indistinguishable from one. We find that none of the unadjusted COE measures in Panel A meets that threshold—the regression coefficients on all COE measures are significantly negative. In contrast, Panel B reports that three COE measures adjusted for analyst forecast errors, including our measure, r_{SE}, as well as r_{zero} and r_{PEG} have regression coefficients close to one. One caveat in interpreting these

[38] The Easton and Monahan (2005) test has proven to be a high bar for estimating construct validity of COE measures. Most conventional implied COE measures are negatively correlated with realized stock returns after controlling for cash-flow and discount-rate news and have significant measurement error.

results is that the COE proxies as well as cash flow and discount rate news proxies can be measured with error. In case these errors are correlated, the regression coefficients can no longer be interpreted at the face value.

The second part of the Easton and Monahan tests addresses the aforementioned issue of correlated measurement errors. Specifically, Easton and Monahan construct a statistic for the extent of the measurement error in the COE proxy that controls for correlation in the measurement errors across the three variables in the regression. We report this statistic ("modified noise variable") in the last column of both Panels A and B in Table 7. The results show that our implied COE measure, r_{SE}, has the lowest measurement error across all unadjusted (adjusted) COE measures.

To summarize, the Easton and Monahan tests of construct validity suggest the following. First, the tests unambiguously establish construct validity of our COE measure adjusted for analyst forecast errors, while our unadjusted COE measure exhibits a negative association with future expected returns (possibly due to correlated measurement errors in cash flow and discount rate news proxies). Second, among all COE measures adjusted (unadjusted) for analyst forecast errors, our measure exhibits the lowest degree of measurement error.

Future Realized Earnings Growth and Survivorship

The growth rates used in validation of implied growth rates are estimated only for the firms that survive over the [t+1, t+8] period. Next, we explore the effects that sample attrition may have on our implied growth validation tests.

Panel A of Figure 3 plots percentage firms for which realized growth in either *EBEI* or *OI* is unavailable. Clearly, percentage of firms leaving the sample ("non-survivors") is higher within higher quintiles of implied growth. For example, growth in *OI* cannot be estimated for 51% of firms within the highest quintile of unadjusted implied growth versus 37% within the lowest quintile.[39] To the extent that "non-survivors" would have had lower realized growth rates, the growth rate estimates are systematically biased upwards, and the degree of bias is higher for the higher quintiles of implied growth.

To investigate the extent of possible bias, we first classify "non-survivors" by reasons for leaving the sample. For that purpose, we use CRSP classification of stock delistings from exchanges. The main categories of delistings are: mergers or stock exchanges, bad performance (such as bankruptcy or liquidation), and other miscellaneous reasons (such as switching to a different exchange or going private). The bad performance-related category is classified following Shumway (1997). Panel B of Figure 3 reports a percentage of firms delisted within eight years following implied growth estimation by quintiles of implied growth measures.[40] The evidence from the figure suggests that the main reason for sample attrition is related to mergers. Mergers are also the biggest source of higher sample attrition for the firms in the higher implied growth quintiles. For example, the difference in delistings percentage between the top and the bottom quintiles of unadjusted (adjusted) implied growth is 7.6% (8.8%) for merger-related delistings versus 0.7% (3%) for bad performance-caused delistings.

Using the above classification results, we perform a robustness test after substituting the missing realized earnings growth rates for non-surviving firms with

[39] The sample attrition for the growth in *EBEI* is higher than for *OI* due to the previously discussed issues with negative growth base (i.e. negative four-year cum-dividend earnings for [t+1, t+4]).

[40] Note, that the percentages of delisted firms do not add up to the total percentage of "non-survivors" from Panel A of Figure 3. The difference is due to the cases where earnings are available, but the growth cannot be computed due to negative four-year cum-dividend earnings for [t+1, t+4].

plausible ad-hoc estimates. Arguably, a firm that goes bankrupt has a relatively lower realized earnings growth compared to a firm that undergoes a merger. Accordingly, as our first robustness check we substitute the missing [*t*+4, *t*+8] earnings for firms with bad performance-related delistings with a negative book value of equity at *t*+4. Such substitution assumes that equity becomes entirely worthless after the delisting, which is a conservative assumption. We re-run the analyses from Table 5, Panels B and C using substituted growth rates. The results are presented in Table 9, Panel A. Both the unadjusted and adjusted implied growth quintiles are positively and significantly associated with future realized growth in *OI*, while unadjusted implied growth quintiles are positively associated with future realized growth in *EBEI*.

Further, we explore robustness of the above regressions to making an additional assumption of a zero growth rate for firms delisting due to mergers. Note, that this is a conservative assumption. Zero represents the 26^{th} (34^{th}) percentile of *OI* (*EBEI*) growth distribution. Regression results after performing this substitution are presented in Panel B of Table 9. Despite the conservative growth assumptions, unadjusted (adjusted) implied growth rate quintiles are positively and significantly associated with the realized growth in *EBEI* (*OI*).

Overall, survivorship bias is a serious concern for the implied growth validity tests. However, our robustness tests suggest that our results are unlikely entirely explained by such bias.

6. Conclusion

The implied COE has recently gained significant popularity as evidenced by the growing body of research employing this measure. Despite its theoretical and practical appeal, the implied COE, as any other valuation model output, is only as good as the model inputs.[41] In particular, the implied COE is sensitive to the assumption about the expected earnings growth rate. In this study, we propose a new method of estimating COE that avoids relying on ad-hoc assumptions about long-term growth by estimating the growth rate *implied in the data*.

Our estimation method follows the work by Easton, Taylor, Shroff, and Sougiannis (2002), who simultaneously estimate sample averages for COE and expected growth in earnings. The two assumptions that allow us to estimate firm COE and expected growth are that each company has a unique risk-growth profile that can be proxied by the firm's characteristics, and that parsimonious measures of risk and growth should allow minimal deviations from such risk-growth profiles.

We validate our COE and growth estimates by examining their association with future stock returns and realized earnings growth, respectively. We find that our COE measure has a significant out-of-sample predictive ability with respect to future returns, which subsumes predictive ability of other commonly used COE measures. At the same time, our expected growth measure is significantly associated with the future long-term

[41] The other two commonly used approaches to estimating COE (multiplying historical estimates of factor risk premia on historical factor loadings, and using ex-post realized returns) have their own merits and demerits. The first, approach is problematic given the ongoing debate about the appropriate asset pricing model and substantial measurement errors in the estimates of factor risk premia and risk loadings (Fama and French 1997). The second approach requires a very large sample spanning dozens of years (and is therefore often not available to the researcher), since more risky stocks can underperform less risky stocks for multi-year periods (Elton 1999). Also, ex-post returns approach does not allow estimating the (ex-ante) COE in real time necessary for capital budgeting and other decisions.

earnings growth. These associations are robust to controlling for various risk and growth drivers. Therefore, both the COE and the long-term growth measures appear to have construct validity.

In addition to firm-level analysis, we provide new evidence on the market-level risk premia and the growth rate implied by stock prices and earnings forecasts. Our estimates are significantly lower than those documented in ETSS, and are in line with the low implied risk premia suggested by theoretical research (Mehra and Prescott 1987) and documented in prior studies using implied COE measures (Claus and Thomas 2001).

References

Botosan, C., and M. Plumlee. 2005. Assessing alternative proxies for the expected risk premium. *The Accounting Review* 80 (1): 21-53.

Carhart, M. 1997. On persistence in mutual fund performance. *Journal of Finance* 52: 57-82.

Chan, L.K.C, J. Karceski, and J. Lakonishok. 2003. The level and persistence of growth rates. The Journal of Finance 58 (2): 643-684.

Chava, S., and A. Purnanadam. 2010. Is default risk negatively related to stock returns? Review of Financial Studies 23 (6): 2523-2559.

Claus, J., and J. Thomas. 2001. Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stock market. *Journal of Finance* 56 (5): 1629-66.

Core, J., W. Guay, and R. Verdi. 2008. Is accruals quality a priced risk factor? *Journal of Accounting and Economics*, 46 (1) 2-22.

Damodaran, A. 2002. Damodaran on valuation. Second Edition. John Wiley & Sons, Inc. New York.

Dhaliwal, D., L. Krull, O. Li, and W. Moser. 2005. Dividend taxes and implied cost of capital. *Journal of Accounting Research* 43, 675–715.

Easton, P. 2004. PE ratios, PEG ratios, and estimating the implied expected rate of return on equity capital. *The Accounting Review* (January): 73-95.

Easton, P. 2006. Use of forecasts of earnings to estimate and compare cost of capital across regimes. *Journal of Business Finance and Accounting* 33 (3) 374-394.

Easton, P. 2007. Estimating the cost of capital implied by market prices and accounting data. *Foundations and Trends in Accounting* 2 (4) 241-346.

Easton, P., and G. Sommers. 2007. Effect of analysts' optimism on estimates of the expected rate of return implied by earnings forecasts. *Journal of Accounting Research* 45 (5): 983-1015.

