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THE ECONOMICS OF VALUE INVESTING

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ABSTRACT

The investment CAPM provides an economic foundation for Graham and Dodd's (1934) Security Analysis. Expected returns vary cross-sectionally, depending on firms' investment, profitability, and expected investment growth. Empirically, many anomaly variables predict future changes in investment-to-assets, in the same direction in which these variables predict future returns. However, the expected investment growth effect in sorts is weak. The investment CAPM has different theoretical properties from Miller and Modigliani's (1961) valuation model and Penman, Reggiani, Richardson, and Tuna's (2017) characteristic model. In all, value investing is consistent with efficient markets.

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1 Introduction

In their masterpiece, Graham and Dodd (1934) lay the intellectual foundation for value investing. The basic philosophy is to invest in undervalued securities that are selling well below the intrinsic value. The intrinsic value of a security is in turn the value that can be justified by the issuing firm's earnings, dividends, assets, and other financial statement information. The underlying premise is that the intrinsic value justified by fundamentals is distinct from the market value "established by artificial manipulation or distorted by psychological excesses (p. 17)."

The academic literature on security analysis, pioneered by Ou and Penman (1989), has largely subscribed to the Graham and Dodd (1934) perspective. "Firms' ('fundamental') values are indicated by information in financial statements. Stock prices deviate at times from these values and only slowly gravitate towards the fundamental values. Thus, analysis of published financial statements can discover values that are not reflected in stock prices. Rather than taking prices as value benchmarks, 'intrinsic values' discovered from financial statements serve as benchmarks with which prices are compared to identify overpriced and underpriced stocks. Because deviant prices ultimately gravitate to the fundamentals, investment strategies which produce 'abnormal returns' can be discovered by the comparison of prices to these fundamental values (Ou and Penman, p. 296)."

Our key insight is that an equilibrium framework, which we call the investment CAPM, provides an economic foundation for Graham and Dodd's (1934) *Security Analysis*, without mispricing. Under the investment CAPM, expected returns varying cross-sectionally, depending on firms' investment, expected profitability, and expected investment growth. This theoretical prediction validates the widespread practice of security analysis, without contradicting the efficient markets hypothesis. Empirically, many anomaly variables predict future changes in investment-to-assets, in the same direction in which these variables predict future returns. However, cross-sectional forecasts of future investment changes are noisy, and the expected investment growth effect in portfolio sorts is weak.

The investment CAPM has more appealing theoretical properties than the two models that currently dominate the fundamental analysis literature, the residual income model (Miller and Modigliani 1961, Ohlson 1995) and an accounting-based characteristic model (Penman, Reggiani, Richardson, and Tuna 2017). The investment CAPM characterizes the one-period-ahead expected return, which is conceptually different from the long-term average expected return, or the internal rate of return, characterized in the residual income model. We also provide new evidence on how the internal rate of return estimates differ from the one-period-ahead average returns.

We also clarify the subtle relations among investment-to-assets, book-to-market, expected investment, and the expected return. While profitability, book-to-market, and expected investment appear to be three separate factors in the residual income model, investment-to-assets and book-to-market are largely substitutable in the investment CAPM. Intuitively, the marginal cost of investment (an increasing function of investment) equals marginal q, which in turn equals average q under constant returns to scale. In addition, reformulating the residual income model in terms of the one-period-ahead expected return, we show that the relation between the expected return and the expected investment (growth) tends to be positive, consistent with the investment CAPM.

Both the Penman-Reggiani-Richardson-Tuna (2017) model and the investment CAPM focus on the one-period-ahead expected stock return. Reassuringly, both argue that the expected earnings and expected growth are important drivers of the expected return. However, while Penman et al. use powerful accounting intuition to relate the expected change in the market equity's deviation from the book equity to the expected earnings growth, the investment-q relation allows us to substitute, mathematically, the expected capital gain with the expected investment growth. Also, while the market equity remains in the Penman et al. model, the investment-q relation allows the substitution of the market equity with investment-to-assets, making the investment CAPM perhaps even more "fundamental." Finally, while the Penman et al. focus on the expected earnings yield and book-to-market, which serves as a proxy for the expected earnings growth, as the key drivers of the expected return, the investment CAPM uses investment, profitability, and the expected investment growth. Factor spanning tests show that the investment and profitability factors subsume factors formed on the earnings yield and book-to-market, but the earnings yield and book-to-market factors cannot subsume the investment and profitability factors.

Our major contribution is to provide an economic framework and an efficient markets perspective of value investing, departing from the conventional mispricing perspective per Graham and Dodd (1934). It is well established that time-varying expected returns provide an economic foundation for stock market predictability (Marsh and Merton 1986), without mispricing advocated by Shiller (1981). Analogously, the investment CAPM implies *cross-sectionally varying* expected returns, which provide an economic foundation for cross-sectional predictability, without mispricing advocated by Barberis and Thaler (2003). We also show that the investment CAPM has several more appealing theoretical properties than the residual income model and the Penman-Reggiani-Richardson-Tuna (2017) model that organize the existing fundamental analysis literature.

The origin of the investment CAPM can be traced to Böhm-Bawert (1891). Böhm-Bawert argues that output rises with the length of the period of production, and is counterbalanced by a positive interest rate. The higher the interest rate, the shorter the optimal production period will be, and the less capital (lower investment) will be tied up in the process. Fisher (1930) constructs the first general equilibrium model with intertemporal consumption and production, in which the equilibrium interest rate is determined from two equivalent ways via the intertemporal rate of substitution and the intertemporal rate of transformation. Hirshleifer (1958, 1965, 1970) extends the Fisherian equilibrium into uncertainty with the state-preference approach.

The investment CAPM is in the spirit of Modigliani and Miller (1958), who ask the cost of capital question of firms with uncertainty. Their Proposition II gives the weighted average cost of capital in terms of the cost of equity, the cost of debt, and leverage, a formulation preserved in the investment CAPM. In their relatively overlooked Proposition III, Modigliani and Miller prescribe that a firm should take an investment project if and only if its real rate of return is as large as or larger than the weighted average cost of capital. This prescription is the essence of the net present value rule in modern capital budgeting. However, when determining the cost of capital, Fama and Miller (1972) and Fama (1976) turn to the investor-centric CAPM. We take the diametrical but complementary perspective by treating the weighted average cost of capital equation as an asset pricing theory.

Cochrane (1991) is the first in the modern era to study asset prices from the investment perspective: "The logic of the production-based model is exactly analogous [to that of the consumption-based model]. It ties asset returns to marginal rates of *transformation*, which are inferred from data on investment (and potentially, output and other production variables) through a *production* function. It is derived from the *producer's* first order conditions for optimal intertemporal *investment* demand. Its testable content is a restriction on the joint stochastic process of *investment* (and/or other production variables) and asset returns (p. 210, original emphasis)."

Liu, Whited, and Zhang (2009) and Hou, Xue, and Zhang (2015) show the empirical power of the investment CAPM in the cross section of expected stock returns. Zhang (2017) clarifies that like any other prices, asset prices are equilibrated by both demand and supply (of risky assets), and that while the consumption CAPM is based on demand, the investment CAPM on supply. Our work differs by applying the investment CAPM to the vast fundamental analysis literature.

