



Earnings beta

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Abstract

The literature on cash flow or earnings beta is theoretically well-motivated in its use of fundamentals, instead of returns, to measure systematic risk. However, empirical measures of earnings beta based on either log-linearizing the return equation or log-linearizing the clean-surplus accounting identity are often difficult to construct. I construct simple earnings betas based on various measures of realized and expected earnings and find that an earnings beta based on price-scaled expectations shocks performs consistently well in explaining the cross-section of returns over 1981–2017. I also examine the relation between different measures of beta and several firm characteristics that are either theoretically connected to systematic risk or are empirically associated with returns and find evidence in support of the construct validity of an earnings beta based on price-scaled expectations shocks. Overall, the findings suggest that this easy-to-construct earnings beta can be suitable for future researchers requiring a measure of systematic risk.

Keywords Cash flow beta · Earnings beta · Systematic risk · Expected returns · Aggregate earnings

JEL classifications G10 · G12 · M41

1 Introduction

The search for a measure of systematic risk that is priced in the cross-section of returns is an important objective of asset pricing research. Motivated by the failure of returns-based market betas to explain the cross-section of returns, recent research has examined cash flow betas. These betas are theoretically appealing,

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as they allow for a direct link between cash flow fundamentals and systematic risk. Most studies measure the cash flow fundamentals needed to estimate betas by either log-linearizing the return equation, following Campbell and Shiller (1988), or log-linearizing the clean surplus accounting identity, following Vuolteenaho (2002). However, the empirical implementation of these two approaches to construct measures of beta presents challenges. Instead, motivated by the positive empirical relation between returns and earnings at the firm level, I consider accounting earnings as a summary measure of cash flow fundamentals. I construct simple earnings betas based on various measures of realized and expected earnings using different scalars and empirically examine their relative performance in explaining the cross-section of portfolio-level and firm-level returns. I also examine the relation between these beta estimates and firm characteristics that are either theoretically connected to systematic risk or are empirically associated with returns, to assess the construct validity of the different earnings betas and illuminate whether certain characteristics explain returns because they indirectly reflect systematic risk.

Studies use one of two empirical approaches to estimate cash flow betas.¹ The first approach follows Campbell (1991) by combining the log-linear return framework of Campbell and Shiller (1988) with a vector autoregression (VAR) model to decompose aggregate returns into aggregate discount rate shocks and aggregate cash flow shocks. While aggregate discount rate shocks are estimated directly, aggregate cash flow shocks are measured as the residuals from the VAR model. A cash flow beta is then estimated using the comovement of realized returns with the aggregate cash flow shocks extracted from the VAR model (e.g., Campbell and Vuolteenaho 2004; Bansal et al. 2005; Hansen et al. 2008; Campbell et al. 2010). However, Chen and Zhao (2009) argue that the VAR approach is problematic, since discount rate shocks and cash flow shocks are not modeled simultaneously, and the measurement errors in estimated discount rate shocks are inherited by the residual cash flow shocks. They find that the results of Campbell and Vuolteenaho (2004) are sensitive to the choice of variables included in the VAR model and exhibit sub-sample instability. Relatedly, Chang and Savickas (2014) find results that are inconsistent with those of Campbell and Vuolteenaho (2004), which they attribute to the high correlation between discount rate shocks and cash flow shocks.

The second approach follows Vuolteenaho (2002) to log-linearize the clean surplus accounting identity and replace the cash flow shock component of the Campbell and Shiller (1988) framework with log return on equity (ROE) summed over an infinite horizon and then use the comovement of return on equity with aggregate return on equity to estimate cash flow beta (e.g., Da 2009; Da and Warachka 2009; Nekrasov and Shroff 2009; Cohen et al. 2009; Campbell et al. 2010). However, betas based on log-linearizing the clean surplus identity can be difficult to construct, since they require forecasting the evolution of ROE over an

¹ Most prior literature uses the term cash flow beta, even though the estimation of beta is based either on dividends in the first approach or on accounting earnings in the second approach, neither of which are actually cash flows. Instead, I prefer to use the term “earnings beta,” since the beta estimation procedure involves accounting earnings.

infinite horizon. For example, the earnings beta of Da and Warachka (2009) is based on ROE estimated from a three-stage earnings growth model that requires assumptions about growth rates over multiple horizons. Further, Penman (2016) points out that some of the assumptions underlying the Vuolteenaho (2002) model could be problematic, and Penman and Zhang (2020) show that ROE can be negatively associated with expected returns as a result of conservative accounting.²

I adopt a different approach to develop several simple and easy-to-construct earnings betas and examine their relative ability to explain cross-sectional variation in returns. Specifically, I estimate earnings betas using 11 different earnings series that involve: (1) either historical realizations of earnings over the last 12 months or analysts' expectations of earnings over the next 12 months; (2) either earnings levels or earnings changes (i.e., growth); (3) three alternatives for scaling earnings, including prior period earnings, book value of equity, or market value of equity; and (4) analysts' expectations of long-term growth in earnings.³ Each earnings series is regressed on an analogous earnings series at the aggregate level in backward-rolling five-year window estimations to provide time-varying earnings betas. Then I evaluate the relative cross-sectional pricing performance of these earnings betas in explaining one-month-ahead realized returns, as a proxy for expected returns. Understanding which earnings series delivers an earnings beta with consistent performance in cross-sectional pricing tests is important for researchers who are interested in using a valid measure of systematic risk in a variety of settings.

The first set of pricing tests I conduct are at the portfolio level. Using each of the 11 earnings series, I estimate earnings betas for 50 portfolios formed on the basis of five characteristics commonly used in prior asset pricing literature: 10 each on size, book-to-price, earnings-to-price, asset growth, and long-term return reversal. These characteristics provide a spread in returns that is not explained by market beta. I then test which earnings betas can explain the cross-sectional variation in value-weighted monthly returns for these 50 portfolios.

Over the 1981–2017 period, I find that six of the 11 earnings betas have positive and significant risk premiums in the cross-section of returns, while market beta continues to carry an insignificant risk premium. Earnings betas based on expected earnings perform relatively better than betas based on realized earnings, and earnings betas based on *changes* in realized or expected earnings outperform

² According to Penman (2016), these potentially problematic assumptions include (1) requiring firms to pay dividends, (2) assuming log book-to-price converges to zero (or to a constant) in the long run, (3) assuming return on equity converges to expected returns in the long run, and (4) potentially violating the assumptions of Miller and Modigliani (1961) by using logs. Penman (2016) also notes that the assumption of a zero premium of price over book is tantamount to assuming “unbiased accounting” of Ohlson (1995). Hence the model does not consider how the accounting system deals with potential future earnings growth tied to the unconditionally conservative accounting for uncertain investments, such as research and development and advertising expenditures (Feltham and Ohlson 1995).

³ In this study, “earnings” refers to core earnings, which is net income before extraordinary items and tax-adjusted special items minus preferred dividends. It is a measure of continuing earnings generated by the core business of the firms and is adjusted for transitory and nonrecurring items. Expectations of earnings refers to forecasts developed by equity research analysts, which are also typically forecasts of normalized or core earnings.

earnings betas based on *levels* of realized or expected earnings. In particular, I find that an earnings beta based on changes in expected earnings (i.e., “price-scaled expectations shock beta”) can explain the cross-section of returns quite well, accounting for 41.9% of the variation in value-weighted monthly excess returns of the 50 portfolios. Differently, earnings betas based on earnings levels, such as realized ROE or expected ROE, do not exhibit consistent statistical significance.⁴ Overall, I find the empirical performance of earnings betas is sensitive to the construction of the earnings series used to estimate beta.

I also conduct out-of-sample tests by splitting the 1981–2017 period into two subsamples. I estimate earnings betas separately for each subsample and examine whether betas from one subsample can explain cross-sectional variation in value-weighted monthly returns in the other. Consistent with the full sample pricing tests, I find that the price-scaled expectations shock beta outperforms the other betas and continues to explain between 11.8% and 26.7% of the cross-sectional variation in returns.

In light of the concerns expressed by Lewellen et al. (2010) about using a limited set of portfolios in asset pricing tests, I assess the robustness of my findings using three-pass regression pricing tests proposed by Giglio and Xiu (2019) to account for omitted factors. I find that six of the 11 earnings betas carry positive and significant risk premiums. Consistent with the portfolio pricing tests, earnings betas based on expected earnings outperform those based on realized earnings, and earnings betas based on changes in earnings outperform those based on levels of earnings. I also find that price-scaled expectations shock beta is among the best performers.

Next, I sort firms each month on the basis of the various earnings betas and form factor-mimicking portfolios that take a long position in high earnings beta firms and a short position in low earnings beta firms. If systematic risk in earnings is priced, I expect to see differences in the returns of these beta-sorted portfolios. I find that the value-weighted monthly excess returns of the factor-mimicking portfolio for price-scaled expectations shock beta are the highest at 0.72%, with an alpha of 0.49% after risk-adjusting for the five factors of Fama and French (2015) and the Carhart (1997) momentum factor. In particular, the positive and significant loadings of the excess returns of this portfolio on the market, size, and value factors suggest that these factors also partially capture systematic risk in earnings. I find similar inferences using the five-factor Instrumented Principal Component Analysis (IPCA) model developed in Kelly et al. (2019), which introduces 36 observable characteristics as instruments for unobservable factor loadings.

Subsequently, I move to firm-level analysis. Using two-stage cross-sectional regressions, I find that four of the 11 earnings betas can explain cross-sectional variation in firm-level returns incrementally to characteristics used in standard pricing tests (i.e., size, book-to-price, short-term reversal, and momentum). Echoing the portfolio-level results, earnings betas formed on expected earnings outperform earnings betas formed

⁴ I also estimate earnings betas using revisions in analysts’ expectations of long-term growth, which are available for fewer firms and cover a slightly shorter period. While this expected long-term growth beta is positively associated with returns, the magnitude and statistical significance is smaller. This could either be due to imprecise beta estimates resulting from insufficient variation in long-term growth forecasts, short-horizon return variation being driven primarily by short-term earnings, or the risk premium for short-term earnings being higher. Along similar lines, Binsbergen et al. (2012) find that short-term dividends carry a higher risk premium than long-term dividends.

on realized earnings, and price-scaled expectations shock beta continues to carry a positive and significant risk premium. My inferences are also robust to controlling for the 36 firm characteristics considered by Kelly et al. (2019) and Freyberger et al. (2020). Overall, I conclude from the various pricing tests that expected earnings and, in particular, changes in expected earnings yield earnings betas that perform consistently well.

Finally, I provide a comprehensive characterization of the average relation between the 11 earnings betas and firm characteristics. The motivation is to focus on characteristics that either (1) are theoretically connected to systematic risk, (2) are empirically associated with returns because they are consistent with rational pricing of uncertain outcomes (Penman and Zhu 2014), (3) inform on fundamental risks originating in the way a firm operates and finances its activities (Penman 2013, p. 651), or (4) reflect how conservative accounting incorporates uncertainty into revenue and expense recognition and measurement (Penman and Zhang 2020). Thus I select a parsimonious set of variables, including size, profitability, leverage, volatility, growth, and investment, and rely on prior literature to develop predictions about their associations with beta. Consistent with these expectations, I find that smaller, less profitable firms with higher financial and operating leverage tend to have higher earnings betas. Further, earnings-to-price and book-to-price are positively associated with several of the earnings betas, suggesting that these characteristics might explain returns because they indirectly capture systematic risk. Importantly, across the 11 earnings betas, price-scaled expectations shock beta has the least number of inconsistent signs for the relation with these characteristics, providing support for the construct validity of this earnings beta as a suitable measure of systematic risk.

This paper contributes to the literature on (1) cash flow beta, (2) accounting beta, and (3) characteristics that explain returns. I contribute to cash flow beta studies by demonstrating that simple earnings betas that use price-scaled expectations shocks seem to perform consistently well in explaining the cross-section of returns. These betas are easier to construct than alternative approaches that either log-linearize returns or log-linearize the clean surplus accounting entity and are a suitable option for future researchers requiring a measure of systematic risk. I also contribute to early literature on accounting beta, which documented a positive relation with CAPM-based market beta (e.g., Ball and Brown 1969; Beaver et al. 1970; Pettit and Westerfield 1972; Gonedes 1973; Beaver and Manegold 1975). However, since market beta cannot explain variation in returns, this positive relation is not a direct test of the pricing of accounting beta. I provide a comprehensive update to this early literature by examining whether systematic risk in earnings is priced in the cross-section of returns. The important role of earnings in assessing systematic risk is also consistent with recent findings of Savor and Wilson (2016) that the covariance between firm specific and market cash flow news spikes around earnings announcements.

Finally, this paper contributes to literature that has examined the return predictability of characteristics, such as size, book-to-price, earnings-to-price, profitability, investment, momentum, leverage, accruals, liquidity, and equity duration, among others.⁵

⁵ Selected examples include Fama and French (1992, 1993, 1996, 2006), Jegadeesh and Titman (1993), Ou and Penman (1989), Sloan (1996), Pastor and Stambaugh (2003), and Dechow et al. (2004). Also see Harvey et al. (2016) for a comprehensive list.

This literature largely makes indirect references to the nondiversifiable risks that these variables might capture. For example, recent empirical works suggest that book-to-price explains returns partly because it is positively associated with higher and more variable future earnings growth (e.g., Penman and Reggiani 2013; Penman et al. 2018; Ellahie et al. 2020). I add to this work by illuminating a potential reason these characteristics explain returns: they indirectly capture systematic risk in earnings. In a similar spirit, Kelly et al. (2019) find that characteristics capture covariances.

2 Using earnings to measure systematic risk

Systematic risk is the susceptibility of an asset's payoffs to be affected by aggregate economic shocks that cannot be diversified away. Assets whose payoffs covary more strongly with aggregate shocks pose a greater risk to smooth consumption, because they generate a poor return precisely when marginal utility of consumption is high. Investors require higher risk premiums (i.e., expected returns) to hold such assets as compensation for bearing greater consumption risk. The classic approach to measuring the systematic risk of an asset is to use historical information to estimate how the returns of an asset covary with the returns of a broad index, such as the aggregate market portfolio (i.e., market beta). However, prior literature has consistently documented a flat or even negative relation between returns and market beta, especially after 1963 (e.g., Fama and French 1992; Cochrane 2011; Frazzini and Pedersen 2014).

Instead of using returns, I use accounting earnings as the basis to estimate beta. Earnings summarize the periodic economic performance of firms as measured by the accounting system and play a critical role in valuation for at least two reasons. First, a key assumption in accounting, also embodied in the clean surplus relation, is that earnings contribute to growth in book value of equity. Since many studies link the market value of equity to book value of equity, the importance of earnings for valuation is easy to see. Second, a common relative valuation approach is to compare firms on the basis of their earnings yields or price-to-earnings multiples. Further, Easton and Harris (1991) show that both earnings levels and earnings changes, scaled by price, relate positively to returns. This positive empirical relation between returns and earnings suggests that earnings can inform about systematic risk. A better understanding of the usefulness of earnings to measure systematic risk could help investors to develop more accurate estimates of expected returns.⁶

⁶ Relatedly, Easton et al. (1992) note “the market buys earnings” (p. 126), and Brown and Ball (1967) and Ball et al. (2009) conclude that firm-level earnings contain a strong systematic component. It is also worth noting that measuring systematic risk using the comovement of earnings with aggregate earnings also indirectly tests whether aggregate earnings is a candidate state variable that is correlated with aggregate consumption and investment opportunities (Merton 1973). Since corporate earnings directly and indirectly contribute to economy-wide output, a link to consumption is plausible. Indeed, Kothari et al. (2006) find a positive correlation between aggregate earnings and several macroeconomic variables, including consumption. In untabulated results, I also find similar positive associations between several of the aggregate earnings series considered here and changes in consumption. Finally, aggregate earnings news could indicate macroeconomic news that drives aggregate stock returns (see Anilowski et al. 2007; Shivakumar 2007).