Easton, P., and S. Monahan. 2005. An evaluation of accounting-based measures of expected returns. *The Accounting Review* 80 (2): 501-538.

Easton, P., G. Taylor, P. Shroff, and T. Sougiannis. 2002. Using forecasts of earnings to simultaneously estimate growth and the rate of return on equity investment. *Journal of Accounting Research* 40 (3): 657-676.

Elton, J. 1999. Expected return, realized return and asset pricing tests. *Journal of Finance* 54: 1199-1220.

Fairfield, P. M. 1994. P/E, P/B and the present value of future dividends. *Financial Analysis Journal* July–Aug: 23–31.

Fama, E., and J. MacBeth. 1973. Risk, return, and equilibrium: empirical tests. *Journal of Political Economy* 81: 607–636.

Fama, E., and K. French. 1992. The cross-section of expected stock returns. *Journal of Finance* 47 (2): 427-465.

Fama, E., and K. French. 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* 33 (1): 3-56.

Fama, E., and K. French. 1995. Size and book-to-market factors in earnings and returns. *Journal of Finance* 50 (1): 131-155.

Fama, E., and K. French. 1997. Industry costs of equity. *Journal of Financial Economics* 43 (2): 153-193.

Feltham, G., and J. Ohlson. 1995. Valuation and clean surplus accounting for operating and financial activities. *Contemporary Accounting Research* 11 (2): 689-731.

Francis, J., R. LaFond, P. Olsson, and K. Schipper. 2004. Costs of capital and earnings attributes. *The Accounting Review* 79, 967–1011.

Garber, S. and S. Klepper, 1980. "Administrative pricing" or competition coupled with errors of measurement? *International Economic Review* 21: 413-435.

Gebhardt, W., C. Lee, and B. Swaminathan. 2001. Towards an ex-ante cost of capital. *Journal of Accounting Research* 39 (1): 135-176.

Gode, D. and P. Mohanram. 2003 Inferreng the cost of capital using the Ohlson-Juettner model. *The Review of Accounting Studies*, 8, 399-431.

Gode, D. and P. Mohanram. 2009. Improving the Relationship between Implied Cost of Capital and Realized Returns by Removing Predictable Analyst Forecast Errors. Working paper, New York University and Columbia University. The paper is available at http://w4.stern.nyu.edu/emplibrary/092208_gode-mohanram.pdf.

Guay, W., S. Kothari , and S. Shu. 2005. Properties of implied cost of capital using analysts' forecasts. Working paper, University of Pennsylvania, Massachusetts Institute of Technology, and Boston College.

Hail, L. and C. Leuz. 2006. International differences in the cost of equity capital: Do legal institutions and securities regulation matter?. *Journal of Accounting Research* 44, 485–532.

Hamada, R. 1972. The effect of the firms' capital structure on the systematic risk of common stocks. *Journal of Finance* 27 (2): 435-452.

Hou, K., M. A. van Dijk, and Y. Zhang. 2010. The implied cost of capital: a new approach. Working paper.

Hribar, P. and N. Jenkins. 2004. The effect of accounting restatements on earnings revisions and the estimated cost of capital. Review of Accounting Studies 9, 337–356.

Huang, R., R. Natarajan, and S. Radhakrishnan. 2005. Estimating firm-specific long-term growth rate and cost of capital. Working paper, University of Texas at Dallas.

Hughes, J. Liu, and J. Liu. 2009. On the relation between expected returns and implied cost of capital. *Review of Accounting Studies* 14: 246-259.

Hughes, J., J. Liu, and W. Su. 2008. On the Relation between Predictable Market Returns and Predictable Analyst Forecast Errors. *Review of Accounting Studies* 13: 266-291.

Jagannathan, R., and Z. Wang. 1996. The conditional CAPM and the cross-section of expected returns. *Journal of Finance* 51: 3-53.

Lee, C., D. Ng, and B. Swaminathan, 2009, "Testing international asset pricing models using implied costs of capital," *Journal of Financial and Quantitative Analysis* 44, 307-335.

Lettau, M., and S. Ludvigson. 2001. Consumption, aggregate wealth, and expected stock returns. *Journal of Finance* 56 (3): 815-849.

Mehra, R, and E. C. Prescott. 1985. The equity premium: a puzzle. *Journal of Monetary Economics* 15 : 145–161.

Merton, R. 1973. An intertemporal capital asset pricing model. *Econometrica* 41 (5): 867–887.

Newey, W., and K. West. 1987. A simple, positive semi-definite heteroscedasticity and autocorrelation consistent covariance matrix. *Econometrica* 55: 703-708.

Ogneva, M., K. R. Subramanyam, and K. Raghunandan. 2007. Internal control weakness and cost of equity: Evidence from SOX section 404 disclosures. *The Accounting Review* 82 (October), 1255–1298.

Ohlson, J. 1995. Earnings, book values, and dividends in security valuation. *Contemporary Accounting Research* 11 (2): 661-687.

Ohlson, J. and B. Juettner-Nauroth. 2005. Expected EPS and EPS growth as determinants of value. *Review of Accounting Studies* 10(2–3): 349–365.

Pastor, L., M. Sinha, and B. Swaminathan, 2008, "Estimating the Intertemporal Risk-Return Tradeoff Using the Implied Cost of Capital", *The Journal of Finance* 63(6), 2859-2897

Penman, S. 1996. The articulation of price-earnings ratios and market-to-book ratios and the evaluation of growth. Journal of Accounting Research 34 (2): 235-259.

Penman, S. 2009. Financial Statement Analysis and Security Valuation. Fourth Edition. McGraw-Hill Irwin, New York.

Penman, S., Zhang, X. 2002. Accounting Conservatism, the Quality of Earnings, and Stock Returns. *The Accounting Review* 77: 237-264.

Petersen, M. 2009. Estimating standard errors in finance panel data sets: Comparing approaches. *Review of Financial Studies* 22 (1): 435-480.

Petkova, R., 2006. Do the Fama–French factors proxy for innovations in predictive variables? *Journal of Finance* 61, 581–612.

Pratt, S. P. and A.V. Niculita. 2007. Valuing a Business: The Analysis and Appraisal of Closely Held Companies. Fifth edition. McGraw-Hill.

Shumway, T. 1997. The delisting bias in CRSP data. *Journal of Finance* 52: 327–340.

Whalen, J., S. Baginski, M. Bradshaw. 2010. Financial reporting, financial statement analysis, and valuation. Seventh Edition. South-Western Centage Learning, Mason.

Zhang, X. J. 2000. Conservative Accounting and Equity Valuation. *Journal of Accounting and Economics* 29: 125-149.

Appendix

Simultaneous Estimation of COE and Long-Term Growth

In this appendix, we derive expressions for firm COE and growth rate. Combining equation (3b) with assumption (4) from Section 2 yields the following system of equations:

$$\begin{cases} \underset{\varepsilon_R^i,\varepsilon_G^i,\varepsilon^i,\gamma_0,\gamma_1,\lambda_R,\lambda_G}{Min} \sum_i w_1^i(\varepsilon_R^i)^2 + w_2^i(\varepsilon_G^i)^2 \\ s.t.\ X_{cT}^i / B_0^i = \gamma_0 + \gamma_1 MB^i + \varepsilon^i \\ \varepsilon^i = (G^i - \overline{G})(1 - MB^i) + (R^i - \overline{R})MB^i \\ \gamma_0 = \overline{G} - 1 \\ \gamma_1 = \overline{R} - \overline{G} \\ R^i = \overline{R} + \lambda_R x_R^i + \varepsilon_R^i \\ G^i = \overline{G} + \lambda_G x_G^i + \varepsilon_G^i \end{cases} \quad (A1)$$

Next, we simplify the problem in (A1) so that it can be solved using standard regression analysis. Substituting the expressions for ε^i, R^i, and G^i into the second equation in (A1) and defining $\nu^i = \varepsilon_G^i + (\varepsilon_R^i - \varepsilon_G^i)MB^i$, we express the above system of equations as follows:

$$\begin{cases} \underset{\varepsilon_R^i,\varepsilon_G^i,\nu^i,\gamma_0,\gamma_1,\lambda_R,\lambda_G}{Min} \sum_i w_1^i(\varepsilon_R^i)^2 + w_2^i(\varepsilon_G^i)^2 \\ \text{s.t.} \quad X_{cT}^i / B_0^i = \gamma_0 + \gamma_1 MB^i + \lambda_R MB^i x_R^i + \lambda_G(1 - MB^i)x_G^i + \nu^i \\ \nu^i = \varepsilon_G^i + (\varepsilon_R^i - \varepsilon_G^i)MB^i \end{cases} \quad (A2)$$