Section 2 briefly reviews the fundamental analysis literature to motivate our work. Section 3 presents the investment CAPM, discusses its implications, and tests some of its new predictions. Section 4 compares the investment CAPM with the residual income model, and Section 5 with Penman, Reggiani, Richardson, and Tuna's (2017) characteristic model. Section 6 concludes.

2 Security Analysis: Background

Graham and Dodd (1934) define security analysis as "concerned with the intrinsic value of the security and more particularly with the discovery of discrepancies between the intrinsic value and the market price (p. 17)." The intrinsic value is "that value which is justified by the facts, e.g., the assets, earnings, dividends, definite prospects, as distinct, let us say, from market quotations established by artificial manipulation or distorted by psychological excesses (p. 17)." The intrinsic value does not have to be exact, however. "It needs only to establish either that the value is *adequate*—e.g., to protect a bond or to justify a stock purchase—or else that the value is considerably higher or considerably lower than the market price (p. 18, original emphasis)."

Graham and Dodd (1934) clearly differentiate the intrinsic value from the market value: "[T]he influence of what we call analytical factors over the market price is both *partial* and *indirect*—partial, because it frequently competes with purely speculative factors which influence the price in the opposite direction; and indirect, because it acts through the intermediary of people's sentiments and decisions. In other words, the market is not a *weighting machine*, on which the value of each issue is recorded by an exact and impersonal mechanism, in accordance with its specific qualities. Rather should we say that the market is a *voting machine*, whereon countless individuals register choices which are the product partly of reason and partly of emotion (p. 23, original emphasis)."

How should an intelligent investor proceed? Graham and Dodd (1934) prescribe: "Perhaps he would be well advised to devote his attention to the field of undervalued securities—issues, whether bonds or stocks, which are selling well below the levels apparently justified by a careful analysis of the relevant facts (p. 13)." However, Graham and Dodd also warn that price can be slow in adjusting to value: "Undervaluations caused by neglect or prejudice may persist for an inconveniently long time, and the same applies to inflated prices caused by overenthusiasm or artificial stimulants. The particular danger to the analyst is that, because of such delay, new determining factors may supervene before the market price adjusts itself to the value as he found it. In other words, by the time the price finally does reflect the value, this value may have changed considerably and the facts and reasoning on which his decision was based may no longer be applicable (p. 22)."

In an article titled "The superinvestors of Graham-and-Doddsville," Warren Buffett (1984) honors the 50th anniversary of Graham and Dodd (1934). Buffett reports the highly successful investment performance of nine famous investors who follow Graham and Dodd, and "search for discrepancies between the *value* of a business and the *price* of small pieces of that business in the market (p. 7, original emphasis)." After concluding their success is beyond chance, Buffett denounces academic finance: "Our Graham & Dodd investors, needless to say, do not discuss beta, the capital asset pricing model or covariance in returns among securities. These are not subjects of any interest to them. In fact, most of them would have difficulty defining those terms (p. 7)." "There seems to be some perverse human characteristic that likes to make easy things difficult. The academic world, if anything, has actually backed away from the teaching of value investing over the last 30 years. It's likely to continue that way. Ships will sail around the world but the Flat Earth Society will flourish. There will continue to be wide discrepancies between price and value in the market place, and those who read their Graham & Dodd will continue to prosper (p. 15)."

Contrary to Buffett (1984), business schools have long taught value investing, often called security analysis or financial statement analysis, in their standard curricula. In a prominent textbook, Penman (2013) adopts Graham and Dodd's (1934) basic premise: "Passive investors accept market prices as fair value. Fundamental investors, in contrast, are active investors. They see that *price is what you pay, value is what you get*. They understand that *the primary risk in investing is the risk of paying too much* (or selling for too little). The fundamentalist actively challenges the market price: Is it indeed a fair price? This might be done as a defensive investor concerned with overpaying or as an investor seeking to exploit mispricing (p. 210, original emphasis)."

In a pathbreaking article, Ou and Penman (1989) launch the academic literature on security analysis. A large set of financial statement items is combined into one summary measure that indicates the direction of one-year-ahead earnings changes. A long-short strategy formed on this summary measure of future earnings earns an average two-year-holding-period return of 12.5%. Lev and Thiagarajan (1993) use a priori conceptual arguments to select 12 fundamental signals, and show that these signals have strong correlations with contemporaneous stock returns and future earnings. Abarbanell and Bushee (1997) show that signals such as inventory changes, account receivables changes, gross margin, changes in selling and administrative expenses, and tax expenses-to-earnings predict one-year-ahead earnings changes and analysts' forecast errors. Abarbanell and Bushee (1998) show further that a trading strategy formed on these fundamental signals earns an average size-adjusted abnormal return of 13.2% per annum.

Frankel and Lee (1998) estimate a firm's intrinsic value from analysts' consensus forecasts with Ohlson's (1995) residual income model, and show that the intrinsic-to-market value predicts future returns, especially in longer horizons up to three years. Piotroski (2000) applies security analysis to value stocks. Piotroski finds that the average returns for value investors can be raised by over 7.5% per annum by selecting financially strong value stocks based on fundamental signals, such as profitability, leverage, the current ratio, equity issuance, gross margin, and asset turnover.

Penman and Zhang (2002) show that conservative accounting for items such as inventories, R&D expenses, and advertising creates temporary changes in earnings, which in turn predict future abnormal returns. Applying security analysis to growth stocks, Mohanram (2005) forms a composite score based on return on assets, cash flow, earnings variability, sales growth variability, R&D, capital expenditure, and advertising. A long-short strategy formed on this composite score earns significant abnormal returns. Finally, Soliman (2008) applies the DuPont analysis to decompose return on net operating assets into profit margin and asset turnover, and shows that changes in asset turnover predict future return on net operating assets and future abnormal returns.

3 The Investment CAPM: Implications for Security Analysis

Section 3.1 sets up an equilibrium framework that encompasses the investment CAPM. Section 3.2 discusses its implications. Finally, Section 3.3 tests the expected investment growth effect.

3.1 An Equilibrium Framework

Consider a dynamic stochastic general equilibrium model with three defining features of neoclassical economics: Agents have rational expectations; consumers maximize utility, and firms maximize market value of equity; and markets clear. Time is discrete and the horizon infinite. The economy is populated by a representative consumer and heterogeneous firms, indexed by $i = 1, 2, \ldots, N$.

The representative consumer maximizes its expected life-time utility, $\sum_{t=0}^{\infty} \rho^t U(C_t)$, in which ρ is the time discount coefficient, and C_t is consumption in period t. Let P_{it} be the ex-dividend equity, and D_{it} the dividend of firm i at period t. The first principle of consumption says that:

$$E_t[M_{t+1} r^S_{it+1}] = 1, \tag{1}$$

in which $r^S_{it+1} \equiv (P_{it+1} + D_{it+1})/P_{it}$ is firm i's stock return, and $M_{t+1} \equiv \rho U'(C_{t+1})/U'(C_t)$ is the consumer's stochastic discount factor. Equation (1) can be rewritten as:

$$E_t[r^S_{it+1}] - r_{ft} = \beta^M_{it} \lambda_{Mt}, \tag{2}$$

in which $r_{ft} \equiv 1/E_t[M_{t+1}]$ is the real interest rate, $\beta^M_{it} \equiv -\text{Cov}(r^S_{it+1}, M_{t+1})/\text{Var}(M_{t+1})$ is the consumption beta, and $\lambda_{Mt} \equiv \text{Var}(M_{t+1})/E_t[M_{t+1}]$ is the price of the consumption risk. Equation (1) is the consumption CAPM due to Rubinstein (1976), Lucas (1978), and Breeden (1979). The classic Sharpe (1964) and Lintner (1965) CAPM is a special case of the consumption CAPM under quadratic utility or exponential utility with normally distributed returns (Cochrane 2005).