Recent studies have estimated cash flow betas by either log-linearizing the return equation or log-linearizing the clean-surplus accounting identity. However, these betas are often difficult to construct, require forecasts of earnings over an infinite horizon, and also present potential challenges (see Penman 2016). Instead, I estimate simple earnings betas using various measures of accounting earnings over the short-term. Focusing on short-term earnings significantly simplifies the construction of the earnings series used to estimate earnings betas. Specifically, I consider 11 different earnings series by combining earnings levels, earnings growth, realized earnings, and expected earnings with three different choices for scaling earnings.

2.1 Measures of earnings

The first two earnings series I consider are based on the *level* of realized accounting earnings. Since the level of earnings cannot be compared across firms due to size differences, I scale earnings by book value of equity (i.e., realized ROE) and market value of equity (i.e., realized earnings yield). Further, in order to remove seasonality effects, I accumulate the four most recent quarters to calculate realized earnings over the trailing 12 months prior to scaling.

However, a potential issue that hinders cross-sectional comparisons is the distortionary effect of conservative accounting for uncertain investments in research and development and advertising on measures that rely on earnings levels, such as ROE (Penman 1991; Penman and Zhang 2002).⁷ Thus, I also consider three measures based on realized earnings *changes*. While measures of earnings levels could be distorted by the effects of conservative accounting for uncertain investments, measures of earnings changes (i.e., growth) could be less distorted. Further, earnings growth could be more informative about the earnings generating process and hence about expected returns. For example, the sign and rate of earnings growth could contain incremental information about acceleration and deceleration of earnings, and the covariance of this growth relative to aggregate earnings growth could be a better basis for measuring systematic risk.

When computing earnings growth, the most natural scalar is prior period earnings. Unfortunately, since firm-level earnings are often negative the growth rate is not always interpretable.⁸ Instead, I compute earnings growth for firm i at time t using the following approach: $\Delta EARN_{i,t} / (|EARN_{i,t}| + |EARN_{i,t-1}|) / 2$. This measure can accommodate negative denominators and ranges between -2 and $+2$. It is also strongly correlated with the traditional calculation of earnings growth rate when only positive prior period earnings are used as the scalar. To further circumvent the problem of negative prior period earnings in the denominator, I

⁷ The distortion is due to the expensing of these uncertain investments as they are incurred, which depresses the current level of earnings. Further, firms recognize earnings from these investments only when they are generated in the future, which inflates earnings in future periods.

⁸ Negative earnings also preclude the use of log earnings growth. Another alternative is to scale change in earnings by absolute values of prior period earnings. However, this measure is not well behaved when prior period earnings are close to zero. A benefit of using portfolios in this study is that the incidence of negative portfolio-level earnings is much less frequent, ranging from less than 1.0% to 5.6% depending on the portfolio sorting variable.

also consider two alternative measures of realized earnings growth based on scaling earnings changes by prior period book value of equity (i.e., book-scaled realized earnings growth) and prior period market value of equity (i.e., price-scaled realized earnings growth).

An obvious limitation of using realized earnings is that past earnings contain incomplete information about expected earnings and hence potentially about expected returns. Inferring market expectations about future earnings from sell-side equity research analysts' forecasts could help. Further, to develop an estimate of expected return, it is important to estimate a forward-looking beta. Using expectations seems conceptually appropriate to estimate a forward-looking beta. I/B/E/S analyst forecasts are also available at monthly frequency, compared to quarterly frequency for realized earnings, which should deliver more efficient beta estimates. However, the trade-off is that forecasts are available for a subset of firms which reduces coverage.

Using analyst forecasts also poses some issues, such as sluggish revisions and behavioral biases. For example, many prior empirical studies have reported systematic analyst optimism, especially at long horizons. Further, the walk down to beatable analyst forecasts documented in Richardson et al. (2004) generates a predictable pattern for earnings expectations as the horizon changes during the year. Thus, to enhance cross-sectional comparability and mitigate the effect of the walk down, I develop a *constant* horizon 12-month-ahead earnings forecast.

Specifically, for each firm i every month t , I construct a 12-month-ahead earnings forecast ($F12$) by time-weighting the consensus mean one-year-ahead ($F1$) and two-year-ahead ($F2$) earnings per share (EPS) forecast in the I/B/E/S summary unadjusted annual files. The EPS forecasts are split-adjusted using CRSP adjustment factors and converted to earnings using shares outstanding from CRSP. I then compute a 12-month-ahead earnings forecast: $E_t[F12_i] = w_{i,t} E_t[F1_i] + (1 - w_{i,t}) E_t[F2_i]$, where the monthly weights ($w_{i,t}$) are based on the number of days between the forecast date and the fiscal period end-date for the firm's one-year-ahead forecast ($F1$), divided by 365 days. This measure of expected earnings places a larger weight on the one-year-ahead forecast earlier in the fiscal period and an increasing weight on the two-year-ahead forecast as the fiscal period progresses. This measure of the level of expected earnings is used for two of the earnings series: expected ROE and expected earnings yield.

I also construct three earnings series based on the monthly changes in expected earnings.⁹ Tracking how expected earnings evolve over time (i.e., expectations shocks) could provide a timelier measure of the expected path of earnings and could be a suitable basis to estimate expected returns.¹⁰ For example, a downward

⁹ Similarly, Da and Warachka (2009) track revisions in analyst earnings forecasts to develop a cash flow news measure and compute cash flow beta. Taking a slightly different approach, Nallareddy (2012) measures earnings shocks as returns driven by revisions to expectations of future earnings and finds that returns to the post-earnings-announcement drift (PEAD) strategy relate to the differential responses of individual stock returns to aggregate earnings shocks.

¹⁰ Present value models also support the role of changes in expected earnings (cash flow) for changes in prices (i.e., expected returns). The first effect is in the numerator by altering the path of future cash flows. The second effect is in the denominator by altering the systematic risk embedded in expected returns. And if the changes in expected earnings indicate aggregate-level shocks, the third effect is through time-varying market risk premiums.

revision in expected earnings during bad times when aggregate expected earnings also experience negative shocks is systematic risk that could be priced. It is also likely that revisions in expectations incorporate both firm-specific and macroeconomic information that is relevant for returns. Consistent with this notion, Carabias (2018) finds that the continuous intra-quarter flow of macroeconomic news is incorporated by equity analysts in subsequent forecast revisions. Finally, using monthly changes in expected earnings could help mitigate the effect of analyst biases, although sluggish revisions will inevitably introduce measurement error, similar to delayed price reactions in returns.

For changes in expectations, I compute monthly revisions in the 12-month-ahead earnings forecast (i.e., $\Delta E_i[F12_i]$) using fixed weights so that the change is driven by revisions (i.e., expectations shocks) and not by elapsed time. The changes in expected earnings are then scaled either by prior period expected earnings (i.e., earnings-scaled expectations shocks), by book value of equity (i.e., book-scaled expectations shocks), or by market value of equity (i.e., price-scaled expectations shocks).

The 10 earnings series considered so far involve either realized earnings over the prior 12 months or expected earnings over the next 12 months. In addition to simplifying the construction and obviating the need to forecast earnings over an infinite horizon, I focus on short-term earnings for several reasons. First, while expected returns should relate to changes in the entire term structure of earnings expectations, whether short-horizon expected returns are driven more by changes in expectations about short-term earnings or by changes in expectations about long-term earnings is not clear. For example, Binsbergen et al. (2012) find that short-term dividends have a higher risk premium than long-term dividends, which is opposite to what most asset pricing models predict. Second, long-term growth forecasts are revised relatively infrequently since performance evaluations and investor rankings of equity research analysts focus mainly on short-term forecasting ability.¹¹ It is also possible that transitory shocks are more frequent than permanent shocks, and, as a result, the pricing effect and market attention may be concentrated on short-horizon earnings. Along similar lines, Croce et al. (2009) show that, if the agents cannot distinguish between short-term and long-term shocks, risk premia on short-term dividend strips can be higher. Third, there are empirical gains from focusing on shorter horizons, because data availability is better for a broader cross-section of firms. Nevertheless, the last earnings series I consider is based on revisions in analysts' long-term growth forecasts for a smaller sub-sample of firms and covering a shorter period.

2.2 Estimation of earnings beta

I use each of the 11 earnings series described above to estimate earnings betas. Each earnings series is regressed on an analogous earnings series at the aggregate level in rolling windows to provide time-varying estimates of earnings beta. To

¹¹ Similarly, Da and Warachka (2011) note that equity research analysts have weak incentives to promptly incorporate information into their long-term growth forecasts, because the average analyst's career lasts four years. In my sample LTG forecasts are revised 22% of the time, while two-year-ahead EPS forecasts are revised 74% of the time.

compute the 11 aggregate earnings series, I sum realized and expected earnings for all firms at each point in time and also sum the relevant prior-period scalar for the same firms at that point in time, ensuring that the numerator and denominator comprise the same firms. This aggregation approach is equivalent to value-weighting firms. To compute period-to-period changes in realized and expected earnings, I aggregate up contiguous periods for the same set of firms before computing changes.

To estimate earnings betas, the various earnings measures are constructed either at the portfolio-level or at the firm-level. These earnings measures are then regressed each period (quarterly for realizations and monthly for expectations) on equivalent aggregate-level measures using backward-rolling five-year windows (minimum of three years) using the following model:

$$Measure_{i,t} = \alpha_i + \beta_{i,t} Measure_{MKT,t} + \varepsilon_{i,t}. \quad (1)$$

Equation (1) delivers time-varying estimates of earnings beta. See Appendix 2 for further details on the construction of each earnings series and the process used to estimate earnings beta. I also estimate market beta using a similar approach by regressing monthly returns on CRSP value-weighted index returns over backward-rolling five-year windows (see Appendix 1).

3 Research design and results

3.1 Sample and data description

I collect data on firm fundamentals, prices, and analysts' earnings forecasts from the intersection of Compustat, CRSP, and I/B/E/S. Table 1 describes the sample construction, which starts with 1,392,337 firm-months covering all firms in the I/B/E/S summary unadjusted files with forecasts for the next two fiscal years ($F1$ and $F2$) that can be matched with CRSP and Compustat data over 1976–2017.¹² I exclude government and non-operating establishments (SIC code 9000–9999). Additional data is lost due to the five-year backward-rolling beta estimation procedure and the requirement of characteristics for the firm-level pricing tests. The final sample is 872,991 firm-months from April 1981 to June 2017 and covers 91.7% of the market value of the CRSP-Compustat-I/B/E/S merged universe.

Following Beaver et al. (2007), I use delisting returns from CRSP where available and compute missing delisting returns using the average delisting return for the same delisting code. For book values of equity, I use the latest available quarterly or annual fiscal period. To avoid look-ahead bias and to ensure that the same accounting reports that would be available to investors are used in the

¹² Using one-year- and two-year-ahead forecasts provides the broadest possible coverage of firms in the cross-section; requiring earnings forecasts for three and four years ahead would reduce the sample by about one-half. Further, long-term forecasts are only available for about two-thirds of the firm-months and are revised infrequently, likely due to stronger analyst incentives to focus on the short-term.

Table 1 Sample Construction

	Firm-months
Firm-months with I/B/E/S one- and/or two-year forecasts and CRSP/ Compustat match	1,392,337
Remove government and non-operating establishments (SIC code: 9000–9999)	–25,608
Number of firm-months in aggregate earnings series construction	1,366,729
Initial firm-months lost in five-year rolling beta estimations	–399,138
Number of firm-level earnings beta estimates	967,591
Keep beta estimates using at least three years of data and require characteristics data	–94,600
Final sample (1981–2017)	872,991

Year	Firms in I/B/E/S	Firms with Betas	Firms with Betas (%)	Market Value Coverage (%)
1981	1,553	1,094	70.4%	91.0%
1982	1,793	1,226	68.4%	89.1%
1983	2,099	1,241	59.1%	86.6%
1984	2,516	1,273	50.6%	85.2%
1985	2,578	1,383	53.6%	82.8%
1986	2,640	1,543	58.4%	84.9%
1987	2,874	1,679	58.4%	84.7%
1988	2,912	1,664	57.1%	91.7%
1989	2,980	1,705	57.2%	90.6%
1990	2,957	1,829	61.9%	92.1%
1991	2,959	1,941	65.6%	93.3%
1992	3,221	2,084	64.7%	92.4%
1993	3,458	2,189	63.3%	92.2%
1994	4,149	2,295	55.3%	88.9%
1995	4,374	2,454	56.1%	91.1%
1996	4,748	2,568	54.1%	89.7%
1997	5,175	2,849	55.1%	89.4%
1998	5,285	2,966	56.1%	91.3%
1999	5,029	3,030	60.3%	90.1%
2000	4,899	3,044	62.1%	89.2%
2001	4,352	2,877	66.1%	91.7%
2002	3,888	2,760	71.0%	93.5%
2003	3,578	2,785	77.8%	95.3%
2004	3,648	2,874	78.8%	94.7%
2005	3,764	2,900	77.0%	95.2%
2006	3,818	2,869	75.1%	94.3%
2007	3,846	2,820	73.3%	94.0%
2008	3,733	2,799	75.0%	93.5%
2009	3,588	2,796	77.9%	95.7%
2010	3,507	2,836	80.9%	95.3%

Table 1 (continued)

2011	3,381	2,835	83.9%	94.4%
2012	3,187	2,704	84.8%	94.0%
2013	3,080	2,647	85.9%	96.5%
2014	3,078	2,587	84.0%	95.9%
2015	3,085	2,526	81.9%	95.8%
2016	2,967	2,441	82.3%	96.6%
2017	2,572	1,978	76.9%	88.2%
Average	3,440	2,327	68.1%	91.7%

This table summarizes the sample selection process. The final sample of firm-level beta estimates covers the period from April 1981 to June 2017. The table also reports the number of firms each year used to compute aggregate earnings series and the number of firms with estimated betas.

empirical analysis, prices are observed six months ($t + 6$) after fiscal period-end, and returns are measured in month $t + 7$, following Fama and French (1993).

Table 2 reports the distribution of the returns and beta estimates for the portfolio-level and firm-level analyses. For the portfolio-level statistics, I form 50 decile portfolios each month by sorting firms on the basis of book-to-price, earnings-to-price, size, long-term return reversal, and asset growth. There are 21,750 portfolio-month observations (50 portfolios \times 435 months). For the firm-level statistics, there are 872,991 firm-month observations over the 435 months (36 years) from April 1981 to June 2017. One of the primary advantages of forming portfolios is a reduction in noise in the beta estimation, which can be observed in the reported coefficient of variation (i.e., standard deviation divided by mean). For the portfolio-level beta estimates the coefficient of variation is an order of magnitude lower than the firm-level estimates. Also, while at the firm-level there are a large number of negative earnings betas (around the 25th percentile), there are much fewer instances of negative earnings betas at the portfolio-level (less than fifth percentile). This increased precision should enable stronger inferences from the portfolio-level pricing tests.