Substituting $\varepsilon_G^i = (\varepsilon_R^i MB^i - \nu^i)/(MB^i - 1)$ from the last equation, we obtain

$$\begin{cases} \underset{\varepsilon_R^i,\nu^i,\gamma_0,\gamma_1,\lambda_R,\lambda_G}{Min} \sum_i w_1^i(\varepsilon_R^i)^2 + w_2^i((\varepsilon_R^i MB^i - \nu^i)/(MB^i - 1))^2 \\ \text{s.t.} \quad X_{cT}^i / B_0^i = \gamma_0 + \gamma_1 MB^i + \lambda_R MB^i x_R^i + \lambda_G(1 - MB^i)x_G^i + \nu^i \end{cases} \quad (A3)$$

Finally, substituting the expression for ε_R^i that satisfies the first order conditions, $\varepsilon_R^i = w_2^i MB^i \nu^i / (w_1^i (MB^i - 1)^2 + w_2^i (MB^i)^2)$, we obtain the following weighted least square regression:

$$\begin{cases} \underset{\nu^i, \gamma_0, \gamma_1, \lambda_R, \lambda_G}{Min} \sum_i \dfrac{w_1^i w_2^i (\nu^i)^2}{w_1^i (1 - MB^i)^2 + w_2^i (MB^i)^2} \\ \text{s.t.} \quad X_{cT}^i / B_0^i = \gamma_0 + \gamma_1 MB^i + \lambda_R MB^i x_R^i + \lambda_G (1 - MB^i) x_G^i + \nu^i \end{cases} \tag{A4}$$

Combining equations (A4) with the above expressions for $\overline{R}$, $\overline{G}$, ε_R^i, ε_G^i, R^i, and G^i, we have the following WLS regression and equations that uniquely determine firm COE and expected growth rate:

$$\begin{cases} \underset{\nu^i, \gamma_0, \gamma_1, \lambda_R, \lambda_G}{Min} \sum_i \dfrac{w_1^i w_2^i (\nu^i)^2}{w_1^i (1 - MB^i)^2 + w_2^i (MB^i)^2} \\ s.t. \; X_{cT}^i / B_0^i = \gamma_0 + \gamma_1 MB^i + \lambda_R MB^i x_R^i + \lambda_G (1 - MB^i) x_G^i + \nu^i \\ \overline{G} = \gamma_0 + 1 \\ \overline{R} = \gamma_1 + \gamma_0 + 1 \\ \varepsilon_R^i = \nu^i \dfrac{w_2^i MB^i}{w_1^i (MB^i - 1)^2 + w_2^i (MB^i)^2} \\ \varepsilon_G^i = \nu^i \dfrac{w_1^i (1 - MB^i)}{w_1^i (MB^i - 1)^2 + w_2^i (MB^i)^2} \\ R^i = \overline{R} + \lambda_R x_R^i + \varepsilon_R^i \\ G^i = \overline{G} + \lambda_G x_G^i + \varepsilon_G^i \end{cases} \tag{A5}$$

The first equation specifies the weights $w^i = w_1^i w_2^i / (w_1^i (1 - MB^i)^2 + w_2^i (MB^i)^2)$ that should be used in the WLS regression $X_{cT}^i / B_0^i = \gamma_0 + \gamma_1 MB^i + \lambda_R MB^i x_R^i + \lambda_G (1 - MB^i) x_G^i + \nu^i$. Having found the intercept, slopes, and residuals from the regression, the third and the fourth equations can be used to obtain the sample mean *R* and *G*, the fifth and the sixth equations can be used to calculate the components of R^i and G^i due to unknown risk and growth factors, and finally the last two equations can be used to calculate the firm COE and growth rate.

Comparison of between Our Model and ETSS'

Recall that our minimization problem outlined in Section 2 is specified as:

$$\begin{cases} \underset{\overline{R},\overline{G},\lambda_R,\lambda_G,\varepsilon_R^i,\varepsilon_G^i}{Min} \sum_i w_1^i(\varepsilon_R^i)^2 + w_2^i(\varepsilon_G^i)^2 \\ R^i = \overline{R} + \boldsymbol{\lambda}_{\mathbf{R}}\,'\mathbf{x}_{\mathbf{R}}^{\mathbf{i}} + \varepsilon_R^i \\ G^i = \overline{G} + \boldsymbol{\lambda}_{\mathbf{G}}\,'\mathbf{x}_{\mathbf{G}}^{\mathbf{i}} + \varepsilon_G^i \end{cases} \tag{4}$$

Estimation of regression (3b) in ETSS implies a different minimization problem. Because OLS minimizes the sum of squared residuals, the deviations of R^i and G^i from the sample means are jointly minimized in the following way:

$$\underset{\overline{R},\overline{G},\varepsilon^i}{Min} \sum_i (\varepsilon_G^i(1-MB^i) + \varepsilon_R^i MB^i)^2$$
$$\begin{cases} R^i = \overline{R} + \varepsilon_R^i \\ G^i = \overline{G} + \varepsilon_G^i \end{cases} \tag{A6}$$

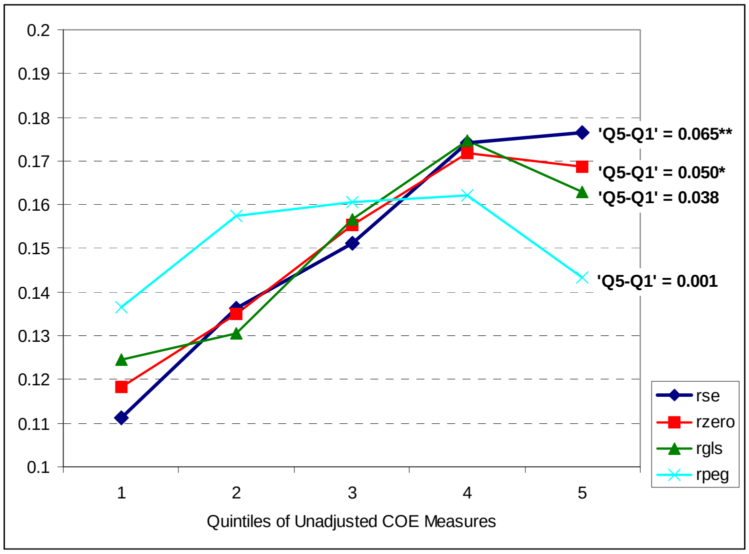
The key difference between ETSS' and our minimization problems is that ETSS' minimization function (A6) does not increase even as ε_R^i and ε_G^i go to infinity as long as their linear combination, $\varepsilon_G^i(1-MB^i)+\varepsilon_R^i MB^i$, remains the same. In contrast, our loss function (4) always increases in the magnitude of ε_R^i and ε_G^i. Mathematically, our minimization function is positive definite while that in ETSS is positive semi-definite.[42] The assumption of a positive definite function is a standard assumption in the definition of a loss function. We find that the minimization of any positive definite quadratic

[42] A quadratic function $w_1^i(\varepsilon_R^i)^2 + w_2^i(\varepsilon_G^i)^2 + w_3^i\varepsilon_R^i\varepsilon_G^i$ is positive (semi-)definite if it is positive (non-negative) for any non-zero argument, $\varepsilon_R^i\varepsilon_G^i \neq 0$, which holds if and only if $w_1^i > 0\,(\geq 0)$ and $4w_1^i w_2^i - (w_3^i)^2 > 0\,(\geq 0)$.

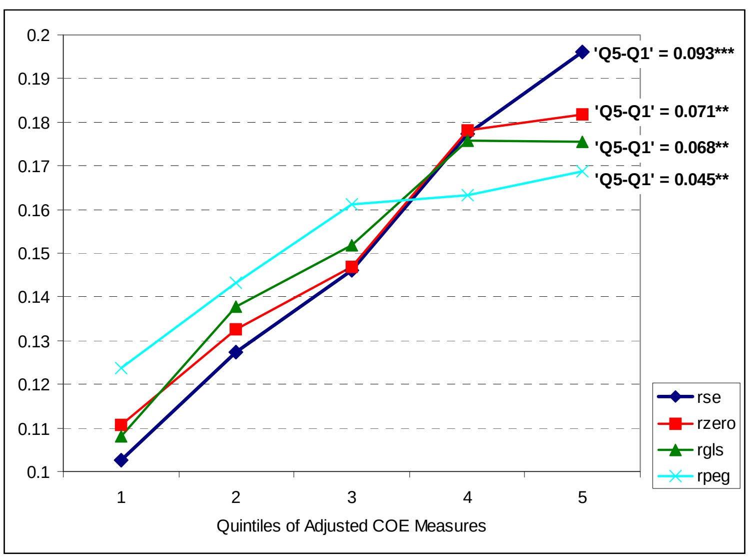
function of ε_R^i and ε_G^i is sufficient to uniquely identify firm *R* and *G* (the proof is available from the authors upon request).