Firms produce a single commodity to be consumed or invested. Firms use capital and costlessly adjustable inputs to produce a homogeneous output. These inputs are chosen each period to maximize operating profits, which are defined as revenue minus the costs of these inputs. Taking operating profits as given, firms choose investment to maximize the market equity. Let $\Pi_{it} \equiv \Pi(X_{it}, A_{it}) = X_{it} A_{it}$ denote the time-t operating profits of firm i, in which A_{it} is productive assets, and X_{it} profitability. The next period profitability, X_{it+1}, is stochastic, and is subject to a vector of exogenous aggregate and firm-specific shocks. In addition, let I_{it} denote investment and δ the depreciation rate of productive assets, then $A_{it+1} = I_{it} + (1-\delta) A_{it}$. Investment entails quadratic adjustment costs, $\Phi(I_{it}, A_{it}) = (a/2)(I_{it}/A_{it})^2 A_{it}$, in which $a > 0$ is a constant parameter.

Firms can finance investment with one-period debt. At the beginning of time t, firm i can issue an amount of debt, B_{it+1}, which must be repaid at the beginning of period $t+1$. The gross corporate bond return on B_{it}, r^B_{it}, can vary across firms and over time. Taxable corporate profits equal operating profits less capital depreciation, adjustment costs, and interest expenses, $X_{it}A_{it} - \delta A_{it} - \Phi(I_{it}, A_{it}) - (r^B_{it} - 1)B_{it}$, in which adjustment costs are expensed. Let τ be the corporate tax rate. We ignore time-varying, and possibly stochastic, tax rates. The free cash flow of firm i equals

$$D_{it} \equiv (1-\tau)[X_{it}A_{it} - \Phi(I_{it}, A_{it})] - I_{it} + B_{it+1} - r^B_{it}B_{it} + \tau\delta A_{it} + \tau(r^B_{it} - 1)B_{it}, \tag{3}$$

in which $\tau\delta A_{it}$ is the depreciation tax shield, and $\tau(r^B_{it} - 1)B_{it}$ is the interest tax shield. If D_{it} is positive, the firm distributes it to the household. Otherwise, a negative D_{it} means external equity.

Let M_{t+1} be the stochastic discount factor, which is correlated with the aggregate component of X_{it+1}. The cum-dividend market equity can be formulated as

$$V_{it} \equiv \max_{\{I_{it+s}, A_{it+s+1}, B_{it+s+1}\}_{s=0}^{\infty}} E_t\left[\sum_{s=0}^{\infty} M_{t+s}D_{it+s}\right], \tag{4}$$

subject to a transversality condition that prevents the firm from borrowing an infinite amount to distribute to shareholders, $\lim_{T\to\infty} E_t\left[M_{t+T}\, B_{it+T+1}\right] = 0$.

3.1.1 The Investment CAPM

The first principle of investment implies $E_t[M_{t+1}r^I_{it+1}] = 1$, in which r^I_{it+1} is the investment return:

$$r^I_{it+1} \equiv \frac{(1-\tau)\left[X_{it+1} + \frac{a}{2}\left(\frac{I_{it+1}}{A_{it+1}}\right)^2\right] + \tau\delta + (1-\delta)\left[1 + (1-\tau)a\left(\frac{I_{it+1}}{A_{it+1}}\right)\right]}{1 + (1-\tau)a\left(\frac{I_{it}}{A_{it}}\right)}. \tag{5}$$

Intuitively, the investment return is the marginal benefit of investment at time $t+1$ divided by the marginal cost of investment at t. The first principle, $E_t[M_{t+1}r^I_{it+1}] = 1$, says that the marginal cost equals the next period marginal benefit discounted to time t with the stochastic discount factor.

The investment return is the ratio of the marginal benefit of investment at time $t+1$ to the marginal cost of investment at t. In its numerator, $(1-\tau)X_{it+1}$ is the marginal after-tax profits produced by an additional unit of capital, $(1-\tau)(a/2)(I_{it+1}/A_{it+1})^2$ is the marginal after-tax reduction in adjustment costs, $\tau\delta$ is the marginal depreciation tax shield, and the last term in the numerator is the marginal continuation value of the extra unit of capital net of depreciation. Finally, the first term in brackets plus $\tau\delta$ in the numerator divided by the denominator is analogous to the dividend yield. The second term in brackets in the numerator divided by the denominator is analogous to the capital gain because this ratio is the growth rate of marginal q.

Let the after-tax corporate bond return be $r^{Ba}_{it+1} \equiv r^{B}_{it+1} - (r^{B}_{it+1} - 1)\tau$, then $E_t[M_{t+1} r^{Ba}_{it+1}] = 1$. As noted, $P_{it} \equiv V_{it} - D_{it}$ is the ex-dividend equity value, and $r^{S}_{it+1} \equiv (P_{it+1} + D_{it+1})/P_{it}$ is the stock return. Let $w_{it} \equiv B_{it+1}/(P_{it} + B_{it+1})$ be the market leverage, then the investment return is the weighted average of the stock return and the after-tax corporate bond return (Appendix A):

$$r^{I}_{it+1} = w_{it}\, r^{Ba}_{it+1} + (1 - w_{it})\, r^{S}_{it+1}, \tag{6}$$

which is exactly the weighted average cost of capital in Modigliani and Miller's (1958) Proposition II.

Together, equations (5) and (6) imply that the weighted average cost of capital equals the ratio of the next period marginal benefit of investment divided by the current period marginal cost of investment. As such, the first principle of investment provides an economic foundation for the weighted average cost of capital approach to capital budgeting first introduced by Modigliani and Miller (1958, Proposition III). Intuitively, firms will keep investing until the marginal cost of investment, which rises with investment, equals the present value of additional investment, which is the next period marginal benefit of investment discounted by the weighted average cost of capital. Finally, solving for the stock return, r^{S}_{it+1}, from equation (6) yields the investment CAPM:

$$r^{S}_{it+1} = \frac{(1-\tau)\left[X_{it+1} + \frac{a}{2}\left(\frac{I_{it+1}}{A_{it+1}}\right)^2\right] + \tau\delta + (1-\delta)\left[1 + (1-\tau)a\left(\frac{I_{it+1}}{A_{it+1}}\right)\right]}{(1-w_{it})\left[1 + (1-\tau)a\left(\frac{I_{it}}{A_{it}}\right)\right]} - \frac{w_{it}}{1-w_{it}} r^{Ba}_{it+1}. \tag{7}$$

As an asset pricing model, equation (7) expresses the stock return in terms of characteristics.

We focus on the cost of capital question in this paper, but note that the investment framework also gives rise to two valuation equations (Appendix A). The first equation is:

$$P_{it} = \left[1 + (1-\tau)a\left(\frac{I_{it}}{A_{it}}\right)\right] A_{it+1} - B_{it+1}, \tag{8}$$

which amounts to the equivalence between the marginal q and the average q under constant returns to scale (Hayashi 1982). Intuitively, managers optimally adjust the supply of risky assets to changes in their market value. In equilibrium, the market value of assets is equal to, can be inferred from, the costs of supplying risky assets (Belo, Xue, and Zhang 2013).