Table 3 reports cross-sectional averages of monthly Pearson (above diagonal) and Spearman (below diagonal) correlations between monthly returns and the various beta estimates variables at the portfolio level (Panel A) and firm level (Panel B). The portfolio-level correlations in Panel A show that value-weighted monthly returns are negatively correlated (Pearson correlation of -0.038) with market beta consistent with prior literature (e.g., Black 1972; Frazzini and Pedersen 2014) but are *positively* correlated with six out of the 11 earnings betas. The highest correlation is for the price-scaled expectations shock beta (Pearson correlation of 0.037). Earnings betas are all mostly positively correlated with market beta as well as with each other.

Table 2 Descriptive Statistics

Panel A: Portfolio-level												
Variable	Mean	Std. Dev.	C.V.	P5	P10	P25	P50	P75	P90	P95		
Value-weighted r_{t+1} (%)	1.023	5.288	5.171	-7.397	-5.027	-1.811	1.287	3.989	6.882	8.973		
Market Beta	1.135	0.216	0.191	0.817	0.891	1.003	1.119	1.237	1.404	1.520		
Realized Earnings Growth Beta	1.371	1.579	1.152	0.211	0.304	0.500	0.849	1.647	3.191	4.461		
Earnings-scaled Expectations Shock Beta	1.624	2.499	1.538	0.318	0.459	0.684	0.960	1.470	3.316	6.393		
Expected Long-Term Growth Beta	1.574	2.802	1.780	0.379	0.513	0.713	0.989	1.459	2.627	4.679		
Realized ROE Beta	1.049	1.233	1.175	-0.251	0.034	0.412	0.839	1.375	2.183	3.064		
Book-scaled Realized Earnings Growth Beta	1.085	0.799	0.737	0.324	0.446	0.645	0.910	1.297	1.856	2.353		
Expected ROE Beta	0.994	1.086	1.092	-0.409	0.008	0.449	0.879	1.410	2.167	2.817		
Book-scaled Expectations Shock Beta	0.935	0.402	0.430	0.415	0.520	0.702	0.899	1.116	1.352	1.542		
Realized Earnings Yield Beta	1.301	2.592	1.992	-0.069	0.184	0.549	0.926	1.367	2.319	3.937		
Price-scaled Realized Earnings Growth Beta	1.659	2.463	1.484	0.242	0.353	0.564	0.933	1.738	3.361	5.166		
Expected Earnings Yield Beta	0.808	0.695	0.860	-0.283	0.143	0.517	0.847	1.130	1.468	1.778		
Price-scaled Expectations Shock Beta	1.143	0.661	0.578	0.445	0.556	0.734	0.998	1.322	1.843	2.439		

Table 2 (continued)

Panel B: Firm-level										
Variable	Mean	Std. Dev.	C.V.	P5	P10	P25	P50	P75	P90	P95
r_{t+1} (%)	1.133	13.227	11.674	-18.042	-12.326	-5.213	0.764	6.848	14.407	20.848
Market Beta	1.141	0.702	0.615	0.227	0.371	0.668	1.047	1.479	2.009	2.414
Realized Earnings Growth Beta	0.364	3.227	8.859	-3.838	-2.014	-0.463	0.145	1.134	3.206	5.035
Earnings-scaled Expectations Shock Beta	1.125	4.732	4.208	-3.681	-1.704	-0.240	0.462	1.838	4.950	8.458
Expected Long-Term Growth Beta	1.179	4.610	3.912	-2.944	-1.368	-0.175	0.495	1.791	4.636	8.189
Realized ROE Beta	0.632	9.661	15.299	-5.234	-2.569	-0.597	0.336	1.661	4.209	7.250
Book-scaled Realized Earnings Growth Beta	0.451	6.906	15.298	-5.198	-2.494	-0.569	0.214	1.330	3.714	6.465
Expected ROE Beta	1.191	3.648	3.062	-2.569	-1.143	-0.073	0.575	1.917	4.488	7.084
Book-scaled Expectations Shock Beta	0.782	2.117	2.709	-1.643	-0.844	-0.096	0.389	1.318	2.988	4.480
Realized Earnings Yield Beta	0.566	7.667	13.555	-4.607	-2.474	-0.683	0.215	1.205	3.426	6.613
Price-scaled Realized Earnings Growth Beta	0.678	6.949	10.247	-5.656	-2.670	-0.553	0.192	1.425	4.652	8.725
Expected Earnings Yield Beta	0.441	2.390	5.421	-2.558	-1.078	-0.073	0.358	1.151	2.467	3.706
Price-scaled Expectations Shock Beta	1.149	3.073	2.674	-2.001	-0.983	-0.099	0.463	1.749	4.181	6.453

This table reports portfolio-level descriptive statistics for 21,750 portfolio-months (Panel A) and 872,991 firms-months (Panel B) from April 1981 to June 2017. For Panel A, 50 decile portfolios are formed each month by sorting firms on the basis of size, book-to-price, earnings-to-price, asset growth, and long-term return reversal. For firm-level statistics, the top and bottom 1% of variables each month were excluded, except for returns. All variables are described in Appendix 1 and Appendix 2.

Table 3 Average Monthly Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13
Panel A: Portfolio-level													
1 Value-weighted r_{t+1}													
2 Market Beta	-0.038												
3 Realized Earnings Growth Beta	-0.001	0.262											
4 Earnings-scaled Expectations Shock Beta	0.015	0.217	0.375										
5 Expected Long-Term Growth Beta	0.008	0.239	0.353	0.858									
6 Realized ROE Beta	-0.016	0.325	0.467	0.290	0.286								
7 Book-scaled Realized Earnings Growth Beta	0.010	0.262	0.773	0.403	0.376	0.586							
8 Expected ROE Beta	-0.016	0.156	-0.030	0.006	0.007	0.206	0.094						
9 Book-scaled Expectations Shock Beta	0.016	-0.049	-0.232	0.163	0.228	-0.079	-0.141	0.159					
10 Realized Earnings Yield Beta	-0.002	0.119	0.396	0.354	0.334	0.440	0.456	0.015	-0.103				
11 Price-scaled Realized Earnings Growth Beta	0.017	0.122	0.810	0.463	0.438	0.468	0.815	-0.068	-0.277	0.594			
12 Expected Earnings Yield Beta	-0.016	-0.006	-0.168	-0.136	-0.139	-0.061	-0.114	0.435	0.317	-0.021	-0.221		
13 Price-scaled Expectations Shock Beta	0.040	-0.007	0.228	0.554	0.620	0.184	0.261	0.005	0.442	0.341	0.377	-0.011	

Table 3 (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13
Panel B: Firm-level													
1		-0.015	0.000	-0.002	-0.001	-0.006	-0.001	0.011	0.010	-0.003	0.003	0.010	0.015
2	r_{t+1}		0.066	0.172	0.191	0.078	0.040	0.124	0.174	0.021	0.055	0.007	0.200
3	Market Beta	-0.026		0.144	0.130	0.349	0.600	0.105	0.149	0.345	0.667	-0.020	0.154
4	Realized Earnings Growth Beta	-0.002	0.094		0.907	0.101	0.089	0.092	0.412	0.068	0.145	-0.035	0.481
5	Earnings-scaled Expectations Shock Beta	-0.004	0.212	0.205		0.080	0.067	0.105	0.403	0.054	0.130	-0.054	0.476
6	Expected Long-Term Growth Beta	-0.003	0.244	0.203	0.906		0.420	0.084	0.085	0.315	0.345	-0.019	0.100
7	Realized ROE Beta	-0.009	0.150	0.496	0.185	0.184		0.075	0.112	0.295	0.621	-0.019	0.102
8	Book-scaled Realized Earnings Growth Beta	-0.003	0.114	0.867	0.212	0.217	0.549		0.255	0.041	0.071	0.338	0.179
9	Expected ROE Beta	0.007	0.150	0.153	0.161	0.173	0.166	0.169		0.052	0.107	0.117	0.716
10	Book-scaled Expectations Shock Beta	0.008	0.206	0.212	0.667	0.663	0.185	0.245	0.254		0.397	0.072	0.050
11	Realized Earnings Yield Beta	-0.003	0.028	0.388	0.122	0.138	0.388	0.360	0.114	0.115		-0.031	0.151
12	Price-scaled Realized Earnings Growth Beta	-0.003	0.106	0.855	0.220	0.225	0.503	0.867	0.150	0.219	0.410		0.070
13	Expected Earnings Yield Beta	0.021	0.053	-0.018	-0.010	-0.027	-0.023	-0.010	0.313	0.116	0.124	-0.016	
	Price-scaled Expectations Shock Beta	0.011	0.223	0.219	0.694	0.691	0.192	0.234	0.206	0.814	0.136	0.241	0.098

This table reports time-series averages of monthly correlations between portfolio-month variables (Panel A) and firm-month variables (Panel B) from April 1981 to June 2017. For Panel A, 50 decile portfolios are formed each month by sorting firms on the basis of size, book-to-price, earnings-to-price, asset growth, and long-term return reversal. Pearson correlations are reported above the diagonal, and Spearman correlations are reported below the diagonal. All variables are described in Appendix 1 and Appendix 2.

3.2 Portfolio-level pricing tests

Consistent with standard asset pricing tests, the primary analyses are conducted at the portfolio-level. This has the potential advantage of producing less noisy beta estimates and reducing the potential influence of outliers. Thus the various earnings series are accumulated up to the portfolio level in the same way that the aggregate earnings series are constructed. I form portfolios by sorting firms on the basis of five characteristics commonly used in the asset pricing literature: 10 each on size, book-to-price, earnings-to-price, asset growth, and long-term return reversal. These characteristics provide a spread in returns that is not explained by market beta. To examine whether any of the earnings betas are priced, I use standard two-stage cross-sectional pricing tests. In the first stage, I use eq. (1) to estimate time-varying portfolio-level earnings betas by regressing the 11 different earnings series at the portfolio level on analogous earnings series at the aggregate level over five year backward-rolling windows. In the second stage, value-weighted monthly excess returns for each portfolio are averaged over 1981 to 2017 and are regressed on the time-series average of estimated portfolio betas from the first stage. Specifically, I conduct the following portfolio-level pricing tests in the second stage:

$$\bar{r}_p^e = \gamma_0 + \gamma_1 \bar{r}_p + \varepsilon_p. \quad (2)$$

If the earnings betas are priced in the cross-section of these portfolio average returns, I expect the estimation of Eq. (2) to yield a positive and statistically significant γ_1 coefficient. Since the 11 different earnings series will deliver different estimates of earnings beta, I am also interested in examining their relative performance in order to assess whether the explanatory power of earnings beta is sensitive to the construction of the earnings series used to estimate beta.

Table 4 reports the results of the two-stage cross-sectional pricing tests for the value-weighted monthly average returns of the 50 characteristics-sorted portfolios. Consistent with prior studies, market beta (row 1) cannot explain much of the variation in returns. Six out of the 11 earnings betas have positive and significant risk premiums (γ_1), including earnings-scaled expectations shock beta (row 3), expected long-term growth beta (row 4), book-scaled realized earnings growth beta (row 6), realized earnings yield beta (row 9), price-scaled realized earnings growth beta (row 10), and price-scaled expectations shock beta (row 12). Two of the earnings betas based on earnings levels, including expected ROE beta (row 7), and expected earnings yield beta (row 11) have negative and significant risk premiums, while realized ROE beta (row 5) and book-scaled expectations shock beta (row 8) do not have significant risk premiums.¹³ The largest coefficient is for

¹³ Interestingly, even though expected ROE beta and expected earnings yield beta have negative and significant estimated risk premiums in Table 4, I find that several of the fitted excess returns for the 50 portfolios generated from these two approaches to estimate earnings beta are close to the average excess returns, as shown by the cluster of data points along the diagonal in Figure 1 (see Panels g and k). This visualization of the fit corroborates the R^2 of 20% and 30% for expected ROE beta and expected earnings yield beta, respectively. One potential explanation for the negative risk premiums could be that the pricing tests are weak and are sensitive to the selection of characteristics used to sort firms into portfolios. Therefore, I conduct additional portfolio-level and firm-level pricing tests for robustness and find that these two betas have consistently positive risk premiums.

Table 4 Two-Stage Cross-Sectional Pricing Tests

Beta Estimation Model:		(1)	(2)	(3)	(4)	(5)
		γ_0	$t(\gamma_0)$	γ_1	$t(\gamma_1)$	Adj. R ²
1	Market Beta	1.076***	(4.67)	-0.346	(-1.64)	8.5%
2	Realized Earnings Growth Beta	0.647***	(17.69)	0.026	(1.51)	1.6%
3	Earnings-scaled Expectations Shock Beta	0.637***	(25.50)	0.029***	(4.11)	6.9%
4	Expected Long-Term Growth Beta	0.635***	(22.66)	0.031**	(2.22)	6.6%
5	Realized ROE Beta	0.654***	(15.98)	0.028	(1.02)	-0.1%
6	Book-scaled Realized Earnings Growth Beta	0.611***	(13.59)	0.067**	(2.08)	4.8%
7	Expected ROE Beta	0.901***	(16.65)	-0.219***	(-3.79)	20.0%
8	Book-scaled Expectations Shock Beta	0.815***	(8.08)	-0.140	(-1.17)	2.8%
9	Realized Earnings Yield Beta	0.619***	(21.16)	0.050***	(3.83)	13.5%
10	Price-scaled Realized Earnings Growth Beta	0.629***	(23.51)	0.033***	(5.45)	15.2%
11	Expected Earnings Yield Beta	0.939***	(14.18)	-0.317***	(-3.70)	30.0%
12	Price-scaled Expectations Shock Beta	0.438***	(8.55)	0.218***	(5.49)	41.9%

This table reports results of two-stage cross-sectional regressions of portfolio-level value-weighted average excess returns on average portfolio-level estimates of various measures of beta. The analysis uses 50 portfolios created by sorting firms each month into deciles on the basis of size, book-to-price, earnings-to-price, asset growth, and long-term return reversal. Each row in the table represents a cross-sectional regression using different portfolio-level beta estimates. See Appendix 2 for further details about the various estimates of earnings beta. In the first stage, time-varying portfolio betas (β_p) are estimated from backward-rolling regressions over five years (minimum of three years required) of the relevant portfolio-level measure on the aggregate-level measure ($Measure_{p,t} = \alpha_p + \beta_p \cdot Measure_{M,t} + \varepsilon_{p,t}$). In the second stage, value-weighted monthly excess returns for each portfolio averaged over the 1981 to 2017 period are regressed on the time-series average of estimated portfolio betas ($\bar{\beta}_p$) from the first stage using the following model: $\bar{r}_p^e = \gamma_0 + \gamma_1 \bar{\beta}_p + \varepsilon_p$. The tables report coefficients and robust t -statistics in parentheses from the second-stage cross-sectional regressions. The coefficient of interest is the estimated risk premium γ_1 in column 3, and the predicted sign is positive. The adjusted R² is also reported. The asterisks *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is April 1981 to June 2017 (435 months). The estimated coefficients in each row are used to generate the plots for value-weighted average excess returns against fitted excess returns presented in Fig. 1.

the price-scaled expectations shock beta of 0.218 with a t -statistic of 5.49 (adjusted R² of 41.9%), which suggests an estimated annual risk premium of 2.6% (0.218×12).

Figure 1 presents scatter plots for the value-weighted average excess returns against fitted (i.e., predicted) excess returns for the 50 test portfolios over the full sample. Fitted returns are generated from the estimated coefficients in Table 4 for market beta and for each of the 11 earnings betas. These plots help to visualize the results in Table 4 by showing whether the fitted returns for the 50 portfolios generated from the various estimated betas lie along the diagonal line. Corroborating the results in Table 4, price-scaled expectations shock beta has the best explanatory power for value-weighted excess returns of the 50 test portfolios.