Figure 1. Future realized returns for portfolios based on COE measures

Panel A. Average future realized returns by quintiles of unadjusted COE measures



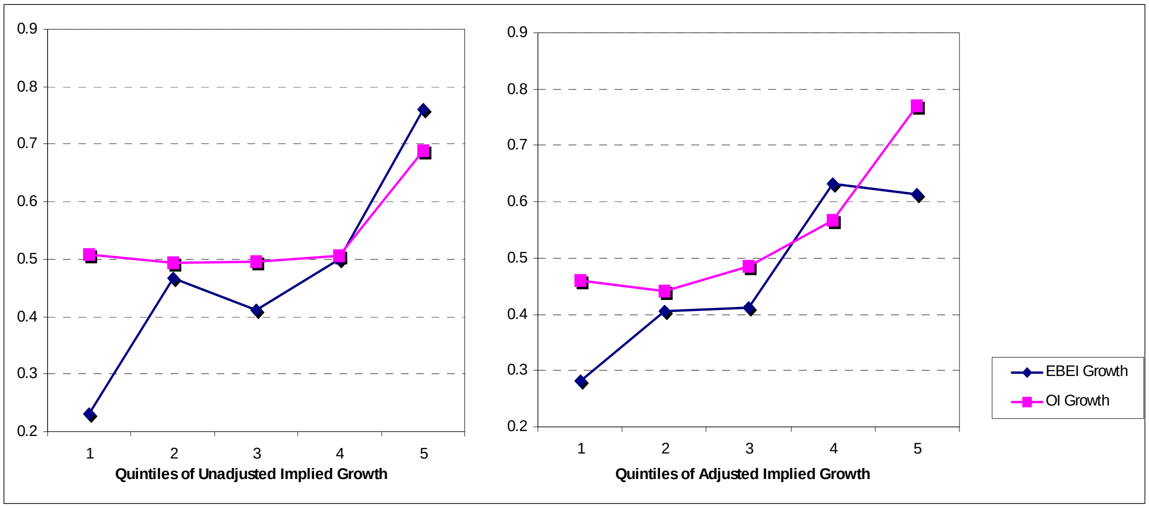
Panel B. Average future realized returns by quintiles of adjusted COE measures



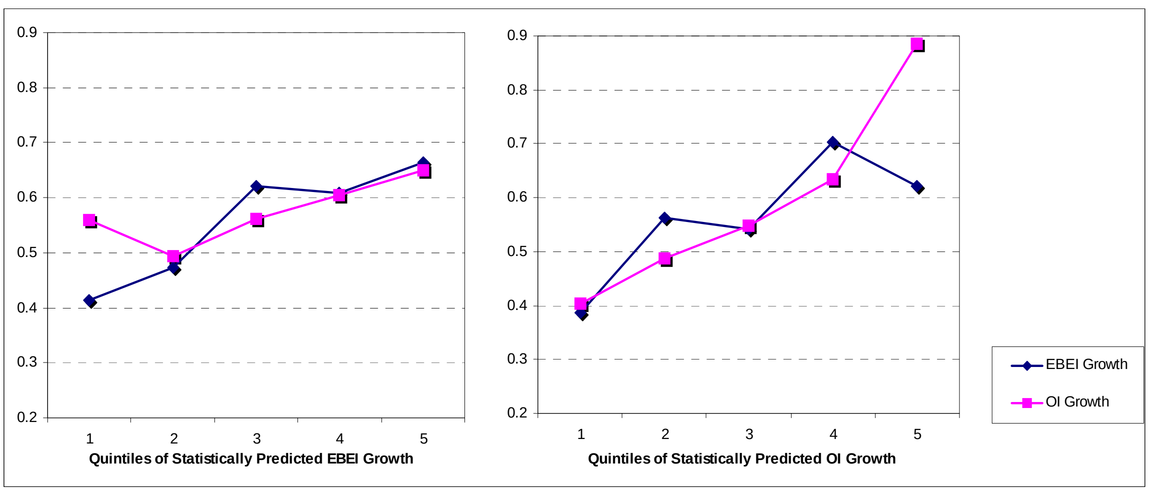
The figure plots the mean future one-year buy-and-hold returns for portfolios based on COE measures. The sample consists of 7,631 firms from 1980 to 2007. r_{SE} is the COE measure based on our model, r_{zero} is the COE measure based on the residual income model with the zero growth rate, r_{GLS} is the COE measure based on the GLS model (Gebhardt et al. 2001), r_{PEG} is the COE measure based on the PEG model (Gode and Mohanram 2009). Unadjusted measures are based on raw analyst earnings forecasts. Adjusted measures are based on analyst earnings forecasts adjusted for predictable forecast errors (Gode and Mohanram 2009).

Figure 2. Realized growth rates by quintiles of predicted growth

Panel A. Average realized growth in four-year cum-dividend earnings by quintiles of implied growth



Panel B. Average realized growth in four-year cum-dividend earnings by quintiles of statistically predicted growth



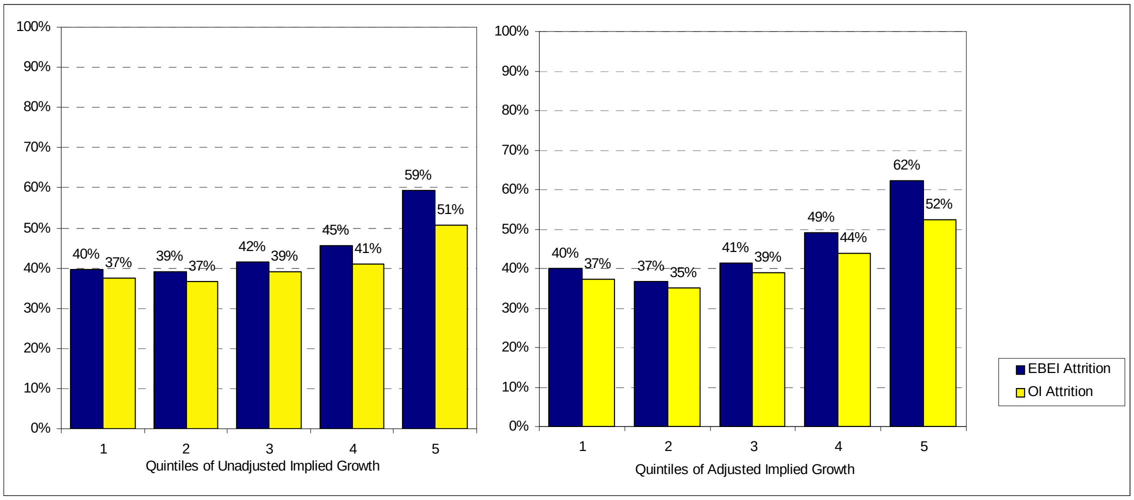
The figure plots average growth in four-year cum-dividend earnings before extraordinary items (*EBEI*) or operating income before depreciation (*OI*) by quintiles of predicted earnings growth rates. Growth rates are calculated as $GR_{t+4,\,t+8} = X_{t+8}^{cumd} / X_{t+4}^{cumd} - 1$, where $X_T^{cumd} = \Sigma_{[t=T-3,T]}(E_t) + \Sigma_{[t=T-3,T-1]}((1+r)^{4-t}-1)d_t$, and E_t is realized earnings for year t, d_t is dividends declared in year t, and r is the risk-free rate at period t.

Panel A reports future average realized growth for firms sorted into quintiles by unadjusted (adjusted) implied growth rates. Unadjusted (adjusted) implied growth is based on raw analyst earnings forecasts (forecasts adjusted for predictable forecast errors (Gode and Mohanram 2009)).

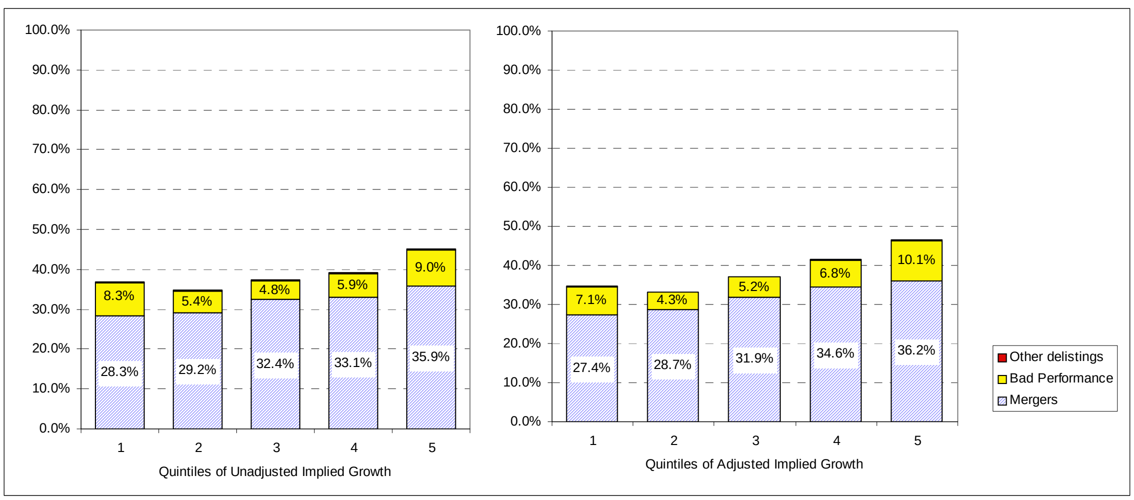
Panel B reports future average realized growth for firms sorted into quintiles by statistically predicted growth in earnings. The statistical growth predictions are based on: (1) estimating the slope coefficients in the hold-out cross-sectional regressions of past realized growth in *EBEI* (*OI*) on the growth drivers lagged by eight years, and (2) applying slope coefficients to current growth drivers (analysts' long-term growth forecasts, deviations of firm's forecasted ROE from the industry ROE, and R&D expenses scaled by sales).