Another valuation equation resembles more the traditional valuation practice (Penman 2013):

$$P_{it} = \frac{(1-\tau)\left[X_{it+1} + \frac{a}{2}\left(\frac{I_{it+1}}{A_{it+1}}\right)^2\right] A_{it+1} + \tau\delta A_{it+1} + (1-\delta)\left[1 + (1-\tau)a\left(\frac{I_{it+1}}{A_{it+1}}\right)\right] A_{it+1}}{w_{it}\, r^{Ba}_{it+1} + (1-w_{it})\, r^{S}_{it+1}} - B_{it+1}. \tag{9}$$

Intuitively, the market value is the discounted value of the total benefit of assets next period discounted by the weighted average cost of capital. Unlike traditional valuation theories, only variables dated $t+1$ appear in the numerator. The reason is that forward-looking in nature, investment-to-assets, I_{it+1}/A_{it+1}, summarizes all the necessary information contained in future cash flows occurring in all subsequent periods. In fact, this forward-looking property of investment gives rise to the first valuation equation (8), with right-hand side variables all known at time t.

3.2 Implications for Security Analaysis

The investment CAPM predicts *cross-sectionally varying* expected returns. Equation (7) says that without leverage, the one-period-ahead expected stock return, $E_t[r^S_{it+1}]$, varies with the current investment-to-assets, I_{it}/A_{it}, the expected profitability, $E_t[X_{it+1}]$, and (approximately) the expected investment-to-assets growth, $E_t[I_{it+1}/A_{it+1}]/(I_{it}/A_{it})$. Strictly speaking, the third determinant is the growth rate of marginal q, which equals the growth rate of the marginal cost of investment. However, since the marginal q involves the unobservable adjustment cost parameter, a, we use the investment-to-assets growth as a convenient, albeit rough, proxy. Finally, with the market leverage, w_{it}, both w_{it} and the expected after-tax corporate bond return, $E_t[r^{Ba}_{it+1}]$, also play a role.

3.2.1 Investment and Profitability

Hou, Xue, and Zhang (2015) work with a simplified two-period model without leverage, capital depreciation, or corporate taxes. In the simple model, equation (7) collapses to:

$$E_t[r^S_{it+1}] = \frac{E_t[X_{it+1}]}{1 + a\,(I_{it}/A_{it})}. \tag{10}$$

All else equal, high investment stocks should earn lower expected returns than low investment stocks, and stocks with high expected profitability should earn higher expected returns than stocks with low expected profitability. Intuitively, investment predicts stock returns because given expected profitability, high costs of capital imply low net present values of new projects and low investment. In addition, profitability predicts stock returns because high expected profitability relative to low investment implies high discount rates, which are necessary to offset the high expected profitability to induce low net present values of new projects and low investment. Empirically, Hou et al. use current profitability (quarterly return on equity, Roe) as the proxy for expected profitability to form their Roe factor in their q-factor model.

3.2.2 The Expected Investment-to-assets Growth

More generally, equation (7) says that in addition to investment-to-assets and expected profitability, the expected stock return is also linked to the expected investment-to-assets growth. As noted, we can decompose the expected investment return from equation (5) into two components, the expected "dividend yield" and the expected "capital gain." The former is given by $(E_t[X_{it+1}] + (a/2)E_t[(I_{it+1}/A_{it+1})^2] + \tau\delta)/(1 + a(1-\tau)(I_{it}/A_{it}))$, which largely conforms to the two-period model in equation (10), as the squared term, $(I_{it+1}/A_{it+1})^2$, and $\tau\delta$ are economically small. The expected "capital gain," $(1-\delta)[1+a(1-\tau)E_t[I_{it+1}/A_{it+1}]]/(1+a(1-\tau)(I_{it}/A_{it}))$, which only appears in the multiperiod model, is roughly proportional to the expected investment-to-assets growth, $E_t[I_{it+1}/A_{it+1}]/(I_{it}/A_{it})$. As such, conceptually, the expected investment-to-assets growth is the third determinant of expected returns in the multiperiod setting (Cochrane 1991).

3.2.3 Market Leverage

With debt financing, equation (7) implies that the expected stock return is also linked to the market leverage, w_{it}, although the relation is in general ambiguous. A higher w_{it} implies a higher levered investment return, which is the first term in the right-hand side of equation (7). However, a higher w_{it} also implies a higher $w_{it}/(1-w_{it})$, which multiplies with the after-tax corporate bond return, r^{Ba}_{it+1}. Because r^{Ba}_{it+1} is small in magnitude relative to the investment return, and $w_{it}/(1-w_{it})$ is likely less than one in the data, we expect the first term to dominate the second term in the right-hand side of equation (7). As such, the overall relation between the market leverage and the expected stock return is more likely to be positive, as in Modigliani and Miller (1958).

3.2.4 Security Analysis in Corporate Bonds

Security analysis can also be applied to corporate bonds. In particular, Graham and Dodd (1934) devote Parts II and III of their book, accounting for in total 235 pages, to the security analysis of fixed income securities and senior securities with speculative features. For comparison, their Parts IV, V, and VI that are devoted to common stocks have 243 pages.

The investment CAPM also provides an economic foundation for security analysis of corporate bonds. Equation (6) implies that the after-tax corporate bond return is given by:

$$r^{Ba}_{it+1} = \frac{(1-\tau)\left[X_{it+1} + \frac{a}{2}\left(\frac{I_{it+1}}{A_{it+1}}\right)^2\right] + \tau\delta + (1-\delta)\left[1 + (1-\tau)a\left(\frac{I_{it+1}}{A_{it+1}}\right)\right]}{w_{it}\left[1 + (1-\tau)a\left(\frac{I_{it}}{A_{it}}\right)\right]} - \frac{1-w_{it}}{w_{it}} r^{S}_{it+1}. \quad (11)$$

As such, the comparative statics for the expected stock return by varying investment-to-assets, profitability, and the expected investment-to-assets growth also apply to $E_t[r^{Ba}_{it+1}]$ in the same direction. However, these relations subsist only after holding the expected stock return constant.

The relation between the market leverage and the expected after-tax corporate bond return is ambiguous. A higher leverage, w_{it}, implies a lower first term in the right-hand side of equation

(11). However, a higher w_{it} also implies a lower $(1 - w_{it})/w_{it}$, which multiplies with the expected stock return with a larger magnitude than the expected bond return. Future empirical work on corporate bonds can help sort out these ambiguous theoretical predictions.

3.2.5 Complementarity with the Consumption CAPM

The consumption CAPM and the investment CAPM are the two sides of the same coin in equilibrium, and both deliver identical expected returns. Combining the beta-pricing form of the consumption CAPM in equation (2) and the investment CAPM shows that the expected stock return can be obtained from the consumption beta, β_{it}^M, as well as from the expectation of the right-hand side of equation (7). Intuitively, the consumption CAPM, which is derived from the first principle of consumption, connects expected returns to consumption betas. The consumption CAPM predicts that consumption betas are sufficient statistics for expected returns. Once consumption betas are controlled for, characteristics should not affect the cross section of expected returns. In contrast, derived from the first principle of investment, the investment CAPM connects expected returns to characteristics. Characteristics are sufficient statistics of expected returns. Once characteristics are controlled for, consumption betas should not affect expected returns.