Generally, earnings betas based on changes in earnings (i.e., growth) outperform betas based on levels of earnings, betas based on earnings expectations

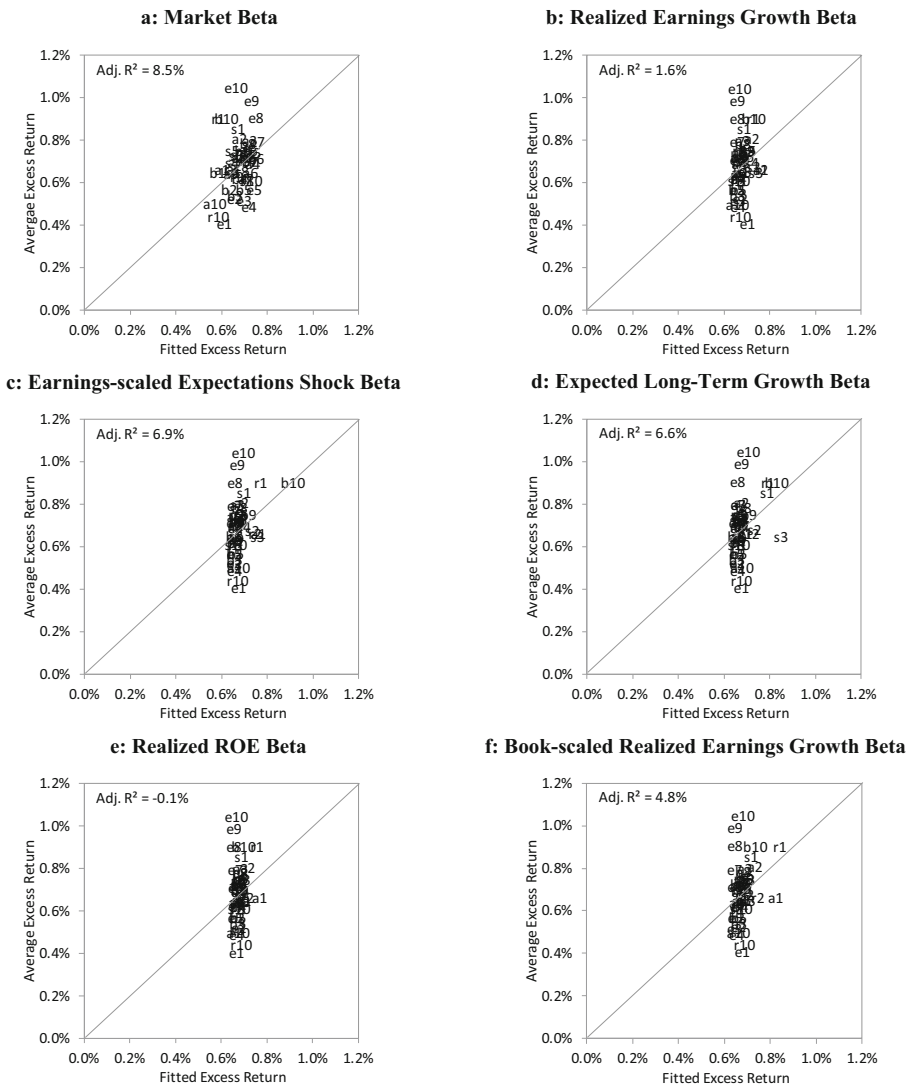


Fig. 1 Average Excess Returns versus Fitted Excess Returns, **a:** Market Beta, **b:** Realized Earnings Growth Beta, **c:** Earnings-scaled Expectations Shock Beta, **d:** Expected Long-Term Growth Beta, **e:** Realized ROE Beta, **f:** Book-scaled Realized Earnings Growth Beta, **g:** Expected ROE Beta, **h:** Book-scaled Expectations Shock Beta, **i:** Realized Earnings Yield Beta, **j:** Price-scaled Realized Earnings Growth Beta, **k:** Expected Earnings Yield Beta, **l:** Price-scaled Expectations Shock Beta. This figure shows plots of value-weighted average monthly excess returns against fitted excess returns for 50 portfolios over the 1981–2017 period: 10 size-sorted from small (s1) to large (s10), 10 B/P-sorted from low (b1) to high (b10), 10 E/P-sorted from low (e1) to high (e10), 10 asset growth-sorted from low (a1) to high (a10), and 10 long-term return reversal-sorted from low (r1) to high (r10). First, earnings betas for each portfolio (β) are estimated from 60-month rolling regressions using this model: $Measure_{i,t} = \alpha_i + \beta_i Measure_{MKT,t} + \varepsilon_{i,t}$, where $Measure$ is either returns (for *Market Beta*) or one of 11 earnings measures (for *Earnings Beta*) described in Appendix 2. Second, value-weighted average monthly excess returns for portfolios are regressed on average estimated betas from the first stage using the following model: $\bar{r}_p^e = \gamma_0 + \gamma_1 \bar{\beta}_p + \varepsilon_p$. Each panel uses a different beta estimate to generate fitted excess returns for the 50 portfolios and plots them against value-weighted average excess returns.

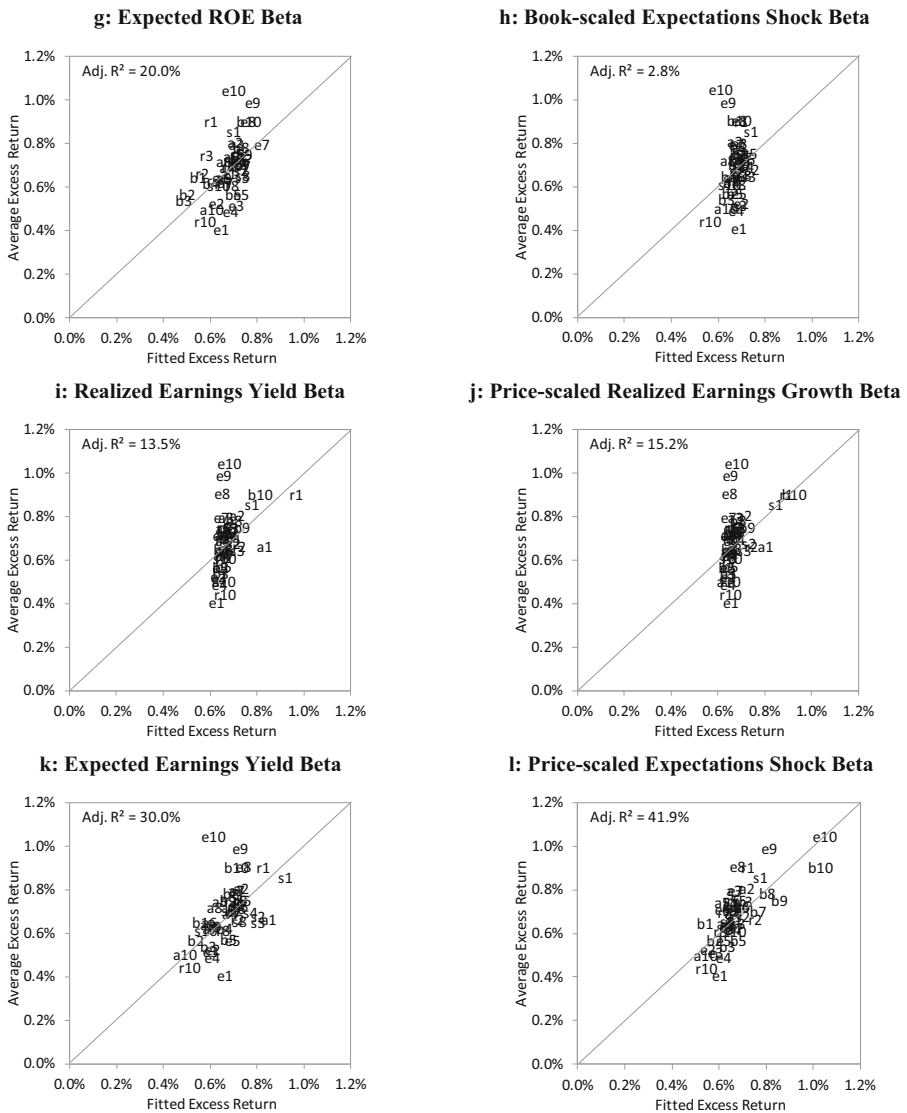


Fig. 1 (continued)

outperform betas based on earnings realizations, and betas based on changes in expectations of earnings outperform betas based on levels of expectations. Also, betas based on price-scaled earnings series outperform betas based on book-scaled earnings series.

Next, I conduct out-of-sample pricing tests by splitting the 1981–2017 sample period into two subsamples (1981–1996 and 2002–2017) and removing the beta estimation period of five years between the two subsamples. I estimate earnings betas separately for each subsample and examine whether betas from one subsample can explain cross-sectional variation in value-weighted monthly returns in the other. Panel A of Table 5 reports the results of pricing tests for monthly

Table 5 Out-of-Sample Pricing Tests

Beta Estimation Model:		(1)	(2)	(3)	(4)	(5)
		γ_0	$t(\gamma_0)$	γ_1	$t(\gamma_1)$	Adj. R ²
Panel A: Beta Estimation from 1981 to 1996 and Return Measurement from 2002 to 2017						
1	Market Beta	1.064***	(6.73)	-0.356**	(-2.46)	5.3%
2	Realized Earnings Growth Beta	0.674***	(16.86)	0.000	(0.01)	-2.1%
3	Earnings-scaled Expectations Shock Beta	0.632***	(23.48)	0.030**	(2.10)	4.6%
4	Expected Long-Term Growth Beta	0.623***	(26.97)	0.036***	(4.34)	8.9%
5	Realized ROE Beta	0.814***	(18.18)	-0.143***	(-3.40)	13.7%
6	Book-scaled Realized Earnings Growth Beta	0.689***	(10.04)	-0.014	(-0.19)	-2.0%
7	Expected ROE Beta	0.820***	(17.46)	-0.156***	(-3.39)	22.0%
8	Book-scaled Expectations Shock Beta	0.956***	(10.31)	-0.314***	(-2.80)	15.0%
9	Realized Earnings Yield Beta	0.704***	(9.76)	-0.027	(-0.41)	-1.2%
10	Price-scaled Realized Earnings Growth Beta	0.621***	(22.51)	0.038**	(2.06)	6.7%
11	Expected Earnings Yield Beta	1.042***	(15.75)	-0.412***	(-5.87)	31.1%
12	Price-scaled Expectations Shock Beta	0.446***	(10.39)	0.184***	(5.63)	26.7%
Panel B: Beta Estimation from 2002 to 2017 and Return Measurement from 1981 to 1996						
1	Market Beta	0.640***	(4.40)	0.036	(0.29)	-1.9%
2	Realized Earnings Growth Beta	0.648***	(15.57)	0.029	(1.07)	0.3%
3	Earnings-scaled Expectations Shock Beta	0.670***	(21.04)	0.007	(0.54)	-1.3%
4	Expected Long-Term Growth Beta	0.691***	(20.27)	-0.005	(-0.29)	-1.7%
5	Realized ROE Beta	0.669***	(19.58)	0.012	(0.66)	-1.4%
6	Book-scaled Realized Earnings Growth Beta	0.670***	(16.49)	0.012	(0.47)	-1.8%
7	Expected ROE Beta	0.766***	(12.21)	-0.079	(-1.42)	1.6%
8	Book-scaled Expectations Shock Beta	0.711***	(7.34)	-0.029	(-0.28)	-1.8%
9	Realized Earnings Yield Beta	0.670***	(23.88)	0.008	(1.04)	-0.9%
10	Price-scaled Realized Earnings Growth Beta	0.665***	(22.83)	0.009	(1.31)	0.0%
11	Expected Earnings Yield Beta	0.736***	(14.17)	-0.073	(-1.17)	1.6%
12	Price-scaled Expectations Shock Beta	0.544***	(11.22)	0.112**	(2.56)	11.8%

This table reports results of out-of-sample two-stage cross-sectional regressions of portfolio-level value-weighted average excess returns on average portfolio-level estimates of various measures of beta. The sample period from April 1981 to June 2017 is split into two subsamples: 1981–1996 and 2002–2017. The periods 1981–1996 and 2002–2017 were selected by splitting 1981–2017 into two subsamples and removing the beta estimation period of five years in between the two subsamples. Panel A uses the 1981–1996 subsample to estimate betas and conducts pricing tests using value-weighted average excess returns over the 2002–2017 subsample. Panel B uses the 2002–2017 subsample to estimate betas and conducts pricing tests using value-weighted average excess returns over the 1981–1996 subsample. The analysis uses 50 portfolios created by sorting firms each month into deciles on the basis of size, book-to-price, earnings-to-price, asset growth, and long-term return reversal. Each row in the table represents a cross-sectional regression using different portfolio-level beta estimates. See Appendix 2 for further details about the various estimates of earnings beta. In the second stage, value-weighted average monthly excess returns for each portfolio from one subsample are regressed on the time-series average of estimated portfolio betas from the second subsample, as indicated. The tables report coefficients and robust t -statistics in parentheses from the second-stage cross-sectional regressions. The coefficient of interest is the estimated risk premium γ_1 in column 3, and the predicted sign is positive. The adjusted R² is also reported. The asterisks *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 6 Three-Pass Pricing Tests

Beta Estimation Model:		(1)	(2)	(3)	(4)	(5)
		γ_0	$t(\gamma_0)$	γ_1	$t(\gamma_1)$	R ²
1	Market Beta	0.839***	(6.36)	0.161	(0.64)	99.1%
2	Realized Earnings Growth Beta	0.839***	(6.36)	0.464	(1.21)	64.6%
3	Earnings-scaled Expectations Shock Beta	0.839***	(6.36)	0.485	(1.48)	67.3%
4	Expected Long-Term Growth Beta	0.804***	(6.22)	0.391	(1.28)	65.5%
5	Realized ROE Beta	0.839***	(6.36)	0.021	(0.59)	50.8%
6	Book-scaled Realized Earnings Growth Beta	0.839***	(6.36)	0.040	(1.16)	61.3%
7	Expected ROE Beta	0.839***	(6.36)	0.326**	(2.07)	53.1%
8	Book-scaled Expectations Shock Beta	0.839***	(6.36)	0.386**	(2.20)	58.4%
9	Realized Earnings Yield Beta	0.839***	(6.36)	0.058*	(1.67)	52.4%
10	Price-scaled Realized Earnings Growth Beta	0.839***	(6.36)	0.034*	(1.81)	59.0%
11	Expected Earnings Yield Beta	0.839***	(6.36)	0.461**	(2.32)	38.2%
12	Price-scaled Expectations Shock Beta	0.839***	(6.36)	0.487**	(2.26)	60.7%

This table reports results from asset pricing tests based on the three-pass regression estimator developed by Giglio and Xiu (2019). The pricing tests involve 202 portfolios: 25 portfolios sorted by size and book-to-price, 17 industry portfolios, 25 portfolios sorted by operating profitability and investment, 25 portfolios sorted by size and variance, 35 portfolios sorted by size and net issuance, 25 portfolios sorted by size and accruals, 25 portfolios sorted by size and beta, and 25 portfolios sorted by size and momentum. Each row in the table reports coefficients and t -statistics in parentheses from the three-pass regression for different estimates of beta. See Appendix 2 for further details about the various estimates of earnings beta. The Giglio and Xiu (2019) three-pass regression estimator allows for an unconstrained zero-beta rate and extracts six principal components from the returns of the 202 portfolios. The estimation was conducted using code made available by the authors on their website and was downloaded from <https://dachxiu.chicagobooth.edu>. The coefficient of interest is the estimated risk premium γ_1 in column 3, and the predicted sign is positive. The table also reports the R² for the time-series regression of the value-weighted returns of the factor (g) underlying each beta estimation model onto the six principal components. The asterisks *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

returns over the 2002–2017 period when earnings betas are estimated over the 1980–1996 period. The results generally echo the full-sample results in Table 4 with four of the 11 earnings betas continuing to have positive and significant risk premiums. The largest risk premium is for price-scaled expectations shock beta, which explains 26.7% of the variation in returns. Panel B of Table 5 reports the results of pricing tests for monthly returns over the earlier subsample (1980–1996) when earnings betas are estimated over the later subsample (2002–2017). Except for price-scaled expectations shock beta, all the other betas have insignificant risk premiums.