Figure 3. Analysis of sample attrition

Panel A. Sample attrition rates during [*t*, *t*+8] by quintiles of implied growth



Panel B. Reasons for delisting during [*t*, *t*+8] by quintiles of implied growth



The figure documents the rates and causes of sample attrition within the eight years following implied earnings growth estimation. Unadjusted (adjusted) implied growth refers to growth derived using raw analyst forecasts (forecasts adjusted for predictable errors). All percentages are calculated based on a number of firms with available implied earnings growth estimates at time *t*.

Panel A reports average percentage of firms with unavailable four-year cum-dividend earnings growth by quintiles of implied growth. *EBEI* (*OI*) refers to growth in earnings before extraordinary items (operating income before depreciation).

Panel B reports average percentage of firms delisted from the exchanges. "Bad performance" category includes delistings due to various adverse events, including bankruptcies, liquidations, and failure to satisfy listing requirements. "Mergers" category includes delistings following merger and acquisition activity, or stock exchanges. "Other delistings" include all delistings not included in the two previous categories (for example, moving to a different exchange). Delisting classification is performed based on CRSP delisting codes; bad performance-related delistings are coded following Shumway (1997).

Table 1. Sample Descriptive Statistics

Panel A: Descriptive Statistics

Variable	Mean	10%	25%	Median	75%	90%
Firm Characteristics						
Size	3,631	66	167	541	1,923	6,716
B/M	0.610	0.189	0.320	0.517	0.773	1.125
Beta	1.040	0.288	0.568	0.951	1.376	1.921
Leverage	1.431	0.002	0.085	0.350	0.974	2.416
Ret_{-12}	0.188	-0.294	-0.091	0.126	0.379	0.717
Disp	0.006	0.001	0.001	0.003	0.007	0.015
σ_β	0.374	0.155	0.199	0.284	0.454	0.709
Unadjusted COE and growth measures						
$\boldsymbol{r_{SE}}$	**0.084**	**0.043**	**0.060**	**0.079**	**0.103**	**0.135**
r_{zero}	0.095	0.055	0.070	0.088	0.113	0.146
r_{GLS}	0.104	0.070	0.083	0.100	0.120	0.143
r_{PEG}	0.111	0.072	0.087	0.105	0.129	0.158
$\boldsymbol{g_{SE}}$	**0.005**	**-0.030**	**-0.022**	**0.003**	**0.024**	**0.044**
Adjusted COE and growth measures						
$\boldsymbol{r_{SE}}$	**0.070**	**0.034**	**0.048**	**0.065**	**0.086**	**0.118**
r_{zero}	0.077	0.041	0.056	0.073	0.092	0.121
r_{GLS}	0.095	0.062	0.076	0.092	0.111	0.133
r_{PEG}	0.102	0.066	0.081	0.097	0.118	0.144
$\boldsymbol{g_{SE}}$	**0.003**	**-0.030**	**-0.018**	**0.001**	**0.019**	**0.036**

Table 1 (continued)

Panel B: Correlations Among Cost of Equity Measures

	Unadjusted COE Measures					Adjusted COE Measures			
	r_{SE}	r_{zero}	r_{GLS}	r_{PEG}		r_{SE}	r_{zero}	r_{GLS}	r_{PEG}
r_{SE}	—	**0.844** **(28/0)**	**0.709** **(28/0)**	**0.529** **(28/0)**	r_{SE}	—	**0.794** **(28/0)**	**0.605** **(28/0)**	**0.429** **(28/0)**
r_{zero}		—	0.789 (28/0)	0.733 (28/0)	r_{zero}		—	0.685 (28/0)	0.554 (28/0)
r_{GLS}			—	0.559 (28/0)	r_{GLS}			—	0.406 (28/0)
r_{PEG}				—	r_{PEG}				—

The sample consists of 7,631 firms from 1980 to 2007. Panel A reports sample descriptive statistics. Panel B reports average by-year correlations. Numbers in parentheses indicate the number of years in which the correlation is significantly positive/negative. *Size* is the market capitalization, *B/M* is the book-to-market ratio, *Beta* is the CAPM beta, *Leverage* is the ratio of the book value of debt to the market value of equity, Ret_{-12} is the past one-year buy-and-hold return, *Disp* is the standard deviation of analyst one-year ahead earnings forecast scaled by price, σ_{β} is the standard error of the beta estimate. r_{SE} is the COE measure based on our model, g_{SE} is the estimate of the terminal growth rate in residual earnings, r_{zero} is the COE measure based on the residual income model with the zero growth rate, r_{GLS} is the COE measure based on the GLS model (Gebhardt et al. 2001), r_{PEG} is the COE measure based on the PEG model (Gode and Mohanram 2009). Unadjusted measures are based on raw analyst earnings forecasts. Adjusted measures are based on analyst earnings forecasts adjusted for predictable forecast errors (Gode and Mohanram 2009).

Table 2. Cross-Sectional Regressions of COE Measures on Risk Characteristics

Variables	Unadjusted COE Measures				Adjusted COE Measures			
	r_{SE}	r_{zero}	r_{GLS}	r_{PEG}	r_{SE}	r_{zero}	r_{GLS}	r_{PEG}
Beta	**-0.004*****	-0.003**	0.001	0.007***	**-0.004*****	-0.004***	0.000	0.004***
	[3.72]	[2.37]	[0.96]	[6.01]	**[5.47]**	[4.66]	[0.03]	[4.03]
Leverage	**0.001*****	0.001***	0.000***	0.000***	**0.000*****	0.000***	0.000***	0.000***
	[7.09]	[6.95]	[5.14]	[3.91]	**[7.54]**	[6.61]	[4.64]	[5.60]
LogSize	**-0.006*****	-0.005***	-0.004***	-0.010***	**-0.004*****	-0.002	-0.003***	-0.007***
	[4.22]	[3.42]	[3.91]	[10.42]	**[2.89]**	[1.42]	[2.87]	[6.81]
B/M	**0.018*****	0.022***	0.041***	0.006***	**0.017*****	0.019***	0.045***	0.006***
	[6.77]	[9.34]	[47.66]	[4.23]	**[7.23]**	[11.22]	[46.58]	[4.23]
Ret_{-12}	**-0.008*****	-0.007***	-0.005***	-0.008***	**0.009*****	0.006**	0.004**	0.013***
	[4.24]	[3.09]	[3.31]	[4.52]	**[3.83]**	[2.32]	[2.32]	[5.91]
Disp	**-0.009*****	0.001	0.004**	0.021***	**-0.014*****	-0.012***	-0.002	0.012***
	[4.40]	[0.16]	[2.03]	[10.59]	**[7.79]**	[4.24]	[1.34]	[6.40]
σ_β	**0.161*****	0.150***	0.112***	0.134***	**0.135*****	0.131***	0.101***	0.145***
	[24.98]	[24.97]	[29.29]	[46.27]	**[23.89]**	[25.86]	[28.63]	[49.06]
Intercept	**-0.004*****	-0.003**	0.001	0.007***	**-0.004*****	-0.004***	0.000	0.004***
	[3.72]	[2.37]	[0.96]	[6.01]	**[5.47]**	[4.66]	[0.03]	[4.03]
Observations	**45,138**	45,138	45,138	42,829	**45,138**	45,138	45,138	42,829
R-squared	**0.55**	0.45	0.66	0.39	**0.60**	0.50	0.69	0.36

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The table reports the results of cross-sectional regressions of COE measures on firm characteristics for a sample of 7,631 firms spanning 1980 to 2007. The absolute values of *t*-statistics in brackets are based on Petersen (2009) standard errors clustered by firm and year. Regressions include year fixed effects. r_{SE} is the COE measure based on our model, g_{SE} is the estimate of the terminal growth rate in residual earnings, r_{zero} is the COE measure based on the residual income model with the zero growth rate, r_{GLS} is the COE measure based on the GLS model (Gebhardt et al. 2001), r_{PEG} is the COE measure based on the PEG model (Gode and Mohanram 2009). *Beta* is the CAPM beta, *Leverage* is the ratio of the book value of debt to the market value of equity, *LogSize* is the log of the market capitalization, *B/M* is the book-to-market ratio, Ret_{-12} is the past one-year buy-and-hold return, *Disp* is the standard deviation of the one-year ahead earnings forecast scaled by price, σ_β is the standard error of the beta estimate. Unadjusted measures are based on raw analyst earnings forecasts. Adjusted measures are based on analyst earnings forecasts adjusted for predictable forecast errors (Gode and Mohanram 2009).