The relation between the investment CAPM and the consumption CAPM is complementary (Zhang 2017). In equilibrium, the first principle of consumption and the first principle of investment are two key optimality conditions. Consumption betas, characteristics, and expected returns are all endogenous variables that are determined simultaneously in equilibrium. No causality runs across these endogenous variables. Neither consumption betas nor characteristics "cause" expected returns to move. Like any other prices in economic theory and in reality, asset prices are determined jointly by supply and demand of risky assets in equilibrium. While the consumption CAPM focuses on demand, the investment CAPM on supply. As such, the investment CAPM is as fundamental as the consumption CAPM in "explaining" expected returns.

Although equivalent in theory, the investment CAPM might be better equipped empirically to explain cross-sectional predictability than the consumption CAPM. Zhang (2017) invokes the aggregation problem. Most consumption CAPM studies assume a representative investor, and ignore aggregation by examining aggregate consumption data. Alas, the Sonnenschein-Mantel-Debreu theorem in general equilibrium theory says that the aggregate excess demand function is not restricted by the rationality of individual demands (Sonnenschein 1973, Debreu 1974, Mantel 1974). In particular, individual optimality does not imply aggregate rationality, and aggregate optimality does not imply individual rationality (Kirman 1992). In contrast, derived from the first principle of investment for individual firms, the investment CAPM is largely immune to the aggregation problem.

3.3 Testing the Expected Investment Growth Effect

In this subsection we test the expected investment growth effect on the expected stock return. Section 3.3.1 presents descriptive statistics of key variables. Section 3.3.2 documents predictive regressions of future changes in investment-to-assets. Finally, Section 3.3.3 tests the expected investment growth effect on the expected stock return in portfolio sorts.

3.3.1 Descriptive Statistics

Monthly returns are from the Center for Research in Security Prices (CRSP) and accounting information from the Compustat Annual and Quarterly Fundamental Files. The sample is from January 1967 to December 2015. Financial firms and firms with negative book equity are excluded.

We examine key anomaly variables, including classic ones such as standard unexpected earnings (Sue), prior six-month returns (R^6), idiosyncratic volatility (Ivff), return on equity (Roe), log book-to-market (log(Bm)), investment-to-assets (I/A), log market equity (log(Me)), and earnings-to-price (Ep). We also include prominent anomalies that the q-factor model cannot explain (Hou, Xue, and Zhang 2017). These q-anomalies are operating accruals (Oa), R&D-to-market (Rdm), cash-based operating profitability (Cop), abnormal returns around earnings announcements (Abr), industry lead-lag effect in prior returns (Ilr), net payout yield (Nop), discretionary accruals (Dac), and net stock issues (Nsi). Appendix B provides detailed variable definitions.

Table 1 reports time series averages of cross-sectional statistics, including mean, standard deviation, percentiles, and pairwise correlations. We winsorize the cross section of each variable in each month at the 1st and 99th percentiles. The descriptive statistics are calculated for both the full sample and the all-but-micro sample. In the latter, we exclude microcaps that are smaller than the 20th percentile of market equity for New York Stock Exchange stocks.

Comparing Panels A and C of Table 1 shows that, in general, excluding microcaps increases the averages but decreases the standard deviations of anomaly variables. For instance, prior six-month returns are on average 6.8% with a standard deviation of 32.5% in the full sample, relative to an average of 10.6% and a standard deviation of 27.4% in the all-but-micro sample. The quarterly Roe is on average 0.56% with a standard deviation of 9% in the full sample, but on average 2.76% with a standard deviation of 6.1% without microcaps. There are exceptions. Sue is on average 22.1% with a standard deviation of 1.76. Excluding microcaps raises the average to 44.7% but also the standard deviation slightly to 1.85. Idiosyncratic volatility is on average 2.9% with a standard deviation of 2% in the full sample. Excluding microcaps decreases the mean to 2% as well as the standard deviation to 1.1%. Finally, microcaps do not materially affect pairwise correlations (Panels B and D).

3.3.2 Forecasting Future Changes in Quarterly Investment-to-assets

We turn our attention to predictive regressions of future investment-to-assets growth. A challenge is that investment-to-assets, measured as changes in assets scaled by lagged assets, can be frequently negative, making the investment growth rate ill-defined. As such, we forecast future changes in quarterly investment-to-assets, $\triangle \mathrm{I/A}^q_\tau$. For each month t, $\triangle \mathrm{I/A}^q_\tau$ is the quarterly investment-to-assets from τ quarters ahead minus that for the fiscal quarter ending at least four months ago.

We perform monthly Fama-MacBeth (1973) cross-sectional regressions of $\triangle \mathrm{I/A}^q_\tau$, for τ varying from one to 12 quarters in the future. To guard against p-hacking via specification search per Leamer and Leonard (1983), we conduct univariate regressions on each of the 16 anomaly variables describe in Table 1. To alleviate the impact of microcaps, we estimate the cross-sectional regressions in two ways. In the full sample with microcaps included, we use weighted least squares with the market equity as weights. In addition, in the all-but-micro sample with microcaps excluded, we use ordinary least squares. Finally, to ease economic interpretation, we scale the slope of a given variable by multiplying the slope with the variable's average standard deviation reported in Table 1.

Panel A of Table 2 shows that Sue and R^6 exhibit some predictive power for future changes of quarterly investment-to-assets for horizons up to four quarters. In particular, for $\tau = 2$, the slopes are 0.17% ($t = 2.84$) and 0.91% ($t = 6.35$) for Sue and R^6, respectively. Despite the statistical significance, the slopes seem economically small. The slopes imply that changes of one standard deviation in Sue and R^6 give rise to only 0.17% and 0.91% of $\triangle\text{I/A}_2^q$, which has an average cross-sectional standard deviation of 16.6% (untabulated). However, we caution that the small slopes do not necessarily mean that the Sue and R^6 effects on the expected return via the expected investment growth are necessarily small because equation (5) is nonlinear. The cross-sectional regression results from the all-but-micro sample are largely similar (Panel A of Table 3).

For the two key variables underlying the q-factor model, investment-to-assets shows no forecasting power for future changes in investment-to-assets across all horizons, but Roe shows some short-term forecasting power in the full sample (Table 2). In particular, for $\tau = 1$, the Roe slope is 0.26% ($t = 2.07$). This short-term power is relevant, as the Roe factor in the q-factor model is rebalanced monthly. However, for longer horizons, the Roe slopes have mixed signs. Although the slope is significantly positive at the 4-quarter, it is significantly negative at the 12-quarter horizon. In addition, Table 3 shows that in the all-but-micro sample the short-term power of Roe vanishes, with a slope close to zero. At longer horizons, the Roe slopes are even significantly negative. Investment-to-assets continues to show no predictive power for future investment-to-assets changes.

Several q-anomalies show reliable predictive power for future changes in investment-to-assets. From Table 2, Rdm, Abr, Ilr, and Nsi have significant slopes in most horizons, in the same direction in which these variables forecast future returns. In particular, for $\tau = 4$, the Rdm, Abr, Ilr, and Nsi slopes are 0.65%, 0.31%, 0.21%, and −0.39% ($t = 3.08, 4.99, 2.54$, and -2.9), respectively. Table 3 reports similar evidence in the all-but-micro sample, with slopes of 0.42%, 0.26%, 0.23%, and −0.53% ($t = 4.66, 8.01, 4.06$, and -4.15), respectively. As such, the q-factor model's failure in explaining these anomalies might be due to Roe's ineffectiveness as an expected growth proxy.