Finally, in light of the concerns expressed by Lewellen et al. (2010) about using a limited set of portfolios in pricing tests, I also employ the three-pass regression pricing tests proposed by Giglio and Xiu (2019) to account for potentially omitted factors in standard pricing tests. These pricing tests involve 202 portfolios including 25 portfolios sorted by size and book-to-price, 17 industry portfolios, 25 portfolios sorted by operating profitability and investment, 25 portfolios sorted by size and variance, 35 portfolios sorted by size and net issuance, 25 portfolios

Table 7 Factor-Mimicking Portfolios Formed on Beta**Panel A: Value-Weighted Average Excess Returns and Alphas for Factor-Mimicking Portfolios**

Factor-Mimicking Portfolio formed on:		VW Excess Returns		Six-Factor Alpha		IPCA Five-Factor Alpha	
		(1) r^e	(2) $t(r^e)$	(3) α_0	(4) $t(\alpha_0)$	(5) α_0	(6) $t(\alpha_0)$
1	Market Beta	-0.132	(-0.52)	-0.098	(-0.53)	-0.255*	(-1.66)
2	Realized Earnings Growth Beta	-0.138	(-0.74)	-0.136	(-0.77)	-0.116	(-0.80)
3	Earnings-scaled Expectations Shock Beta	-0.135	(-0.65)	-0.089	(-0.55)	-0.127	(-0.77)
4	Expected Long-Term Growth Beta	-0.111	(-0.48)	-0.104	(-0.54)	-0.158	(-0.88)
5	Realized ROE Beta	-0.092	(-0.57)	-0.116	(-0.75)	-0.012	(-0.09)
6	Book-scaled Realized Earnings Growth Beta	-0.136	(-0.77)	-0.087	(-0.52)	-0.175	(-1.26)
7	Expected ROE Beta	0.184	(1.42)	0.173	(1.45)	0.273***	(2.67)
8	Book-scaled Expectations Shock Beta	0.293*	(1.90)	0.294**	(1.99)	0.311**	(2.56)
9	Realized Earnings Yield Beta	-0.002	(-0.01)	-0.078	(-0.51)	0.120	(0.86)
10	Price-scaled Realized Earnings Growth Beta	-0.070	(-0.37)	-0.100	(-0.56)	-0.016	(-0.10)
11	Expected Earnings Yield Beta	0.434***	(3.77)	0.471***	(4.13)	0.359***	(3.16)
12	Price-scaled Expectations Shock Beta	0.723***	(4.05)	0.488***	(2.70)	0.422***	(2.96)

Panel B: Factor Loadings for Factor-Mimicking Portfolios

Factor-Mimicking Portfolio formed on:		(1)	(2)	(3)	(4)	(5)	(6)
		RMRF	SMB	HML	RMW	CMA	UMD
1	Market Beta	0.553***	0.424***	-0.243**	-0.470***	-0.400***	-0.169***
2	Realized Earnings Growth Beta	0.169***	0.475***	0.219*	-0.417***	-0.284**	0.008
3	Earnings-scaled Expectations Shock Beta	0.296***	0.379***	-0.022	-0.714***	0.241**	-0.106**
4	Expected Long-Term Growth Beta	0.278***	0.397***	-0.021	-0.595***	0.191	-0.142***
5	Realized ROE Beta	0.180***	0.279***	-0.113	-0.130	-0.055	-0.097**
6	Book-scaled Realized Earnings Growth Beta	0.150***	0.358***	0.028	-0.363***	-0.146	-0.082*
7	Expected ROE Beta	0.156***	-0.011	-0.422***	-0.062	0.028	-0.035
8	Book-scaled Expectations Shock Beta	0.203***	0.135**	-0.215***	-0.275***	0.046	-0.040
9	Realized Earnings Yield Beta	0.213***	0.279***	0.354***	-0.511***	-0.109	0.006
10	Price-scaled Realized Earnings Growth Beta	0.183***	0.423***	0.504***	-0.513***	-0.207	-0.013
11	Expected Earnings Yield Beta	0.121***	-0.149***	-0.139**	-0.236***	-0.140*	-0.031
12	Price-scaled Expectations Shock Beta	0.184***	0.292***	0.137*	-0.520***	-0.206	-0.040

This table reports value-weighted average excess returns, alphas, and factor loadings for factor-mimicking portfolios formed by ranking firms each June on the basis of different estimates of beta. The portfolio formation procedure adopts the methodology used for the Small Minus Big (SMB) size and High Minus Low (HML) value factors by Fama and French (1993). The beta-sorted portfolios mimic the returns from a long-short strategy that invests in high beta firms and shorts low beta firms. See Appendix 2 for further details about the different estimates of earnings beta used to form the portfolios. For each factor-mimicking portfolio, Panel A reports value-weighted average excess return in column 1, alphas from the Fama and French (2015) five-factor model plus the Carhart (1997) momentum factor (i.e., six-factor alpha) in column 3, and alphas from the Kelly et al. (2019) unrestricted five-factor Instrumental Principal Component Analysis (IPCA) model in column 5. The data and code for the five-factor IPCA model is available on Seth Pruitt's website and was downloaded from <https://sethpruitt.net/research/downloads>. The alphas are computed from time-series regressions of value-weighted average excess returns for each portfolio on the relevant factors. Panel B reports six-factor loadings for each portfolio from the following regression using monthly data: $r_{p,t}^e = \alpha_0 + \beta_1 RMRF_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \beta_6 UMD_t + \varepsilon_{p,t}$. RMRF is the value-weighted return for all CRSP firms less the one-month risk-free rate. Up Minus Down (UMD) is the Carhart (1997) momentum factor. The RMRF (market), SMB (size), HML (value), RMW (profitability), CMA (investment), and UMD factors are from Kenneth French's website. The sample period covers April 1981 to June 2017. The *t*-statistics reported in each column alongside the portfolio returns and alphas are based on standard errors clustered by month. The asterisks *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

sorted by size and accruals, 25 portfolios sorted by size and beta, and 25 portfolios sorted by size and momentum. Table 6 reports the estimated risk premiums using the estimator of Giglio and Xiu (2019), which allows for an unconstrained zero-beta rate and extracts six principal components from the returns of the 202 portfolios. I find that six of the 11 earnings betas carry positive and significant risk premiums. Consistent with the previous pricing tests, earnings betas based on expected earnings outperform those based on realized earnings, and carry an estimated annual risk premium ranging from 4% to 6%. Different from the previous pricing tests, while expected ROE beta and expected earnings yield beta had negative and significant risk premiums in Table 4, these betas now have positive and significant risk premiums. I also find that price-scaled expectations shock beta is among the best performers with a positive and significant estimated risk premium.

3.3 Factor-mimicking portfolios

To further test whether systematic risk in earnings is priced, I form 12 factor-mimicking portfolios on the various beta estimates and perform time-series pricing regressions on excess returns of known risk factors. To form the portfolios, I follow the Fama and French (1993) procedure to sort all firms each June into quintiles based on firm-level estimates of the 11 earnings betas and market beta. Then I form factor-mimicking portfolios that buy high beta firms and short low beta firms and measure the value-weighted monthly excess returns for these long-short portfolios. If systematic risk in earnings is priced, I expect to see differences in the returns of these beta-sorted portfolios. Panel A of Table 7 reports value-

Table 8 Firm-Level Pricing Tests

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Fama and MacBeth Regressions for Monthly Excess Returns												
<i>Beta</i> (γ_1)	+	-0.040 (-0.22)	0.002 (0.10)	-0.006 (-0.33)	-0.002 (-0.20)	-0.004 (-0.43)	0.059*** (4.61)	0.094*** (4.33)	-0.014 (-0.98)	0.001 (0.15)	0.099*** (4.64)	0.104*** (4.49)
<i>Size</i>	-	-0.041 (-1.12)	-0.035 (-0.90)	-0.031 (-0.82)	-0.032 (-0.77)	-0.033 (-0.85)	-0.047 (-1.16)	-0.044 (-1.09)	-0.029 (-0.76)	-0.026 (-0.66)	-0.042 (-1.11)	-0.029 (-0.74)
<i>B/P</i>	+	0.344*** (2.78)	0.423*** (3.24)	0.419*** (3.24)	0.304** (2.16)	0.437*** (3.29)	0.507*** (3.73)	0.463*** (3.41)	0.408*** (3.14)	0.416*** (3.18)	0.478*** (3.61)	0.400*** (2.98)
$r_{1,1}$	-	-3.536*** (-7.94)	-2.953*** (-6.63)	-3.233*** (-6.98)	-2.269*** (-4.92)	-3.024*** (-6.75)	-3.052*** (-6.85)	-3.032*** (-6.82)	-3.092*** (-6.86)	-3.120*** (-6.83)	-3.120*** (-6.82)	-3.167*** (-6.90)
$r_{12,2}$	+	0.579*** (3.96)	0.490** (2.51)	0.489** (2.39)	0.343 (1.53)	0.470** (2.42)	0.480** (2.48)	0.531*** (2.85)	0.469** (2.28)	0.445** (2.16)	0.418** (2.06)	0.463** (2.32)
Intercept		0.772** (2.34)	0.642 (1.41)	0.600 (1.40)	0.758 (1.60)	0.651 (1.46)	0.627 (1.41)	0.558 (1.23)	0.594 (1.33)	0.566 (1.26)	0.528 (1.17)	0.504 (1.12)
Average Adjusted R ²		5.8%	4.1%	4.3%	4.6%	4.2%	4.1%	4.3%	4.2%	4.1%	4.1%	4.3%

Table 8 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel B: Fama and MacBeth Regressions for Monthly Excess Returns, Controlling for 36 Firm Characteristics												
$Beta(\gamma_1)$	0.104 (1.11)	0.003 (0.16)	-0.003 (-0.22)	0.005 (0.77)	-0.010 (-1.36)	0.000 (0.03)	0.072*** (8.21)	0.080*** (5.47)	-0.018 (-1.22)	-0.005 (-0.57)	0.092*** (6.30)	0.098*** (5.86)
# Controls Included	36	36	36	36	36	36	36	36	36	36	36	36
Average Adjusted R ²	9.4%	9.3%	9.3%	9.9%	9.3%	9.3%	9.2%	9.3%	9.3%	9.3%	9.3%	9.3%

This table reports time-series average coefficients and *t*-statistics from firm-level cross-sectional regressions that predict monthly excess return using various estimates of beta at time *t* as well as other time *t* characteristics. Specifically, the following firm-level model is estimated in Fama and MacBeth (1973) regressions: $r_{i,t+1}^{excess} = \gamma_0 + \gamma_1 Beta_t + \gamma_2 Size_t + \gamma_3 B/P_t + \gamma_4 r_{1,t} + \gamma_5 r_{12,2} + \varepsilon_{t+1}$. Each column examines a different estimate of beta: (1) Market Beta, (2) Realized Earnings Growth Beta, (3) Earnings-scaled Expectations Shock Beta, (4) Expected Long-Term Growth Beta, (5) Realized ROE Beta, (6) Book-scaled Realized Earnings Growth Beta, (7) Expected ROE Beta, (8) Book-scaled Expectations Shock Beta, (9) Realized Earnings Yield Beta, (10) Price-scaled Realized Earnings Growth Beta, (11) Expected Earnings Yield Beta, and (12) Price-scaled Expectations Shock Beta. See Appendix 2 for further details about the various estimates of earnings beta. The sample period covers April 1981 to June 2017 and there are maximum 872,991 firm-month observations. In Panel B, the time-series average coefficients γ_1 are from an extended firm-level model estimated by Fama and MacBeth (1973) regressions that includes 36 firm characteristics from Kelly et al. (2019). Data on characteristics was downloaded from <https://sethpruitt.net/research/downloads>. The sample period covers April 1981 to May 2014, and there are maximum 541,291 firm-month observations due to the additional data requirements for firm characteristics and the slightly earlier end to the sample period in Kelly et al. (2019). The reported *t*-statistics are based on standard errors that incorporate a Newey-West adjustment for four lags. The time-series averages of adjusted R² are also reported. The asterisks *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. See Appendix 1 for variable descriptions.

weighted average excess returns and risk-adjusted alphas for the factor-mimicking portfolios formed on various estimates of beta. The factor-mimicking portfolio for price-scaled expectations shock beta (row 12) has the highest value-weighted monthly average excess returns of 0.72% followed by expected earning yield beta (0.43%) and book-scaled expectations shock beta (0.29%). The factor-mimicking portfolio for price-scaled expectations shock beta also has the highest six-factor alpha of 0.49% (5.9% annually) after adjusting for the factors proposed by Fama and French (2015) and Carhart (1997). I find similar results when using the five-factor Instrumented Principal Component Analysis (IPCA) model developed by Kelly et al. (2019).

Panel B of Table 7 reports the factor loadings for the 12 factor-mimicking portfolios on the six-factors from Fama and French (2015) and Carhart (1997). Perhaps unsurprisingly, the value-weighted average excess returns for all factor-mimicking portfolios load strongly and positively on the market factor (RMRF). The returns for 10 of the portfolios load strongly and positively on the size factor (SMB), suggesting that the higher returns for small firms could compensate for higher exposure to systematic risk in earnings. The returns for the portfolios formed on realized earnings growth beta (row 2), realized earnings yield beta (row 9), price-scaled realized earnings growth beta (row 10), and price-scaled expectations shock beta (row 12) also load positively and significantly on the value (HML) factor. This is consistent with these earnings betas being able to explain excess returns of B/P-sorted portfolios in Table 4 and is consistent with a risk-based explanation for book-to-price (Ellahie et al. 2020). The returns for all the portfolios load negatively on the profitability factor (RMW), which points to a negative relation between ROE and beta, consistent with Penman (1991). Finally, the investment (CMA) and momentum factors (UMD) mostly relate negatively with returns for the factor-mimicking portfolios, although many of the estimated coefficients are statistically insignificant.¹⁴

3.4 Firm-level pricing tests

Next, I move to firm-level two-stage cross-sectional pricing tests. I use the time-varying firm-level beta estimates from the first-stage to estimate the following second-stage cross-sectional model to predict monthly excess returns (firm subscripts suppressed):

$$r_{t+1}^e = \gamma_0 + \gamma_1 \text{Beta}_t + \gamma_2 \text{Size}_t + \gamma_3 \text{B/P}_t + \gamma_4 r_{1,1} + \gamma_5 r_{12,2} + \varepsilon_{t+1}. \quad (3)$$

I estimate Eq. (3) for one-month-ahead excess returns using the Fama and Macbeth (1973) approach and following Lewellen (2015), I assess statistical significance using heteroskedasticity and autocorrelation-consistent Newey-West *t*-statistics that incorporate four lags. The coefficient of interest is the estimated risk premium (γ_1) and is expected to be positive and statistically significant. I control for firm-level characteristics

¹⁴ In a similar vein, the literature documents that momentum portfolio returns are not due to compensation for systematic risk and possibly are due to delayed stock price reaction (Jegadeesh and Titman 1993).

commonly used in standard pricing tests, following Ball et al. (2015, 2016). These control variables include size, book-to-price, short-term reversal, and momentum. (See Appendix 1 for variable definitions.) Size and short-term reversal are expected to have a negative sign, while book-to-price and momentum are expected to have a positive sign.