Table 3. Cross-Sectional Regressions of Future Returns on COE measures

Panel A: Univariate Cross-Sectional Regressions of Future Returns on COE measures

	Unadjusted COE Measures				**Adjusted COE Measures**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Intercept	0.074 [2.79]***	0.110 [4.6]***	0.094 [2.88]***	0.155 [4.98]***	0.015 [0.39]	0.076 [3.39]***	0.056 [1.66]	0.106 [3.94]***
$\boldsymbol{r_{SE}}$	**0.709**				**1.502**			
=0	**[2.12]****				**[3.20]*****			
=1	**[0.87]**				**[1.07]**			
r_{zero}		0.397				0.934		
=0		[1.54]				[2.80]***		
=1		[2.34]**				[0.20]		
r_{GLS}			0.521				0.934	
=0			[1.55]				[2.58]**	
=1			[1.43]				[0.18]	
r_{PEG}				-0.040				0.439
=0				[0.16]				[1.60]
=1				[4.08]***				[2.04]*
R^2	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.01

Panel B: Cross-Sectional Regressions of Future Returns on COE measures

	Unadjusted COE Measures			**Adjusted COE Measures**		
	1	**2**	**3**	**1**	**2**	**3**
Intercept	0.072 [2.53]**	0.074 [2.19]**	0.096 [3.48]***	0.018 [0.45]	0.010 [0.21]	0.019 [0.54]
$\boldsymbol{r_{SE}}$	**0.926**	**0.599**	**0.962**	**1.604**	**1.265**	**1.411**
=0	**[1.77]***	**[1.73]***	**[2.32]****	**[2.70]****	**[3.26]*****	**[2.9]*****
=1	**[0.14]**	**[1.16]**	**[0.09]**	**[1.02]**	**[0.68]**	**[0.85]**
r_{zero}	-0.201			-0.168		
=0	[0.52]			[0.44]		
=1	[3.09]***			[3.08]***		
r_{GLS}		0.118			0.281	
=0		[0.34]			[0.83]	
=1		[2.53]**			[2.13]**	
r_{PEG}			-0.405			0.040
=0			[1.49]			[0.16]
=1			[5.17]***			[3.91]***
R^2	0.02	0.02	0.04	0.03	0.03	0.03

Table 3 (continued)

Panel C: Cross-Sectional Regressions of Future Returns on COE measures

	Unadjusted COE Measures				Adjusted COE Measures			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Intercept	0.131	0.158	0.143	0.187	0.098	0.144	0.125	0.163
	[2.07]**	[2.33]**	[2.05]*	[2.66]**	[1.77]*	[2.21]**	[1.75]*	[2.29]**
$\boldsymbol{r_{SE}}$	**0.497**				**1.039**			
=0	**[2.11]****				**[3.27]*****			
=1	**[2.13]****				**[0.12]**			
r_{zero}		0.259				0.562		
=0		[1.34]				[2.11]**		
=1		[3.84]***				[1.64]		
r_{GLS}			0.471				0.823	
=0			[1.50]				[2.14]**	
=1			[1.68]				[0.46]	
r_{PEG}				-0.023				0.190
=0				[0.12]				[0.77]
=1				[5.52]***				[3.28]***
Beta	-0.011	-0.012	-0.013	-0.011	-0.007	-0.010	-0.013	-0.014
	[0.83]	[0.87]	[0.99]	[0.88]	[0.59]	[0.76]	[0.99]	[1.06]
LogSize	-0.015	-0.016	-0.015	-0.018	-0.016	-0.016	-0.016	-0.016
	[0.80]	[0.82]	[0.82]	[0.94]	[0.87]	[0.88]	[0.84]	[0.82]
B/M	0.012	0.014	0.002	0.022	0.005	0.009	-0.014	0.021
	[0.86]	[0.97]	[0.11]	[1.36]	[0.29]	[0.58]	[0.56]	[1.30]
Ret_{-12}	0.068	0.067	0.067	0.067	0.058	0.066	0.061	0.068
	[3.84]***	[3.78]***	[3.91]***	[3.88]***	[3.65]***	[3.65]***	[3.89]***	[3.76]***
R^2	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The table reports results of cross-sectional regressions of future one-year returns on COE measures and risk proxies. The sample consists of 7,631 firms from 1980 to 2007.

Reported values are the means of by-year regression coefficients. The absolute values of Fama-MacBeth *t*-statistics in brackets are calculated with Newey-West autocorrelation adjustment. The slopes on the COE measures have two corresponding *t*-statistics, where =0 (=1) denotes a null of the slope equal to zero (one).

r_{SE} is the COE measure based on our model, r_{zero} is the COE measure based on the residual income model with the zero growth rate, r_{GLS} is the COE measure based on the GLS model (Gebhardt et al. 2001), r_{PEG} is the COE measure based on the PEG model (Gode and Mohanram 2009). *Beta* is the CAPM beta, *LogSize* is the log of the market capitalization, *B/M* is the book-to-market ratio, Ret_{-12} is the past one-year buy-and-hold return. Unadjusted measures are based on raw analyst earnings forecasts. Adjusted measures are based on analyst earnings forecasts adjusted for predictable forecast errors (Gode and Mohanram 2009).

Table 4. Predicting earnings growth using implied growth estimates

Panel A. Descriptive statistics for realized growth rates

Variable	Number of Observations	Mean	10%	25%	Median	75%	90%
Growth in EBEI	18,801	0.48	-1.17	-0.25	0.30	0.93	2.06
Growth in OI	20,267	0.52	-0.39	-0.01	0.32	0.79	1.52

Panel B. Regressions of realized growth rates in four-year cum-dividend earnings on quintiles of unadjusted implied growth

	Growth in four-year Cum-Dividend *EBEI*		Growth in four-year Cum-Dividend *OI*	
	1	**2**	**3**	**4**
R **(g_{SE})**	**0.122*****	**0.04**	**0.026**	**-0.002**
	[4.35]	**[1.35]**	**[1.64]**	**[0.15]**
Ltg		0.711		1.666***
		[1.00]		[8.19]
dIndROE		2.226***		1.007***
		[3.40]		[3.75]
RdSales		-3.086**		-0.378
		[2.05]		[0.52]
Constant	-0.099*	0.07	0.350***	0.189***
	[1.75]	[0.65]	[10.90]	[4.38]
Observations	18,801	18,801	20,267	20,267
R-squared	0.03	0.03	0.02	0.04

Panel C. Regressions of realized growth rates in cumulative four-year cum-dividend earnings on quintiles of adjusted implied growth

	Growth in four-year Cum-Dividend *EBEI*		Growth in four-year Cum-Dividend *OI*	
	1	**2**	**3**	**4**
R **(g_{SE})**	**0.098*****	**0.011**	**0.060*****	**0.006**
	[2.77]	**[0.38]**	**[4.24]**	**[0.49]**
Ltg		0.683		1.637***
		[0.95]		[7.30]
dIndROE		2.574***		0.923***
		[4.40]		[3.16]
RdSales		-3.038**		-0.387
		[2.04]		[0.53]
Constant	-0.053	0.145	0.280***	0.174***
	[0.76]	[1.46]	[9.67]	[5.91]
Observations	18,801	18,801	20,267	20,267
R-squared	0.03	0.03	0.02	0.04

Panel D. Comparing predictive ability of unadjusted implied growth and simple statistical prediction model: predicting growth in cumulative four-year cum-dividend earnings

	Growth in *EBEI*				Growth in *OI*			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
***R* (g_{SE})**	**0.148*****			**0.133*****	**0.050*****			**0.034***
	[5.01]			**[5.22]**	**[2.76]**			**[1.83]**
R (*pGrEBEI*)		0.093**		0.047		0.028		
		[2.03]		[1.00]		[0.94]		
R (*pGrOI*)			0.077				0.105***	0.099***
			[1.51]				[5.62]	[5.54]
Constant	0.449***	0.533***	0.571***	0.386***	0.348***	0.384***	0.241***	0.189***
	[11.05]	[6.10]	[6.63]	[3.98]	[11.08]	[6.68]	[7.21]	[4.08]
Observations	15,416	15,416	15,416	15,416	16,766	16,766	16,766	16,766
R-squared	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.03

Panel E. Comparing predictive ability of adjusted implied growth and simple statistical prediction model: predicting growth in cumulative four-year cum-dividend earnings

	Growth in *EBEI*				Growth in *OI*			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
***R* (g_{SE})**	**0.149*****			**0.133*****	**0.085*****			**0.051*****
	[4.73]			**[4.50]**	**[5.14]**			**[2.71]**
R (*pGrEBEI*)		0.093**		0.048		0.028		
		[2.03]		[0.96]		[0.94]		
R (*pGrOI*)			0.077				0.105***	0.084***
			[1.51]				[5.62]	[4.20]
Constant	0.435***	0.533***	0.571***	0.374***	0.274***	0.384***	0.241***	0.183***
	[9.70]	[6.10]	[6.63]	[3.94]	[9.07]	[6.68]	[7.21]	[4.57]
Observations	15,416	15,416	15,416	15,416	16,766	16,766	16,766	16,766
R-squared	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.03

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The table documents association between the implied earnings growth estimates and future realized earnings growth. The analyses are based on a sample of observations with available realized growth rates in four-year cum-dividend earnings before extraordinary items (operating income before depreciation) for a period from 1980 to 2001.