Several other q-anomalies also indicate predictive power for future changes in investment-to-assets, but the results are sensitive to different samples. Oa, Cop, Nop, and Dac do not show predictive power in the full sample with weighted least squares, and their slopes are mostly insignificant (Table 2). However, their slopes are mostly significant, with the same signs with which these variables forecast returns, in the all-but-micro sample with ordinary least squares (Table 3). In particular, for $\tau = 4$, their slopes are $-0.15\%, 0.17\%, 0.41\%$, and -0.14% ($t = -3.17, 1.78, 6.29$, and -2.9), respectively. Finally, log(Bm) and log(Me) show some predictive power for future investment-to-assets changes at the 8- and 12-quarters, but Ivff and Ep show little predictive power.

Tables 2 and 3 also report cross-sectional regressions of future quarterly Roe and future cumulative stock returns. Sue and R^6 reliably forecast future Roe, as well as for future returns, especially within four quarters in the future. Rdm reliably predicts future Roe with a negative slope. Intuitively, R&D expenses reduce current Roe, and through its persistence, future Roe as well. As such, the Roe factor loading in the q-factor model goes in the wrong way in explaining the Rdm anomaly. Oa, and to a less extent, Dac, are positively correlated with future Roe, as accruals are counted as part of earnings. As such, their Roe factor loadings also go in the wrong way in explaining the accruals anomaly. Ivff is negatively correlated with future Roe, but the predictive power of Ivff for future returns is mixed. It is insignificant in the full sample but significant in the all-but-micro sample. To summarize, most q-anomalies predict future changes in investment-to-assets, in the same direction in which these variables predict future stock returns.

3.3.3 The Expected Investment Growth Effect in Portfolio Sorts

In view of the predictability of future investment growth documented in Tables 2 and 3, albeit small, we evaluate to what extent this predictability can be exploited in the form of trading strategies. We proceed in two steps. First, we form cross-sectional forecasts of future changes in investment-to-assets each month. Second, we sort stocks into deciles based on the expected investment-to-assets changes. The average return spreads across the deciles then provide a quantitative metric for the economic impact of the expected investment growth on the expected stock return.

To guard against p-hacking via specification search, we use all 16 anomaly variables jointly to form cross-sectional forecasts. At the beginning of each month t, we perform multiple cross-sectional regressions of future changes in quarterly investment-to-assets on the 16 variables. The cross-sectional regressions are estimated in the full sample with weighted least squares with the market equity as weights, as well as in the all-but-micro sample with ordinary least squares. Table 4 reports the detailed results from July 1976 to December 2015. The starting date is July 1976 due to the data limitation of R&D. Because of potential multicollinearity, we refrain from interpreting individual slopes. The important message from Table 4 is that even with all 16 variables included, the amount of predictability measured by R^2 is small in the full sample, ranging from only 13.2% to 15.6%, across the horizons. The amount of predictability is even smaller in the all-but-micro sample, with the R^2 varying from 6.7% to 8.8%. As such, the cross-sectional forecasts are noisy.

To form the expected investment growth deciles, at the beginning of each month t, we calculate the expected changes in quarterly investment-to-assets, $E_t[\triangle \mathrm{I/A}^q_\tau]$, with τ from 1 to 12 quarters. We compute $E_t[\triangle \mathrm{I/A}^q_\tau]$ with the latest predictor values known as of month t and the average cross-sectional regression slopes estimated from month $t-120-\tau\times 3$ to month $t-1-\tau\times 3$. We require a minimum of 36 months. In the full sample, the cross-sectional regressions are estimated with weighted least squares with the market equity as weights. We sort all stocks into deciles based on the NYSE breakpoints of the $E_t[\triangle \mathrm{I/A}^q_\tau]$ values, and calculate value-weighted returns for month t.

The deciles are rebalanced at the beginning of month $t+1$. In the all-but-micro sample, the cross-sectional regressions are estimated with ordinary least squares. We split all stocks into deciles based on the all-but-micro breakpoints of the $E_t[\triangle\text{I}/\text{A}^q_\tau]$ values, and calculate equal-weighted returns for month t. The deciles are again rebalanced monthly. Microcaps are excluded in these deciles.

Panel A of Table 5 shows weak evidence on the expected investment growth effect in the full sample. The high-minus-low deciles on the expected investment-to-assets changes earn insignificant, albeit positive, average returns across all forecasting horizons. The largest average return spread is 0.37% per month ($t = 1.43$) for $\tau = 4$. In the all-but-micro sample, Panel A of Table 6 shows some mixed evidence that indicates an expected investment growth effect. For $\tau = 1, 3, 4$, and 8, the high-minus-low expected growth deciles earn significantly positive average returns. In particular, the average return spread for $\tau = 1$ is 0.96% ($t = 3.52$), and the estimate for $\tau = 4$ is 0.95% ($t = 3.92$). However, the q-factor model reduces these average returns to insignificance, although the alphas are still 0.63% and 0.51%, respectively. In addition, for $\tau = 2$ and 12, the average return spreads are only 0.35% and 0.25% ($t = 1.27$ and 0.93), respectively.

The likely culprit for the weak expected investment growth effect in sorts is the noisy cross-sectional forecasts of future changes in investment-to-assets. As such, we experiment with different regression specifications to gauge robustness. Out of abundant sensitivity against p-hacking, we tie our hands by using only anomaly variables that are significant in univariate regressions for each forecasting horizon τ. We then combine these variables to form cross-sectional forecasts of future investment-to-assets changes, and construct the expected investment growth deciles accordingly.

Panel B of Table 5 shows that these alternative cross-sectional forecasts raise the average return spreads across the expected investment growth deciles in the full sample, but the effect remains weak. The spreads become significant, 0.7% per month ($t = 2.93$) for $\tau = 3$, and 0.51% ($t = 2.38$) for $\tau = 4$, and their q-factor alphas are 0.23% ($t = 0.76$) and 0.27% ($t = 1.2$), respectively. In addition, the spreads are all insignificant for other τ values. The q-factor model produces economically small and statistically insignificant alphas across all forecasting horizons. Panel B of Table 6 shows further that the expected investment growth effect from the alternative cross-sectional forecasts in the all-but-micro sample is even weaker than the effect from the original cross-sectional forecasts. The average return spreads are significant for three τ values, as opposed to four in Panel A. Their magnitudes are also generally smaller. Finally, the q-factor model again reduces all average return spreads to insignificance, although some q-factor alphas remain large.

To summarize, consistent with Chan, Karceski, and Lakonishok (2003) who work with earnings growth, we show that cross-sectional forecasts of future investment growth are noisy. As a result, although the expected investment growth is a potentially important determinant of the expected stock return in the investment CAPM, detecting the expected growth effect is empirically challenging.