Panel A of Table 8 reports the time-series average of the coefficients estimated using Eq. (3). Each column of the table uses a different estimate of beta, with column 1 using market beta and columns 2–12 using each of the 11 different estimates of earnings beta. Consistent with prior findings, the coefficient on market beta in column 1 is insignificant. Four of the 11 earnings betas have positive and significant risk premiums at the firm-level, including expected ROE beta, book-scaled expectations shock beta, expected earnings yield beta, and price-scaled expectations shock beta. The largest coefficient is for the price-scaled expectations shock beta of 0.104 with a *t*-statistic of 4.49, which suggests an estimated annual risk premium of 1.2% (0.104×12). Overall, the firm-level results are mostly consistent with the portfolio-level results, with earnings betas based on expected earnings outperforming earnings betas based on realized earnings.¹⁵ Also consistent with the Giglio and Xiu (2019) pricing tests, expected ROE beta and expected earnings yield beta have positive and significant risk premiums. The coefficients on size, book-to-price, short-term reversal, and momentum have the expected signs and the relations are consistent with those reported elsewhere (e.g., Lewellen 2015; Ball et al. 2015, 2016).

In Panel B of Table 8, I replace the standard control variables in Eq. (3) with the 36 firm-level characteristics considered by Kelly et al. (2019) and Freyberger et al. (2020). For brevity, Panel B does not report individual coefficients for the 36 firm characteristics. The sample is reduced due to the additional data requirements for the 36 firm characteristics and ends in May 2014 based on the dataset made available by Kelly et al. (2019). Even in this reduced sample, the main inferences remain unchanged. Earnings betas based on expected earnings continue to explain an economically meaningful proportion of the cross-sectional variation in one-month-ahead excess returns at the firm-level, and this explanatory power is incremental to firm characteristics.

3.5 Beta and firm characteristics

Next, I examine the relation between each of the 11 different estimates of earnings beta (plus market beta) and firm characteristics. This analysis serves as a test of the construct validity of the estimated betas, given understanding of how accounting-based characteristics should relate to systematic risk (e.g., Botosan and Plumlee 2005). While prior literature has identified many accounting-based

¹⁵ In untabulated results, I also estimate Eq. (3) using panel regressions with month fixed effects and find generally consistent results. I find that the four earnings betas that have positive and significant risk premiums in Table 8 are also positive and significant in panel regressions. The largest coefficient is for the price-scaled expectations shock beta of 0.085 with a *t*-statistic of 3.55 where the standard errors are clustered by firm and month. I also find that, while the betas based on levels of realized earnings (i.e., realized ROE beta and realized earnings yield beta) are insignificant, the earnings betas based on changes in realized earnings are weakly significant.

characteristics for fundamental analysis (e.g., Ou and Penman 1989), I focus on variables that are either theoretically connected to systematic risk or are empirically associated with returns because they reflect uncertain outcomes or inform on fundamental risks originating in the way a firm operates and finances its activities (Penman 2013). I select a parsimonious set of variables such as size, profitability, leverage, volatility, growth, investment, and other indicators of fundamental risk from Fig. 19.3 of Penman (2013). I examine the relation between the various estimates of beta and these firm characteristics by estimating the following panel regression model with firm and month fixed effects, and clustering the standard errors by firm and month (see Petersen 2009):

$$\begin{aligned}
 \text{Beta}_t = & \beta_0 + \beta_1 \text{Size}_t + \beta_2 \text{Net Margin}_t + \beta_3 \text{Asset Turnover}_t \\
 & + \beta_4 \text{Financial Leverage}_t + \beta_5 \text{Operating Leverage}_t \\
 & + \beta_6 \text{Sales Volatility}_t + \beta_7 \text{Earnings Volatility}_t + \beta_8 \text{Asset Growth}_t \\
 & + \beta_9 \text{Earnings Growth}_t + \beta_{10} \text{Fwd.E/P}_t + \beta_{11} \text{B/P}_t + \beta_{12} \text{D/P}_t \\
 & + \Sigma \beta \text{Firm FE} + \Sigma \beta \text{Month FE} + \varepsilon_t.
 \end{aligned} \tag{4}$$

Many of the variables in Eq. (4) have a direct or indirect theoretical relationship with systematic risk. See Appendix 1 for detailed descriptions of these variables. Based on prior theory on the costly reversibility of assets in place, I expect a negative relation between beta and *Size* as well as between beta and *Asset Growth*. Berk et al. (1999) analytically show that the level of investment increases with the availability of low risk projects and productivity, which reduces the risk of assets in place (Cooper and Priestley 2011; Zhang 2005). Further, Penman and Zhu (2014) argue that asset recognition coincides with resolution of uncertainty (e.g., an increase in receivables resolves uncertainty about sales growth, and an increase in inventory indicates expected future sales). This suggests a negative relation between beta and asset growth. Based on Penman (1991), I also expect a negative relation between beta and *Net Margin*, which is a component of ROE used in DuPont decomposition analysis.

I do not make a sign prediction about the relation between beta and *Asset Turnover*, because an increase in asset turnover can either be due to a reduction in uncertainty from more sales being realized in the numerator or due to an increase in uncertainty from fewer assets being recognized in the denominator. Further, asset turnover could either describe the relative importance of growth opportunities and assets in place (Berk et al. 1999) or indicate more efficient asset utilization.

I expect a positive relation between beta and *Financial Leverage*, as well as between beta and *Operating Leverage*. Leverage increases the fixed costs that the firm must bear, which reduces operating flexibility and increases the sensitivity of earnings to changes in demand-driven output (Hamada 1972; Lev 1974; Bowman 1979). Further, corporate finance theory suggests that the beta of a financially levered firm is higher than the beta of an unlevered firm.

Table 9 Beta and Firm Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
<i>Size</i>	-	-0.005 (-0.48)	0.041 (0.93)	0.088 (1.33)	0.057 (0.71)	-0.067 (-1.00)	0.060 (0.97)	-0.331*** (-5.42)	0.059* (1.83)	-0.053 (-0.71)	0.189* (1.96)	0.036 (0.91)	-0.151*** (-3.39)
<i>Net Margin</i>	-	-0.027** (-2.05)	-0.092** (-2.36)	-0.101* (-1.76)	-1.705*** (-4.06)	-0.343*** (-2.26)	-0.326*** (-2.85)	-0.202** (-2.26)	-0.020 (-0.76)	-0.027 (-0.25)	-0.562*** (-3.66)	0.059 (1.31)	-0.106*** (-3.78)
<i>Asset Turnover</i>	±	-0.080*** (-4.94)	-0.400*** (-4.86)	-0.138 (-1.15)	-0.178 (-1.23)	-0.511*** (-4.10)	-0.519*** (-4.16)	-0.287** (-2.43)	0.205*** (3.39)	-0.420*** (-3.69)	-0.337** (-2.05)	0.105* (1.67)	0.256*** (3.06)
<i>Financial Leverage</i>	+	0.001 (0.42)	0.023* (1.71)	0.033 (1.50)	0.036 (1.35)	-0.043 (-1.43)	0.011 (0.47)	-0.162*** (-6.60)	0.003 (0.34)	-0.037 (-1.24)	0.159*** (4.91)	-0.013 (-0.98)	0.016 (1.17)
<i>Operating Leverage</i>	+	0.003** (2.29)	0.042*** (5.04)	0.022 (1.57)	0.041*** (2.74)	0.041*** (2.87)	0.065*** (4.15)	0.002 (0.20)	0.011** (2.42)	0.006 (0.31)	0.162*** (5.93)	-0.007 (-1.16)	0.022*** (2.83)
<i>Sales Volatility</i>	+	1.306*** (7.67)	5.240*** (5.64)	2.305** (2.05)	1.884 (1.57)	4.872*** (3.29)	8.760*** (4.95)	11.829*** (11.30)	2.489*** (4.38)	1.966 (1.64)	7.754*** (4.62)	1.744*** (2.96)	2.138*** (2.92)
<i>Earnings Volatility</i>	+	1.635*** (8.53)	1.174 (1.52)	5.237*** (4.15)	7.084*** (4.39)	11.285*** (3.76)	1.670 (0.56)	0.379 (0.28)	3.082*** (5.30)	5.045** (2.22)	6.257** (2.52)	-1.279* (-1.82)	5.055*** (6.59)
<i>Asset Growth</i>	-	0.019* (1.75)	-0.416*** (-5.81)	-0.424*** (-5.65)	-0.418*** (-4.99)	-0.465*** (-4.45)	-0.625*** (-5.44)	-0.043 (-0.66)	0.012 (0.35)	-0.132 (-1.18)	-0.913*** (-7.90)	0.188*** (4.93)	-0.142*** (-2.98)
<i>Earnings Growth</i>	+	0.011*** (3.41)	-0.280*** (-6.12)	-0.019 (-0.52)	0.046 (1.15)	-0.126*** (-4.11)	-0.262*** (-6.01)	-0.130*** (-8.28)	-0.033*** (-2.71)	0.131*** (3.74)	-0.517*** (-6.34)	-0.029*** (-2.63)	0.016 (0.80)
<i>Fwd. E/P</i>	+	-0.103*** (-6.00)	-0.062 (-0.73)	-0.358*** (-2.62)	-0.913*** (-3.22)	-0.134 (-1.13)	-0.205* (-1.85)	-0.420** (-2.06)	0.762*** (6.99)	0.266 (1.44)	-1.050*** (-3.88)	0.624*** (3.77)	0.622*** (4.41)
<i>B/P</i>	+	0.063*** (6.50)	0.143*** (2.65)	0.523*** (6.63)	0.529*** (5.92)	-0.151** (-2.26)	0.078 (1.09)	0.076 (1.37)	0.028 (0.92)	-0.238** (-1.98)	1.771*** (6.85)	-0.102** (-2.31)	0.298*** (4.75)
<i>D/P</i>	±	-1.587*** (-8.53)	-0.487 (-1.10)	-2.571** (-2.00)	-4.110*** (-3.14)	-3.965*** (-3.14)	-0.899 (-1.09)	-9.834*** (-9.83)	-0.314 (-0.31)	-1.922 (-1.92)	-0.321 (-0.32)	-3.140*** (-3.14)	-2.533*** (-2.53)

Table 9 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Predicted Sign												
Adjusted R ²	(-5.13)	(-0.61)	(-2.05)	(-2.67)	(-3.65)	(-0.87)	(-6.36)	(-0.64)	(-0.95)	(-0.09)	(-3.06)	(-2.89)
Within R ²	62.4%	34.8%	44.2%	47.7%	33.3%	33.7%	32.9%	45.2%	37.3%	33.8%	38.6%	42.9%
# Inconsistent Signs	9.3%	3.3%	1.7%	2.4%	1.9%	2.4%	6.0%	1.9%	2.2%	5.5%	9.1%	3.2%
	2	1	1	1	2	2	3	2	1	3	4	0

This table reports slope coefficients and *t*-statistics from the following panel regressions of different firm-level estimates of beta on firm characteristics at time *t* as well as firm and month fixed effects (firm subscripts suppressed): $\beta_{it} = \beta_0 + \beta_1 \text{Size}_i + \beta_2 \text{Net Margin}_i + \beta_3 \text{Asset Turnover}_i + \beta_4 \text{Financial Leverage}_i + \beta_5 \text{Operating Leverage}_i + \beta_6 \text{Sales Volatility}_i + \beta_7 \text{Earnings Volatility}_i + \beta_8 \text{Asset Growth}_i + \beta_9 \text{Earnings Growth}_i + \beta_{10} \text{Fwd. E/P}_i + \beta_{11} \text{B/P}_i + \beta_{12} \text{D/P}_i + \Sigma \beta \text{Firm FE} + \Sigma \beta \text{Month FE} + \epsilon_i$. Each column examines a different beta estimate as the dependent variable: (1) Market Beta, (2) Realized Earnings Growth Beta, (3) Earnings-scaled Expectations Shock Beta, (4) Expected Long-Term Growth Beta, (5) Realized ROE Beta, (6) Book-scaled Realized Earnings Growth Beta, (7) Expected ROE Beta, (8) Book-scaled Expectations Shock Beta, (9) Realized Earnings Yield Beta, (10) Price-scaled Realized Earnings Growth Beta, (11) Expected Earnings Yield Beta, and (12) Price-scaled Expectations Shock Beta. The sample period covers April 1981 to June 2017, and there are maximum 667,856 firm-month observations due to the additional data requirements for firm characteristics. The *t*-statistics are based on standard errors clustered by firm and month, to account for serial and cross-sectional correlation. The asterisks *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. See Appendix 1 for variable descriptions and Appendix 2 for details on beta estimates.

Further, since a more volatile sales and earnings generating process could indicate greater uncertainty about future realizations, I expect a positive relation between beta and *Sales Volatility* as well as between beta and *Earnings Volatility*. The empirical findings of Beaver et al. (1970) also suggest that earnings variability relate positively to market beta.¹⁶ Similarly, based on the arguments of Penman and Zhang (2020) that conservative accounting induces earnings growth that is tied to uncertainty, I expect a positive relation between beta and *Earnings Growth*.

I expect a positive relation between beta and *B/P*. Fama and French (1995) note that, with rational pricing, *B/P* must proxy for sensitivity to common risk factors in returns, while Zhang (2005) argues that value firms (i.e., high *B/P*) have more assets in place, which increases systematic risk due to costly reversibility. Further, Ball (1978) finds that several yield variables, including *E/P*, are positively associated with returns. Since increases in earnings and book values of equity are associated with a reduction in uncertainty about payoffs, as indicated by the accounting system, the price in the denominator captures how these payoffs are priced and largely determines the relation with returns. Thus I test for a positive relation.

Finally, I do not make a prediction about the relation between beta and *D/P*. On the one hand, payment of dividends resolves investor uncertainty about consumption risk and could signal more certain prospects. Dividends also displace current earnings which could reduce future earnings growth through lower reinvestment. Both of these potential effects would point to a negative relation with expected returns. On the other hand, higher dividend yields can also be due to higher discounting of future dividends (i.e., lower price today in the denominator), which suggests a positive relation with expected returns. Since the dividend yield is affected by both dividend changes and price changes, the effect that dominates would determine the relation with systematic risk. Finally, dividends could be irrelevant for valuation (Miller and Modigliani 1961). Thus the ex-ante relation with beta is not clear.

Table 9 reports the results from estimating Eq. (4) for different estimates of beta. Column 1 examines market beta, and columns 2–12 examine each of the 11 different estimates of earnings beta. Interestingly, some estimates of beta have signs that are inconsistent with the predicted relations for various firm characteristics (highlighted in bold). For example, while *Size* is not significantly associated with market beta, it is positively associated with book-scaled expectations shock beta and price-scaled realized earnings growth beta. Given that smaller firms have higher returns, the expected sign for beta to explain returns of smaller firms is negative (i.e., smaller firms should have larger betas). Only expected ROE beta and price-scaled expectations shock beta have a sign consistent with this expectation.