Panel A contains descriptive statistics for the realized earnings growth. Realized growth rates are calculated as $GR_{t+4,\ t+8} = X_{t+8}^{cumd} / X_{t+4}^{cumd} - 1$, where $X_T^{cumd} = \Sigma_{[t=T-3,T]}(E_t) + \Sigma_{[t=T-3,T-1]}((1+r)^{4-t}-1)d_t$, and E_t is realized earnings for year *t*, d_t is dividends declared in year *t*, and *r* is the risk-free rate at period *t*. Growth in *EBEI* (*OI*) refers to growth in earnings before extraordinary items (operating income before depreciation).

Panels B and C report coefficients from regressing growth in *EBEI* (*OI*) on the quintile rank of unadjusted (adjusted) implied earnings growth rate, $R(g_{SE})$, and control variables: *Ltg* - the long-term growth forecast, *dIndROE* - the difference between the industry ROE and the firm average forecasted ROE over years *t+1* to *t+4*, and *RdSales* - R&D expenses scaled by sales. Industry ROE is calculated as a ten-year moving median ROE excluding loss firms (Gebhardt et al. 2001). Unadjusted (adjusted) implied growth is based on raw analyst earnings forecasts (forecasts adjusted for predictable forecast errors (Gode and Mohanram 2009)).

Panels D and E report coefficients from regressing growth in *EBEI* (*OI*) on the quintile rank of unadjusted (adjusted) implied earnings growth rate, $R(g_{SE})$, and the quintile rank of statistically predicted growth in earnings, *R*(*pGrEBEI*) or *R*(*pGrOI*). Statistically predicted growth in earnings is based on (1) estimating the slope coefficients in the hold-out cross-sectional regressions of past realized growth in *EBEI* (*OI*) on the growth drivers lagged by eight years, and (2) applying slope coefficients to current growth drivers (analysts' long-term growth forecasts, deviations of firm's forecasted ROE from the industry ROE, and R&D expenses scaled by sales).

All regressions use a pooled sample, with year fixed effects and standard errors clustered by firm and year as in Petersen (2009). The absolute values of t-statistics are reported in brackets.

Table 5. Comparison with the GLS model: Double-sorted portfolios based on industry-adjusted book-to-market ratios and COE

Panel A. Sorts based on industry-adjusted book-to-market ratios and COE from the GLS model, r_{GLS}

	Adjusted r_{GLS}						
B/M - (B/M)$_{Ind}$	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q5-Q1**	**t-stat**
Q1	0.104	0.118	0.123	0.152	0.151	0.047	[1.62]
Q2	0.089	0.118	0.122	0.145	0.155	0.066	[2.02]*
Q3	0.098	0.127	0.124	0.153	0.160	0.063	[1.92]*
Q4	0.104	0.135	0.144	0.169	0.172	0.067	[2.42]**
Q5	0.116	0.149	0.156	0.145	0.144	0.028	[0.97]
Average Q5-Q1						0.054	[2.15]**

Panel B. Sorts based on industry-adjusted book-to-market ratios and COE from our model, r_{SE}

	Adjusted r_{SE}						
B/M - (B/M)$_{Ind}$	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q5-Q1**	**t-stat**
Q1	0.083	0.129	0.107	0.141	0.173	0.090	[2.87]***
Q2	0.061	0.105	0.121	0.150	0.172	0.111	[3.17]***
Q3	0.087	0.106	0.129	0.156	0.190	0.103	[3.08]***
Q4	0.089	0.130	0.150	0.163	0.190	0.101	[3.27]***
Q5	0.117	0.118	0.153	0.161	0.169	0.052	[2.17]**
Average Q5-Q1						0.091	[3.25]***

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The table reports average future one-year buy-and-hold returns for portfolios sorted on the difference between the firm and industry book-to-market ratio (B/M - (B/M)$_{Ind}$) and COE measures. The sample consists of 7,631 firms from 1980 to 2007.

In each sample year, firms in Panel A (Panel B) are first sorted into quintiles based on (B/M - (B/M)$_{Ind}$), firms within each (B/M - (B/M)$_{Ind}$) quintile are further sorted into quintiles based on r_{GLS} (r_{SE}). Q5-Q1 refers to the difference in returns between the top (Q5) and the bottom (Q1) quintiles. The absolute values of *t*-statistics in brackets are based on the Fama-MacBeth test with the Newey-West autocorrelation adjustment.

r_{SE} is the COE measure based on our model, r_{GLS} is the COE measure based on the GLS model (Gebhardt et al. 2001). COE measures based on analyst earnings forecasts adjusted for predictable forecast errors (Gode and Mohanram 2009).

Table 6. Annual estimates of cost of equity and expected growth

	Unadjusted COE Measures				Adjusted COE Measures			
Year	r_{ETSS}	$Gearn_{ETSS}$	r_{SE}	$Gearn_{SE}$	r_{ETSS}	$Gearn_{ETSS}$	r_{SE}	$Gearn_{SE}$
1980	0.157	0.107	0.155	0.115	0.140	0.094	0.136	0.098
1981	0.158	0.109	0.147	0.107	0.146	0.094	0.138	0.093
1982	0.156	0.101	0.167	0.124	0.147	0.070	0.155	0.094
1983	0.130	0.093	0.113	0.085	0.133	0.091	0.114	0.080
1984	0.144	0.107	0.133	0.099	0.118	0.079	0.111	0.078
1985	0.130	0.098	0.109	0.082	0.117	0.089	0.101	0.081
1986	0.113	0.090	0.080	0.052	0.123	0.072	0.088	0.053
1987	0.119	0.094	0.081	0.056	0.086	0.057	0.059	0.035
1988	0.124	0.099	0.095	0.065	0.089	0.056	0.068	0.037
1989	0.119	0.095	0.091	0.061	0.080	0.064	0.061	0.035
1990	0.119	0.095	0.093	0.066	0.080	0.058	0.065	0.039
1991	0.113	0.090	0.093	0.076	0.079	0.055	0.069	0.051
1992	0.105	0.088	0.080	0.055	0.082	0.056	0.065	0.039
1993	0.101	0.091	0.074	0.052	0.068	0.056	0.054	0.033
1994	0.108	0.098	0.080	0.059	0.076	0.067	0.057	0.039
1995	0.124	0.110	0.086	0.067	0.104	0.090	0.076	0.058
1996	0.121	0.109	0.078	0.062	0.100	0.087	0.067	0.053
1997	0.108	0.102	0.069	0.052	0.093	0.086	0.058	0.043
1998	0.113	0.110	0.065	0.050	0.100	0.094	0.057	0.043
1999	0.118	0.106	0.079	0.067	0.096	0.078	0.063	0.050
2000	0.134	0.111	0.097	0.091	0.111	0.084	0.080	0.071
2001	0.109	0.099	0.067	0.052	0.090	0.075	0.053	0.038
2002	0.089	0.082	0.064	0.048	0.066	0.058	0.049	0.035
2003	0.087	0.081	0.064	0.048	0.067	0.059	0.051	0.036
2004	0.092	0.087	0.062	0.046	0.079	0.074	0.051	0.037
2005	0.087	0.082	0.059	0.039	0.072	0.070	0.048	0.030
2006	0.098	0.090	0.072	0.056	0.088	0.079	0.065	0.050
2007	0.087	0.084	0.055	0.037	0.093	0.085	0.056	0.036
Avg.	0.117	0.097	0.090	0.067	0.097	0.074	0.076	0.052
Avg. Diff.			-0.027	-0.030			-0.022	-0.022
[*t*-stat]			[11.14]***	[8.41]***			[9.91]***	[6.87]***

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The table reports annual means of COE and growth measures for our and ETSS models. The means of by-year averages are reported in the last row. Avg. Diff. is the difference between average estimates for our and ETSS' models. The absolute values of *t*-statistics in brackets are based on the Fama-MacBeth test with the Newey-West autocorrelation adjustment. r_{SE} and g_{SE} (r_{ETSS} are g_{ETSS}) are COE and growth in residual earnings estimates based on our (ETSS) model. Unadjusted measures are based on raw analyst earnings forecasts. Adjusted measures are based on analyst earnings forecasts adjusted for predictable forecast errors (Gode and Mohanram 2009).