4 Comparison with the Residual Income Model

In this section, we compare the implications of the investment CAPM with the residual income model. We start with the dividend discounting model:

$$P_{it} = \sum_{\tau=1}^{\infty} \frac{E[D_{it+\tau}]}{(1+r_i)^{\tau}}, \tag{12}$$

in which P_{it} is the market equity, D_{it} is dividends, and r_i is the long-term average expected stock return or the internal rate of return (Williams 1938). The clean surplus relation implies that dividends equal earnings minus the change in book equity, $D_{it+\tau} = Y_{it+\tau} - \triangle Be_{it+\tau}$, in which $\triangle Be_{it+\tau} \equiv Be_{it+\tau} - Be_{it+\tau-1}$ is the change in book equity. Miller and Modigliani (1961) and Ohlson (1995) reformulate the dividend discounting model as the residual income model:

$$\frac{P_{it}}{Be_{it}} = \frac{\sum_{\tau=1}^{\infty} E[Y_{it+\tau} - \triangle Be_{it+\tau}]/(1+r_i)^{\tau}}{Be_{it}}. \tag{13}$$

The residual income model is the dominant framework in capital markets research in accounting. In particular, Richardson, Tuna, and Wysocki (2010) use the residual income model as the organizing framework in their influential survey of the fundamental analysis literature.

In asset pricing, Fama and French (2006, 2015) derive asset pricing implications from equation (13). First, fixing everything except the market value and the expected stock return, a low market value, or a high book-to-market equity implies a high expected return. Second, fixing everything except the expected profitability and the expected stock return, high expected profitability implies a high expected return. Third, fixing everything except the expected growth in book equity and the expected return, high expected growth in book equity implies a low expected return.

Fama and French (2006) construct proxies of the expected profitability and the expected investment (the growth rate in book equity or total assets) as the fitted components from first-stage annual cross-sectional regressions of future profitability and future growth rate in book equity or total assets on current variables. In second-stage cross-sectional regressions of future returns on these proxies, Fama and French report some evidence on the expected profitability effect, but the relation between the expected investment and expected returns is weakly positive.

In this section, we show that the investment CAPM has more appealing theoretical properties than the residual income model as an asset pricing framework. Section 4.1 shows although the residual income model only characterizes the internal rate of return, its implementation often involves the one-period-ahead realized return, which can deviate greatly from the internal rate of return. In contrast, the investment CAPM explicitly characterizes the one-period-ahead expected stock return. Section 4.2 clarifies the subtle relations between past investment, future investment, and the expected return in the context of the two models.

4.1 Interpreting the Implied Cost of Capital

The residual income model in equation (13) connects book-to-market, investment, and profitability to the internal rate of return. Initiated by Claus and Thomas (2001) and Gebhardt, Lee, and Swaminathan (2001), a large accounting literature estimates the internal rate of return (IRR) from equation (13), and compares its empirical properties with the one-period-ahead average stock return. The IRR is often referred to as the implied cost of capital (ICC) in the accounting literature.

In asset pricing, Fama and French (2015) also assume that the difference between the one-period-ahead expected return and the internal rate of return is not important, and proceed with motivating their investment and profitability factors from the residual income model.

However, the IRR can differ greatly from the one-period ahead expected return. The difference is perhaps most striking in the context of price and earnings momentum. Chan, Jegadeesh, and Lakonishok (1996) show that momentum profits, measured with the one-month-ahead monthly average return, are short-lived. Momentum profits are large and positive within horizons up to 12 months, but turn negative afterward. In contrast, Tang, Wu, and Zhang (2014) report that price and earnings momentum profits are significantly negative, once measured with the IRR estimates from the Gebhardt, Lee, and Swaminathan (2001) procedure.

To quantify how the IRR deviates from the one-period-ahead average return, we estimate the IRRs for the Fama-French (2015) size, value, profitability, and investment factors (SMB, HML, RMW, and CMA, respectively) using four different accounting-based procedures from Claus and Thomas (2001), Gebhardt, Lee, and Swaminathan (2001), Easton (2004), and Ohlson and Juettner-Nauroth (2005), as well as their arithmatic averages. Although differing in implementation details, these procedures all share the basic idea of backing out the IRR from equation (13).

4.1.1 Estimating Procedures

We briefly describe the IRR estimation procedures (see Appendix C for a detailed description). First, in the Gebhardt, Lee, and Swaminathan (2001, GLS) model, at the end of June in each year t, we estimate the ICC from the following nonlinear equation:

$$P_t = Be_t + \sum_{\tau=1}^{11} \frac{(E_t[\text{Roe}_{t+\tau}] - \text{ICC}) \times Be_{t+\tau-1}}{(1+\text{ICC})^{\tau}} + \frac{(E_t[\text{Roe}_{t+12}] - \text{ICC}) \times Be_{t+11}}{\text{ICC} \times (1+\text{ICC})^{11}}, \qquad (14)$$

in which P_t is the market equity in year t, $Be_{t+\tau}$ is the book equity, and $E_t[\text{Roe}_{t+\tau}]$ is the expected return on equity (Roe) for year $t+\tau$ based on information available in year t.

Second, in the Easton (2004) model, at the end of June in each year t, we estimate the ICC from:

$$P_t = \frac{E_t[Y_{t+2}] + \text{ICC} \times E_t[D_{t+1}] - E_t[Y_{t+1}]}{\text{ICC}^2}, \tag{15}$$

in which P_t is the market equity in year t, $E_t[Y_{t+\tau}]$ is the expected earnings for year $t+\tau$ based on information available in year t, and $E_t[D_{t+1}]$ is the expected dividends for year $t+1$.

Third, in the Claus and Thomas (2001, CT) model, we estimate the ICC from:

$$P_t = Be_t + \sum_{\tau=1}^{5} \frac{(E_t[\text{Roe}_{t+\tau}] - \text{ICC}) \times Be_{t+\tau-1}}{(1+\text{ICC})^\tau} + \frac{(E_t[\text{Roe}_{t+5}] - \text{ICC}) \times Be_{t+4} \times (1+g)}{(\text{ICC} - g) \times (1+\text{ICC})^5}, \tag{16}$$

in which P_t is the market equity in year t, $Be_{t+\tau}$ is the book equity, $E_t[\text{Roe}_{t+\tau}]$ is the expected Roe for year $t+\tau$ based on information available in year t, and g is the long-term growth rate of abnormal earnings defined as $(E_t[\text{Roe}_{t+\tau}] - \text{ICC}) \times Be_{t+\tau-1}$. Finally, in the Ohlson and Juettner-Nauroth (2005, OJ) model, at the end of June in each year t, we construct the ICC as:

$$\text{ICC} = A + \sqrt{A^2 + \frac{E_t[Y_{t+1}]}{P_t} \times (g - (\gamma - 1))}, \tag{17}$$

in which

$$A \equiv \frac{1}{2}\left((\gamma - 1) + \frac{E_t[D_{t+1}]}{P_t}\right), \tag{18}$$

$$g \equiv \frac{1}{2}\left(\frac{E_t[Y_{t+3}] - E_t[Y_{t+2}]}{E_t[Y_{t+2}]} + \frac{E_t[Y_{t+5}] - E_t[Y_{t+4}]}{E_t[Y_{t+4}]}\right). \tag{19}$$

P_t is the market equity in year t, $E_t[Y_{t+\tau}]$ is the expected earnings for year $t+\tau$ based on information available in t, $E_t[D_{t+1}]$ is the expected dividends for year $t+1$, and $\gamma - 1$ is the perpetual growth rate of abnormal earnings that is set to be the ten-year Treasury bond rate minus 3%.