¹⁶ Bowman (1979) shows that theoretically earnings variability does not have a (direct) role in determining systematic risk since it is covariability of earnings that matters. However, variability can have an indirect effect since beta can be viewed as correlated relative volatility of earnings. The volatility of earnings in relation to volatility in aggregate earnings will scale the correlation term and in turn affect the magnitude of beta.

While the signs for the different earnings betas are generally consistent with the predicted relations for *Net Margin*, *Operating Leverage*, and *Sales Volatility*, the empirical relations with *Financial Leverage*, *Earnings Volatility*, *Asset Growth*, *Earnings Growth*, *E/P*, and *B/P* are somewhat inconsistent. Across the 12 different estimates of beta in columns 1 through 12, seven have at least two coefficients with signs that are inconsistent with predicted relations, and all except price-scaled expectations shock beta have at least one coefficient with an unexpected sign. I find that the best performing earnings beta from the pricing tests is also the one with the least number of inconsistent relations with firm characteristics. Overall, the results lend support to the construct validity of this earnings beta as a suitable measure of systematic risk.

4 Conclusion

While using cash flow fundamentals to estimate cash flow beta is theoretically appealing, approaches suggested in prior studies require researchers to either log-linearize the return equation or log-linearize the clean-surplus accounting identity. These cash flow betas can be difficult to construct and also present some potential challenges. I propose a simpler approach to estimate earnings betas based on 11 different earnings series involving realized earnings and expected earnings, either in levels or in changes, and employing three different scalars for earnings.

In portfolio-level and firm-level pricing tests over the 1981–2017 period, I find that the explanatory power of earnings betas for the cross-section of monthly excess returns is sensitive to the construction of the earnings measure that is used to estimate beta. In summary, I find that (1) earnings betas outperform market beta, (2) earnings betas based on changes in earnings outperform betas based on levels of earnings, (3) betas based on earnings expectations outperform betas based on earnings realizations, (4) betas based on changes in expectations of earnings outperform betas based on levels of expectations, and (5) betas based on price-scaled earnings series outperform betas based on book-scaled earnings series. In particular, an earnings beta based on price-scaled expectations shocks performs consistently well across the various pricing tests.

I also examine the relation between earnings beta and firm characteristics that are either theoretically connected to systematic risk or are empirically associated with returns. This analysis illuminates the construct validity of the estimated betas given our theoretical and empirical priors about how accounting-based characteristics should relate to systematic risk and expected returns. I find that firm characteristics, such as size, profitability, volatility, leverage, and investment, are indeed associated with systematic risk, although the sign of the observed relation can differ from the predicted sign, depending on the estimate of earnings beta used as a measure of systematic risk. Overall, the best performing earnings beta from the pricing tests (i.e., price-scaled expectations shock beta) has the least number of inconsistent actual relations with characteristics relative to the predicted relations, lending support to the

construct validity of this earnings beta as a suitable measure of systematic risk. The results also suggest that a potential reason certain firm characteristics explain returns is that they might indirectly capture systematic risk.

A few caveats are worth mentioning for researchers interested in using the earnings betas developed in this study. First, while earnings betas based on price-scaled earnings measures have the advantages of avoiding negative scalars when computing growth and empirically outperforming book-scaled versions, these earnings betas are not based purely on cash flow fundamentals. Researchers should consider whether price-scaling is problematic in their particular setting and, if so, use the book-scaled versions of earnings beta instead. Second, even though the results suggest that the price-scaled expectations shock beta outperforms simple ROE betas, this earnings beta may not necessarily outperform more sophisticated ROE betas developed by Da and Warachka (2009). While an advantage of the approach proposed in this study to estimate earnings beta using short-term earnings is its simplicity, in some settings it might be more appropriate to estimate an earnings beta based on the log-linearization approach that involves earnings over an infinite horizon. Third, scaling earnings by price is not possible for private firms, and using expected earnings is not possible for firms that are not covered by equity research analysts or that are unavailable in I/B/E/S. In these cases, earnings betas that involve book-scaled realized earnings offer viable alternatives for measuring systematic risk. However, since these earnings betas rely on quarterly data, researchers should be cognizant of estimation imprecision.

Finally, this study is silent on why the explanatory power of earnings betas is sensitive to the construction of the earnings measure that is used to estimate beta. For example, betas based on expected earnings might outperform betas based on realized earnings either because expectations contain forward-looking information or monthly data enable more precise beta estimates. Further, earnings betas based on changes in earnings might outperform earnings betas based on levels of earnings either because changes provide more information about the evolution of earnings or levels are more distorted by the effects of conservative accounting for uncertain investments. It would be interesting for future research to explore these alternative explanations.

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Appendix 1 Description of Variables

Variable	Description and Calculation Methodology
<i>Asset Growth</i>	A measure of investment computed as annual change in total assets (Compustat item: <i>at</i>) scaled by prior period total assets.
<i>Asset Turnover</i>	Trailing 12-month sales (<i>sale</i>) scaled by total assets (<i>at</i>) averaged over the prior four quarters.
<i>B/P</i>	Book-to-price, measured as book value of common equity scaled by price observed six months after fiscal period-end. Book value is common equity (<i>ceq</i>) plus any preferred treasury stock (<i>stltp</i>) less any preferred dividends in arrears (<i>dypa</i>).
<i>D/P</i>	Dividend yield, measured as common dividends (<i>dvc</i>) for the trailing 12-month period scaled by price.
<i>E/P</i>	Realized earnings yield, measured as trailing 12-month core earnings (<i>EARN</i>) scaled by price observed six months after fiscal period-end.
<i>Earnings Growth</i>	Realized growth in trailing 12-month core earnings (<i>EARN</i>). Core earnings (<i>EARN</i>) are net income before extraordinary items (<i>ib</i>) and special items (<i>spi</i>) minus preferred dividends (<i>dvp</i>). Special items are allocated taxes based on the prevailing statutory corporate income tax rate for that period. Annual earnings growth for firm <i>i</i> at time <i>t</i> is computed as $\Delta EARN_{i,t} / (EARN_{i,t} + EARN_{i,t-1}) / 2$. This approach to compute growth can accommodate negative denominators and ranges between -2 and $+2$.
<i>Earnings Volatility</i>	Rolling standard deviation of quarterly return on equity (<i>ROE</i>) over the prior 20 quarters.
<i>Financial Leverage</i>	Leverage measured using the equity multiplier, which is calculated as total assets (<i>at</i>) scaled by total equity (<i>ceq</i>). Equivalently, the equity multiplier can be expressed as $1 + \text{total liabilities } (lt) \text{ scaled by total equity } (ceq)$.
<i>Fwd. E/P</i>	Forward earnings yield measured as the constant horizon 12-month-ahead consensus analyst forecast (<i>F12</i>) scaled by price observed six months after fiscal period-end. <i>F12</i> is calculated by time-weighting the 1/B/E/S consensus annual earnings forecasts for the one-year-ahead (<i>F1</i>) and two-year-ahead (<i>F2</i>) periods. Specifically, <i>F12</i> is computed as $E_t[F12_t] = w_{i,t} E_t[F1_t] + (1 - w_{i,t}) E_t[F2_t]$, where the monthly weights ($w_{i,t}$) are based on the number of days between the forecast date and the fiscal period end date for the firm's one-year-ahead forecast, divided by 365 days.
<i>Long-Term Return Reversal</i>	Cumulative past stock returns over 36 months, excluding the most recent 12 months. Specifically, past returns are accumulated from month -48 to month -13 , consistent with the measurement approach of Fama and French (1996).
<i>Market Beta</i>	A measure of systematic risk based on the sensitivity of portfolio-level (or firm-level) returns to aggregate stock returns, proxied by the CRSP value-weighted index returns. Market beta is estimated using monthly data over backward-rolling five-year windows (minimum of three-year required) based on the market model: $r_{i,t} = \alpha_i + \beta_{i,t}^{MKT} r_{M,t} + \varepsilon_{i,t}$. The backward-rolling estimations provide time-varying estimates of market beta for each month.
<i>Net Margin</i>	Trailing 12-month core earnings (<i>EARN</i>) scaled by trailing 12-month sales (<i>sale</i>).
<i>Operating Leverage</i>	A measure of the degree of operating leverage calculated as the change in trailing 12-month unlevered earnings scaled by the change in trailing 12-month sales. Unlevered earnings are core earnings (<i>EARN</i>), plus tax-adjusted interest expense (<i>xint</i>), less tax-adjusted interest expense (<i>idit</i>).
r_{t+1}	One-month ahead stock returns from CRSP. Delisting returns from CRSP are used where available, and missing delisting returns are computed using the procedure described by Beaver et al. (2007), where the average delisting return from the same delisting code is used. Where indicated, monthly <i>excess</i> stock returns (r_{t+1}^e) are calculated by subtracting the one-month Treasury bill rate for that month from the raw monthly stock return. The one-month risk-free rate is sourced from Kenneth

Appendix 1 (continued)

Variable	Description and Calculation Methodology
	French's website.
$r_{1,1}$	Past stock returns over the most recent month.
$r_{12,2}$	Momentum measured as cumulative past stock returns over 12 months, excluding the most recent month. Specifically, past returns are accumulated from month -12 to month -2.
<i>Return on Equity</i>	Trailing 12-month core levered earnings (EARN) scaled by common equity averaged over the prior four quarters.
<i>Size</i>	Natural logarithm of market value of equity.
<i>Sales Volatility</i>	Rolling standard deviation of quarterly sales (scaled by assets) over the prior 20 quarters.

Appendix 2 Description of Various Estimates of Earnings Beta

Realized Earnings Growth Beta: A measure of the sensitivity of realized earnings growth to aggregate realized earnings growth. Realized annual growth in trailing 12-month core earnings (*EARN*) for firm i at time t over the prior 12 months is computed using the following approach: $\Delta EARN_{i,t}/(|EARN_{i,t}| + |EARN_{i,t-1}|)/2$. This measure can accommodate negative denominators and ranges between -2 and +2. Portfolio-level and aggregate earnings are computed by summing earnings across firms before calculating growth using the above approach, ensuring that the numerator and denominator pertain to the same firms.

Earnings-scaled Expectations Shock Beta: A measure of the sensitivity of earnings expectations shocks to aggregate earnings expectations shocks. First, for each firm (i) every month (t), a constant horizon 12-month-ahead forecast ($F12$) is calculated by time-weighting the I/B/E/S consensus annual earnings forecasts for the one-year-ahead ($F1$) and two-year-ahead ($F2$) periods. Specifically, the constant horizon forecast is computed as $E_t[F12_i] = w_{i,t}E_t[F1_i] + (1 - w_{i,t})E_t[F2_i]$, where the monthly weights ($w_{i,t}$) are based on the number of days between the forecast date and the fiscal period end date for the firm's one-year-ahead forecast, divided by 365 days. Second, the monthly changes in forecasts ($F12$) are computed as $\Delta E_t[F12_i] = w_{i,t}(E_t[F1_i] - E_{t-1}[F1_i]) + (1 - w_{i,t})(E_t[F2_i] - E_{t-1}[F2_i])$. This approach ensures that the changes are driven only by monthly revisions in expectations and not by elapsed time. Finally, expectations shocks are computed as $\Delta E_t[F12_i]/(|E_t[F12_i]| + |E_{t-1}[F12_i]|)/2$, which allows for negative denominators, and ranges between -2 and +2. Similarly, portfolio-level and aggregate earnings expectations shocks are computed after summing $F12$ across firms each month, ensuring that the numerator and denominator pertain to the same firms.

Expected Long-Term Growth Beta: A measure of the sensitivity of long-term earnings growth expectations to aggregate long-term earnings growth expectations. Each month long-term earnings forecast (LTF) is developed for each firm by applying the consensus median long-term growth forecast from I/B/E/S (*medltg*) to the 12-month-ahead earnings forecast ($F12$): $E_t[LTF_i] = E_t[F12_i] \times (1 + E_t[LTG_i])$. The monthly growth in long-term earnings is computed as $\Delta E_t[LTF_i]/(|E_t[LTF_i]| + |E_{t-1}[LTF_i]|)/2$, which allows for negative denominators, and ranges between -2 and +2. Similarly, portfolio-level and aggregate

Appendix 2 Description of Various Estimates of Earnings Beta

Earnings Measure Used in Numerator	
Levels of Realizations	Levels of Expectations
Changes in Realizations	Changes in Expectations
<i>Realized Earnings Growth</i>	
<i>Beta:</i>	
Earnings	<i>Earnings-scaled</i> <i>Expectations Shock Beta:</i>
$\beta\left(\frac{\Delta EARN_{i,t}}{EARN_{i,t-1}}, \frac{\Delta EARN_{M,t}}{EARN_{M,t-1}}\right)$	$\beta\left(\frac{\Delta E_t[F12_i]}{E_{t-1}[F12_i]}, \frac{\Delta E_t[F12_M]}{E_{t-1}[F12_M]}\right)$
<i>Book-scaled Realized Earnings Growth</i>	
<i>Expected ROE Beta:</i>	
Book Equity (B)	<i>Book-scaled Expectations Shock Beta:</i>
$\beta\left(\frac{EARN_{i,t}}{B_{i,t-1}}, \frac{EARN_{M,t}}{B_{M,t-1}}\right)$	$\beta\left(\frac{E_t[F12_i]}{B_{i,t-1}}, \frac{E_t[F12_M]}{B_{M,t-1}}\right)$
<i>Price-scaled Realized Earnings Yield</i>	
<i>Beta:</i>	
Market Equity (P)	<i>Price-scaled Expectations Shock Beta:</i>
$\beta\left(\frac{EARN_{i,t}}{P_{i,t-1}}, \frac{EARN_{M,t}}{P_{M,t-1}}\right)$	$\beta\left(\frac{E_t[F12_i]}{P_{i,t-1}}, \frac{E_t[F12_M]}{P_{M,t-1}}\right)$

This table describes the various estimates of firm-level and portfolio-level earnings beta used in this study as well as the different earnings measures used to estimate beta. The numerator is either realizations or expectations of earnings, both in levels and changes. The denominator is either prior period earnings, prior period book value of equity, or market value of equity. To estimate earnings betas, the earnings measures are constructed either at the firm level or at the portfolio level. These entity-level (*i*) earnings measures are then regressed on equivalent aggregate-level (*M*) measures using backward-looking rolling window estimations in the following model: $Measure_{i,t} = \alpha_i + \beta_i Measure_{M,t} + \varepsilon_{i,t}$. When realizations of earnings are used, the periodicity of the data is quarterly and earnings betas are estimated over backward-rolling 20-quarter windows (minimum of 12 quarters required). When expectations of earnings are used, the periodicity of the data is monthly and the earnings betas are estimated over backward-rolling 60-month windows (minimum of 36 months required). The definitions below the table describe the construction of the entity-level and aggregate-level earnings series.

growth in long-term earnings are computed after summing *LTF* across firms each month, ensuring that the numerator and denominator pertain to the same firms.

Realized ROE Beta: A measure of the sensitivity of realized return on equity to aggregate realized return on equity. Realized return on equity is calculated as trailing 12-month core earnings (*EARN*) divided by beginning of period book value of equity. Portfolio-level and aggregate earnings are computed by summing earnings across firms before calculating return on equity, ensuring that the numerator and denominator pertain to the same firms.

Book-scaled Realized Earnings Growth Beta: A measure of the sensitivity of book-scaled realized earnings growth to aggregate book-scaled realized earnings growth. Book-scaled realized annual growth in trailing 12-month core earnings (*EARN*) for firm *i* at time *t* over the past 12 months is computed using the following approach: $\Delta EARN_{i,t} / B_{i,t-1}$. Portfolio-level and aggregate earnings are computed by summing earnings and book values of equity across firms before calculating book-scaled growth, ensuring that the numerator and denominator pertain to the same firms.