Table 7. Easton and Monahan analysis

Panel A: Regressions of realized returns on COE measures, cash flow news, and discount rate news

COE Measure	*Intercept*	***LOG_ER***	*LOG_CN*	*LOG_RN*	Adjusted R^2	**Modified Noise Variable**
r_{SE}	0.119	**-0.127**	0.802	0.082	0.25	0.0002
=0	[2.77]**	**[0.26]**	[10.67]***	[10.23]***		
=1	[20.60]***	**[2.29]****	[2.63]**	[113.84]***		
r_{zero}	0.131	**-0.163**	0.837	0.073	0.24	0.0003
=0	[4.00]***	**[0.45]**	[10.66]***	[11.01]***		
=1	[26.63]***	**[3.24]*****	[2.07]**	[139.36]***		
r_{GLS}	0.199	**-0.900**	0.799	0.201	0.37	0.0002
=0	[6.69]***	**[3.07]*****	[11.22]***	[22.17]***		
=1	[26.87]***	**[6.47]*****	[2.83]***	[88.21]***		
r_{PEG}	0.187	**-0.633**	0.842	0.074	0.23	0.0095
=0	[7.44]***	**[2.40]****	[9.90]***	[11.79]***		
=1	[32.26]***	**[6.20]*****	[1.86]*	[146.69]***		

Panel B: Regressions of realized returns on forecast-error-adjusted COE measures, cash flow news, and discount rate news

COE Measure	*Intercept*	***LOG_ER***	*LOG_CN*	*LOG_RN*	Adjusted R^2	**Modified Noise Variable**
r_{SE}	0.033	**1.169**	0.750	0.004	0.18	-0.0003
=0	[0.82]	**[1.98]***	[10.59]***	[0.36]		
=1	[23.75]***	**[0.29]**	[3.53]***	[95.61]***		
r_{zero}	0.059	**0.869**	0.791	0.042	0.20	-0.0002
=0	[1.58]	**[1.61]**	[10.66]***	[4.14]***		
=1	[25.14]***	**[0.24]**	[2.82]***	[94.28]***		
r_{GLS}	0.138	**-0.250**	0.746	0.178	0.32	-0.0001
=0	[4.97]***	**[0.80]**	[10.95]***	[13.87]***		
=1	[30.96]***	**[4.00]*****	[3.73]***	[64.13]***		
r_{PEG}	0.049	**0.784**	0.828	-0.004	0.16	0.0004
=0	[2.35]**	**[2.34]****	[9.46]***	[0.54]		
=1	[45.27]***	**[0.64]**	[1.97]*	[129.24]***		

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The table evaluates reliability of the COE estimates using the Easton and Monahan (2005) method.

The second to sixth columns contain mean regression coefficients and adjusted R-squared for the annual cross-sectional regressions of (log) realized returns on a COE measure, cash flow news, and expected return news: $LOG\_RET_{i,t+1} = Intercept + \alpha_1 * LOG\_ER_{i,t} + \alpha_2 * LOG\_CN_{i,t+1} + \alpha_3 * LOG\_RN_{i,t+1} + \varepsilon_{i,}$

where $LOG\_RET_{i,t+1}$ is the realized return over the one year after the COE estimation, LOG_ER_i is the expected return, i.e. one of the COE estimates, $LOG\_CN_{i,t+1}$ is the cash flow news measured over the one year after the COE estimation, and $LOG\_RN_{i,t+1}$ is the discount rate news over the one year after the COE estimation. All return measures are continuously compounded. The last column reports the modified noise coefficient for each COE measure.

Cash flow news is measured as a sum of the forecast error realized over year *t*+1, the revision in one-year-ahead forecasted ROE, and the capitalized revision in the two-year-ahead forecasted ROE: $LOG\_CN_{i,t+1}$=$LOG\_FERR_{i,t+}\Delta LOG\_FROE_{i,t+1}$+ρ/(1-ρω)*$\Delta LOG\_FROE_{i,t+2}$, where LOG_FERR_{it} is the realized forecast error on the EPS_t forecast made at the end of fiscal year *t,*[43] and revisions refer to changes in forecasts from June *t* to June *t*+1. Forecasted ROE is defined as EPS forecast divided by book value of equity divided by number of shares used to calculate EPS. We use *ρ* estimates reported in Easton and Monahan (2005). Persistence coefficients ω_t are estimated through a pooled time-series cross-sectional regression for each of the 48 Fama-French industries: $LOG\_ROE_{i,t-\tau} = \omega_{0t} + \omega_t \times LOG\_ROE_{i,t-(\tau-1)},$ where τ is a number between zero and nine, and *ROE* is return on equity.

Discount rate news is measured as $LOG\_RN_{i,t+1}$= ρ/(1-ρ)*($LOG\_ER_{1,t+1}$-$LOG\_ER_{i,t}$), where $LOG\_ER_{i,t}$ is the continuously compounded COE estimate measured as of June *t*, and $LOG\_ER_{i,t+1}$ is the continuously compounded COE estimate measured as of June *t*+1.

The details of estimating the modified noise coefficient are described in Easton and Monahan (2005) pp. 506-507.

Reported values are the means of by-year regression coefficients. The absolute values of Fama-MacBeth *t*-statistics in brackets are calculated with Newey-West autocorrelation adjustment. Each coefficient has two corresponding *t*-statistics, where =0 (=1) denotes a null of the coefficient equal to zero (one).

All estimations are performed after deleting observations that fall in the top and bottom 0.5 percent for $LOG\_RET_{i,t+1}$, $LOG\_ER_{i,}$, LOG_CN_i, or $LOG\_RN_{i,}$ distributions.

[43] $FERR_{it}$ captures a revision in expectations that occurs in year *t*+1 due to announcement of actual year *t* earnings.

Table 8. Future realized earnings growth and survivorship bias

Panel A. Regressions of realized growth rates in four-year cum-dividend earnings on quintiles of implied growth with missing growth substituted for bad performance delistings

	Growth in four-year Cum-Dividend *EBEI*	**Growth in four-year Cum-Dividend *OI***
	1	**2**
	Unadjusted Implied Growth	
***R* (g_{SE})**	**0.088*** **	**0.025***
	[3.32]	**[1.95]**
Constant	-0.032	0.348***
	[0.59]	[13.25]
Observations	21,357	23,508
R-squared	0.023	0.016
	Adjusted Implied Growth	
***R* (g_{SE})**	**0.050**	**0.050*** **
	[1.57]	**[3.87]**
Constant	0.042	0.298***
	[0.66]	[11.34]
Observations	21,357	23,508
R-squared	0.022	0.018

Panel B. Regressions of realized growth rates in four-year cum-dividend earnings on quintiles of implied growth with missing growth substituted for bad performance and merger delistings

	Growth in four-year Cum-Dividend *EBEI*	**Growth in four-year Cum-Dividend *OI***
	1	**2**
	Unadjusted Implied Growth	
***R* (g_{SE})**	**0.061*** **	**0.014**
	[3.33]	**[1.54]**
Constant	0.006	0.302***
	[0.17]	[15.68]
Observations	25,589	28,290
R-squared	0.020	0.012
	Adjusted Implied Growth	
***R* (g_{SE})**	**0.032**	**0.031*** **
	[1.47]	**[3.31]**
Constant	0.063	0.268***
	[1.43]	[13.90]
Observations	25,589	28,290
R-squared	0.020	0.013

The table examines how sensitive is the association of the implied earnings growth estimates with future realized earnings growth to survivorship bias. Both panels report coefficients from regressing growth in *EBEI* (*OI*) on the quintile rank of unadjusted (adjusted) implied earnings growth rate, *R*(g_{SE}). The missing realized growth rates are substituted with assumed rates depending on the reason of firm's exit from the sample.

In Panel A, missing realized growth rates of firms delisted due to bad performance are calculated as $GR_{t+4, t+8} = -BV_{t+4} / X_{t+4}^{cumd} - 1$, where BV_{t+4} is the book value of equity at the end of t+4, $X_T^{cumd} = \Sigma_{[t=T-3,T]}(E_t) + \Sigma_{[t=T-3,T-1]}((1+r)^{4-t}-1)d_t$, and E_t is realized earnings for year t, d_t is dividends declared in year t, and r is the risk-free rate at period t. Growth in *EBEI* (*OI*) refers to growth in earnings before extraordinary items (operating income before depreciation).

In Panel B, in addition to substitution present in Panel A, missing realized growth rates of firms delisted due to mergers are set equal to zero.

All regressions use a pooled sample, with year fixed effects and standard errors clustered by firm and year as in Petersen (2009). The absolute values of t-statistics are reported in brackets.