Expected ROE Beta: A measure of the sensitivity of expected return on equity to aggregate expected return on equity. Expected return on equity is calculated as the constant horizon 12-month-ahead forecast (*F12*) divided by the beginning of period book value of equity: $E_i[F12_i] / B_{i,t-1}$. Portfolio-level and aggregate earnings are computed by summing the constant horizon 12-month-ahead forecast (*F12*) and book values of equity across firms each month before calculating return on equity, ensuring that the numerator and denominator pertain to the same firms.

Book-scaled Expectations Shock Beta: A measure of the sensitivity of earnings expectations shocks to aggregate earnings expectations shocks. Book-scaled expectations shocks are measured as the monthly changes in the constant horizon 12-month-ahead forecast (*F12*) scaled by the beginning of period book value of equity: $\Delta E_i[F12_i] / B_{i,t-1}$. Portfolio-level and aggregate earnings expectations shocks are computed by summing changes in expectations of the constant horizon 12-month-ahead forecast (*F12*) and book values of equity across firms each month before calculated expectations shocks, ensuring that the numerator and denominator pertain to the same firms.

Realized Earnings Yield Beta: A measure of the sensitivity of realized earnings yield to aggregate realized earnings yield. Realized earnings yield is calculated as trailing 12-month core earnings (*EARN*) divided by prior period market value of equity. Price (market value of equity) is observed six months after fiscal period-end. Portfolio-level and aggregate earnings yield are computed by summing trailing 12-month core earnings and market values of equity across firms before calculating earnings yield, ensuring that the numerator and denominator pertain to the same firms.

Price-scaled Realized Earnings Growth Beta: A measure of the sensitivity of price-scaled realized earnings growth to aggregate price-scaled realized earnings growth. Price scaled realized annual growth in trailing 12-month core earnings (*EARN*) for firm *i* at time *t* over the past 12 months is computed using the following approach: $\Delta EARN_{i,t} / P_{i,t-1}$. Price (market value of equity) is observed six months after fiscal period-end. Portfolio-level and aggregate earnings are computed by summing earnings and market values of equity across firms before calculating priced-scaled

growth using the above approach, ensuring that the numerator and denominator pertain to the same firms.

Expected Earnings Yield Beta: A measure of the sensitivity of expected earnings yield (i.e., forward earnings yield) to aggregate expected earnings yield. Expected earnings yield is calculated as the constant horizon 12-month-ahead forecast ($F12$) divided by market value of equity at the beginning of the prior month: $E_t[F12_i]/P_{i,t-1}$. Portfolio-level and aggregate earnings are computed by summing $F12$ and market values of equity across firms each month before calculating expected earnings yield, ensuring that the numerator and denominator pertain to the same firms.

Price-scaled Expectations Shock Beta: A measure of the sensitivity of earnings expectations shocks to aggregate earnings expectations shocks. Price-scaled expectations shocks are measured as the monthly changes in the constant horizon 12-month-ahead forecast ($F12$) scaled by market value of equity at the beginning of the prior month: $\Delta E_t[F12_i]/P_{i,t-1}$. Portfolio-level and aggregate earnings expectations shocks are computed by summing changes in expectations of $F12$ and market values of equity across firms each month before calculating expectations shocks, ensuring that the numerator and denominator pertain to the same firms.

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References

- Anilowski, C., Feng, M., & Skinner, D. (2007). Does earnings guidance affect market returns? The nature and information content of aggregate earnings guidance. *Journal of Accounting and Economics*, 44(1–2), 36–63.
- Ball, R. (1978). Anomalies in relationships between securities' yields and yield-surrogates. *Journal of Financial Economics*, 6(2–3), 103–126.
- Ball, R., & Brown, P. (1969). Portfolio theory and accounting. *Journal of Accounting Research*, 7(2), 300–323.
- Ball, R., Sadka, G., & Sadka, R. (2009). Aggregate earnings and asset prices. *Journal of Accounting Research*, 47(5), 1097–1133.
- Ball, R., Gerakos, J., Linnainmaa, J., & Nikolaev, V. (2015). Deflating profitability. *Journal of Financial Economics*, 117(2), 225–248.
- Ball, R., Gerakos, J., Linnainmaa, J., & Nikolaev, V. (2016). Accruals, cash flows, and operating profitability in the cross section of stock returns. *Journal of Financial Economics*, 121(1), 28–45.
- Bansal, R., Dittmar, R., & Lundblad, C. (2005). Consumption, dividends, and the cross section of equity returns. *Journal of Finance*, 60(4), 1639–1672.
- Beaver, W., & Manegold, J. (1975). The association between market-determined and accounting-determined measures of systematic risk: Some further evidence. *Journal of Financial and Quantitative Analysis*, 10(2), 231–284.
- Beaver, W., Kettler, P., & Scholes, M. (1970). The association between market-determined and accounting-determined measures of risk. *The Accounting Review*, 45(4), 654–682.
- Beaver, W., McNichols, M., & Price, R. (2007). Delisting returns and their effect on accounting-based market anomalies. *Journal of Accounting and Economics*, 43(2–3), 341–368.

- Berk, J., Green, R., & Naik, V. (1999). Optimal investment, growth options and security returns. *Journal of Finance*, *54*(5), 1553–1607.
- Binsbergen, J. V., Brandt, M., & Koijen, R. (2012). On the timing and pricing of dividends. *American Economic Review*, *102*(4), 1596–1618.
- Black, F. (1972). Capital market equilibrium with restricted borrowing. *Journal of Business*, *45*(3), 444–455.
- Botosan, C., & Plumlee, M. (2005). Assessing alternative proxies for the expected risk premium. *The Accounting Review*, *80*(1), 21–53.
- Bowman, R. (1979). The theoretical relationship between systematic risk and financial (accounting) variables. *Journal of Finance*, *34*(3), 617–630.
- Brown, P., & Ball, R. (1967). Some preliminary findings on the association between the earnings of a firm, its industry, and the economy. *Journal of Accounting Research*, *5*, 55–77.
- Campbell, J. (1991). A variance decomposition of stock returns. *Economic Journal*, *101*(405), 157–179.
- Campbell, J., & Shiller, R. (1988). Dividend-price ratio and expectations of future dividends and discount factors. *Review of Financial Studies*, *1*(3), 195–228.
- Campbell, J., & Vuolteenaho, T. (2004). Bad beta, good beta. *American Economic Review*, *94*(5), 1249–1275.
- Campbell, J., Polk, C., & Vuolteenaho, T. (2010). Growth or glamour? Fundamentals and systematic risk in stock returns. *Review of Financial Studies*, *23*(1), 2739–2782.
- Carabias, J. (2018). The real-time information content of macroeconomic news: Implications for firm-level earnings expectations. *Review of Accounting Studies*, *23*(1), 136–166.
- Carhart, M. (1997). On persistence in mutual fund performance. *Journal of Finance*, *52*(1), 57–82.
- Chang, Y., & Savickas, R. (2014). Return decomposition: A Bayesian state-space model approach. Working paper, George Washington University. Available at <https://ssrn.com/abstract=2170586>.
- Chen, L., & Zhao, X. (2009). Return decomposition. *Review of Financial Studies*, *22*(12), 5213–5249.
- Cochrane, J. (2011). Presidential address: Discount rates. *Journal of Finance*, *66*(4), 1047–1108.
- Cohen, R., Polk, C., & Vuolteenaho, T. (2009). The price is (almost) right. *Journal of Finance*, *64*(6), 2739–2782.
- Cooper, I., & Priestley, R. (2011). Real investment and risk dynamics. *Journal of Financial Economics*, *101*(1), 182–205.
- Croce, M., Lettau, M., & Ludvigson, S. (2009). Investor information, long-run risk, and the duration of risky cash-flows. *Review of Financial Studies*, *28*(3), 706–742.
- Da, Z. (2009). Cash flow, consumption risk, and the cross-section of stock returns. *Journal of Finance*, *64*(2), 923–956.
- Da, Z., & Warachka, M. (2009). Cashflow risk, systematic earnings revisions, and the cross-section of stock returns. *Journal of Financial Economics*, *94*(3), 448–468.
- Da, Z., & Warachka, M. (2011). The disparity between long-term and short-term forecasted earnings growth. *Journal of Financial Economics*, *100*(2), 424–442.
- Dechow, P., Sloan, R., & Soliman, M. (2004). Implied equity duration: A new measure of equity risk. *Review of Accounting Studies*, *9*(2), 197–228.
- Easton, P., & Harris, T. (1991). Earnings as an explanatory variable. *Journal of Accounting Research*, *29*(1), 19–36.
- Easton, P., Harris, T., & Ohlson, J. (1992). Aggregate accounting earnings can explain most of security returns. *Journal of Accounting and Economics*, *15*(2), 119–142.
- Ellahie, A., Katz, M., & Richardson, S. (2020). Risky value. Working paper, the University of Utah and AQR Capital Management. Available at <https://ssrn.com/abstract=2325524>.
- Fama, E., & French, K. (1992). The cross-section of expected stock returns. *Journal of Finance*, *47*(2), 427–465.
- Fama, E., & French, K. (1993). Common risk factors in the returns of stocks and bonds. *Journal of Financial Economics*, *33*(1), 3–56.
- Fama, E., & French, K. (1995). Size and book-to-market factors in earnings and returns. *Journal of Finance*, *50*(1), 131–155.
- Fama, E., & French, K. (1996). Multifactor explanations of asset pricing anomalies. *Journal of Finance*, *51*(1), 55–84.
- Fama, E., & French, K. (2006). Profitability, investment and average returns. *Journal of Financial Economics*, *82*(3), 491–518.
- Fama, E., & French, K. (2015). A five-factor asset pricing model. *Journal of Financial Economics*, *116*(1), 1–22.
- Fama, E., & Macbeth, J. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy*, *81*(3), 607–636.

- Feltham, G., & Ohlson, J. (1995). Valuation and clean surplus accounting for operating and financial activities. *Contemporary Accounting Research*, 12(2), 689–731.
- Frazzini, A., & Pedersen, L. (2014). Betting against beta. *Journal of Financial Economics*, 111(1), 1–25.
- Freyberger, J., Neuhierl, A., & Weber, M. (2020). Dissecting characteristics nonparametrically. *Review of Financial Studies*, 33(5), 2326–2377.
- Giglio, S., & Xiu, D. (2019). Asset pricing with omitted factors. Working paper, Chicago Booth Research Paper No. 16-21. Available at <https://ssrn.com/abstract=2865922>.
- Gonedes, N. (1973). Evidence on the information content of accounting numbers: Accounting-based and market-based estimates of systematic risk. *Journal of Financial and Quantitative Analysis*, 8(3), 407–443.
- Hamada, R. (1972). The effect of the firm's capital structure on the systematic risk of common stocks. *Journal of Finance*, 27(2), 435–452.
- Hansen, L., Heaton, J., & Li, N. (2008). Consumption strikes back? Measuring long-run risk. *Journal of Political Economy*, 116(21), 260–302.
- Harvey, C., Liu, Y., & Zhu, H. (2016). ... and the cross-section of expected returns. *Review of Financial Studies*, 29(1), 5–68.
- Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *Journal of Finance*, 48(1), 65–91.
- Kelly, B., Pruitt, S., & Su, Y. (2019). Characteristics are covariances: A unified model of risk and return. *Journal of Financial Economics*, 134(3), 501–524.
- Kothari, S. P., Lewellen, J., & Warner, J. (2006). Stock returns, aggregate earnings surprises, and behavioral finance. *Journal of Financial Economics*, 79(3), 537–568.
- Lev, B. (1974). On the association between operating leverage and risk. *Journal of Financial and Quantitative Analysis*, 9(4), 627–641.
- Lewellen, J. (2015). The cross-section of expected stock returns. *Critical Finance Review*, 4(1), 1–44.
- Lewellen, J., Nagel, S., & Shanken, J. (2010). A skeptical appraisal of asset pricing tests. *Journal of Financial Economics*, 96(2), 175–194.
- Merton, R. (1973). An intertemporal capital asset pricing model. *Econometrica*, 41(5), 867–887.
- Miller, M., & Modigliani, F. (1961). Dividend policy, growth and the valuation of shares. *Journal of Business*, 34(4), 411–433.
- Nallareddy, S. (2012). Does differential sensitivity to aggregate earnings shocks drive post-earnings-announcement drift? Working paper. Available at <https://ssrn.com/abstract=2163237>.
- Nekrasov, A., & Shroff, P. (2009). Fundamentals-based risk measurement in valuation. *The Accounting Review*, 84(6), 1983–2011.
- Ohlson, J. (1995). Earnings, book values, and dividends in equity valuation. *Contemporary Accounting Research*, 11(2), 661–687.
- Ou, J., & Penman, S. (1989). Financial statement analysis and the prediction of stock returns. *Journal of Accounting and Economics*, 11(4), 295–329.
- Pastor, L., & Stambaugh, R. (2003). Liquidity risk and expected stock returns. *Journal of Political Economy*, 111(3), 642–685.
- Penman, S. (1991). An evaluation of accounting rate-of-return. *Journal of Accounting, Auditing and Finance*, 6(2), 233–255.
- Penman, S. (2013). *Financial statement analysis and security valuation* (5th ed.). New York: McGraw-Hill.
- Penman, S. (2016). Valuation: Accounting for risk and the expected return. *Abacus*, 52(1), 106–130.
- Penman, S., & Reggiani, F. (2013). Returns to buying earnings and book value: Accounting for growth and risk. *Review of Accounting Studies*, 18(4), 1021–1049.
- Penman, S., & Zhang, X. (2002). Accounting conservatism, the quality of earnings, and stock returns. *The Accounting Review*, 77(2), 237–264.
- Penman, S., & Zhang, X. (2020). A theoretical analysis connecting conservative accounting to the cost of capital. *Journal of Accounting and Economics*, 69(1), 101236.
- Penman, S., & Zhu, J. (2014). Accounting anomalies, risk, and return. *The Accounting Review*, 89(5), 1835–1866.
- Penman, S., Reggiani, F., Richardson, S., & Tuna, İ. (2018). A framework for identifying accounting characteristics for asset pricing models, with an evaluation of book-to-price. *European Financial Management*, 24(4), 488–520.
- Petersen, M. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. *Review of Financial Studies*, 22(1), 435–480.
- Pettit, R., & Westerfield, R. (1972). A model of capital asset risk. *Journal of Financial and Quantitative Analysis*, 7(2), 1649–1668.
- Richardson, S., Teoh, S., & Wysocki, P. (2004). The walk-down to beatable analyst forecasts: The role of equity issuance and insider trading incentives. *Contemporary Accounting Research*, 21(4), 885–924.

- Savor, P., & Wilson, M. (2016). Earnings announcements and systematic risk. *Journal of Finance*, 71(1), 83–138.
- Shivakumar, L. (2007). Aggregate earnings, stock market returns and macroeconomic activity: A discussion of ‘Does earnings guidance affect market returns? The nature and information content of aggregate earnings guidance’. *Journal of Accounting and Economics*, 44(1–2), 64–73.
- Sloan, R. (1996). Do stock prices fully reflect information in accruals and cash flow about future earnings? *The Accounting Review*, 71(3), 289–315.
- Vuolteenaho, T. (2002). What drives firm-level stock returns? *Journal of Finance*, 57(1), 233–264.
- Zhang, L. (2005). The value premium. *Journal of Finance*, 60(1), 67–103.

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