These accounting-based methods all use analysts' earnings forecasts to predict future profitability. Because analysts' forecasts are limited to a relatively small sample and are likely even biased, we also implement two modified procedures. The Hou-van Dijk-Zhang (2012) modification uses pooled cross-sectional regressions to forecast future earnings, and the Tang-Wu-Zhang (2014) modification uses annual cross-sectional regressions to forecast future profitability.

4.1.2 How the ICC Deviate from the One-period-ahead Expected Return

We estimate the ICCs for SMB, HML, RMW, and CMA in the Fama-French (2015) five-factor model using the 12 different combinations from interacting the aforementioned four accounting models with the three different earnings forecasts. For each combination, Table 8 reports the averages of the ICCs estimated at the end of June of each year t to compare with the average realized annual returns, with each observation covering the period from July of year t to June of year $t+1$.

Panel A reports that the ICCs of RMW differ drastically from its one-period-ahead average returns. The differences are economically large and statistically significant in all 12 combinations. The ICCs of RMW are even significantly negative in eight combinations, in contrast to the average returns that are significantly positive in all combinations.[1] In particular, in the sample for the standard GLS procedure with analysts' forecasts, the average RMW return is 3.75% per annum ($t = 2.59$). However, its average ICC is -1.18% ($t = 8.32$), and the ICC-average return difference is 4.93% ($t = 3.49$). Averaged across the accounting models with analysts' forecasts, the average RMW return is 4.47% ($t = 2.76$), in contrast to the average ICC of -1.59% ($t - 9.74$), and the difference of 6.06% is more than 3.5 standard errors from zero.

Estimating the ICCs with earnings or Roe forecasts from cross-sectional regressions yields largely similar results. Panel B shows that with the Hou-van Dijk-Zhang (2012) cross-sectional earnings forecasts, averaging across the accounting models yields an average RMW return of 3.47% per annum ($t = 2.52$), an average ICC of -1.85% ($t = 9.41$), and a significant difference of 5.32% ($t = 3.88$). With the Tang-Wu-Zhang (2014) cross-sectional ROE forecasts, Panel C shows that averaging across the accounting models, we estimate an average RMW return of 2.01% ($t = 3.01$), an average ICC of -2.46% ($t = 20.72$), and an ICC-average return difference of 5.46% ($t = 4.28$).

[1] The average returns vary across different combinations because of their different sample criteria. We reconstruct RMW and other common factors with the Fama-French (2015) procedure on the same sample on which a given combination is implemented. Doing so ensures that we compare ICCs with average returns on the same sample of stocks.

Table 8 also reports some ICC-average return differences for CMA, but not as drastic as for RMW. The differences for CMA are significant for four out of 12 combinations. Except for one combination, average CMA returns are larger in magnitude than the corresponding average ICCs. Finally, without going through the details, we can report that, consistent with Tang, Wu, and Zhang (2014), the ICC-average return differences for SMB and HML are mostly insignificant.

The difference between the ICC and the one-period-ahead expected return, both conceptually and empirically, has important implications. Many studies document that various ICCs have weak predictive power for future returns. In particular, Easton and Monahan (2005) show that none of the seven ICCs examined have a positive correlation with future realized returns, even after controlling for potential biases of average returns as a proxy for expected returns. Guay, Kothari, and Shu (2011) also report that ICCs have little explanatory power of subsequent realized returns in the cross section, and attribute this difficulty to analysts being sluggish in updating their earnings forecasts. Echoing Hughes, Liu, and Liu (2009), we suggest that there exists essentially no theoretical reason why the IRR should be related to the one-period-ahead expected return.

4.2 The Subtle Relations Among Past Investment, Book-to-market, Expected Investment, and the Expected Return

4.2.1 The Relation between Investment and Book-to-market Equity

Fama and French (2015) argue that book-to-market, expected profitability, and expected investment give rise to three separate factors in the residual income model. However, empirically, once RMW and CMA are added to their three-factor model, Fama and French document that HML becomes redundant in describing average returns, inconsistent with their comparative statics.

However, the evidence is consistent with the investment CAPM. The denominator of equation (5) is the marginal cost of investment, which equals marginal q (the value of an extra unit of assets). With constant returns to scale, marginal q equals average q, which is in turn highly correlated with market-to-book equity. This tight economic relation between investment and market-to-book implies that HML should be highly correlated with the investment factor. Empirically, from January 1967 to December 2015, the correlation between HML and CMA is 0.7, the correlation between HML and the investment factor in the q-factor model is 0.68, and the correlation between the investment factor and CMA is 0.91. The investment-value linkage also implies that CMA can be motivated from the market-to-book term in the residual income model.

4.2.2 The Relation between the Expected Investment and the Expected Return

Fama and French (2015) argue that equation (13) predicts a negative relation between the expected investment and the IRR. However, the negative sign does not carry over to the relation between the expected investment and the one-period-ahead expected return, $E_t[r_{it+1}]$.

Using the definition of return, $P_{it} = (E_t[D_{it+1}]+E_t[P_{it+1}])/(1+E_t[r_{it+1}])$, and the clean surplus relation, we rewrite the valuation equation (13) in terms of the one-period-ahead expected return as:

$$P_{it} = \frac{E_t[Y_{it+1} - \triangle Be_{it+1}] + E_t[P_{it+1}]}{1 + E_t[r_{it+1}]}. \tag{20}$$

Dividing both sides of equation (20) by B_{it} and rearranging, we obtain:

$$\frac{P_{it}}{Be_{it}} = \frac{E_t\left[\frac{Y_{it+1}}{Be_{it}}\right] - E_t\left[\frac{\triangle Be_{it+1}}{Be_{it}}\right] + E_t\left[\frac{P_{it+1}}{Be_{it+1}}\left(1 + \frac{\triangle Be_{it+1}}{Be_{it}}\right)\right]}{1 + E_t[r_{it+1}]}, \tag{21}$$

$$\frac{P_{it}}{Be_{it}} = \frac{E_t\left[\frac{Y_{it+1}}{Be_{it}}\right] + E_t\left[\frac{\triangle Be_{it+1}}{Be_{it}}\left(\frac{P_{it+1}}{Be_{it+1}} - 1\right)\right] + E_t\left[\frac{P_{it+1}}{Be_{it+1}}\right]}{1 + E_t[r_{it+1}]}. \tag{22}$$

Fixing everything except $E_t\left[\triangle Be_{it+1}/Be_{it}\right]$ and $E_t[r_{it+1}]$, high $E_t\left[\triangle Be_{it+1}/Be_{it}\right]$ implies *high* $E_t[r_{it+1}]$, as market-to-book, P_{it+1}/Be_{it+1}, is more likely to be higher than one in the data. More generally, leading equation (22) by one period at a time and recursively substituting P_{it+1}/Be_{it+1} in the same equation implies a positive $E_t\left[\triangle Be_{it+\tau}/Be_{it}\right]$-$E_t[r_{it+1}]$ relation for all $\tau \geq 1$.

In the investment CAPM, as noted, the relation between the expected investment growth and the expected return is positive. As such, the model's implications are consistent with those from the (reformulated) residual income model on the one-period-ahead expected return. Empirically, at the aggregate level, Lettau and Ludvigson (2002) document that high risk premiums forecast high future investment growth rates. Section 3.3 reports weakly positive relations between the expected investment growth and the expected return. The evidence lends support to our theoretical analysis.

4.2.3 Past Investment Is a Poor Proxy for the Expected Investment

After motivating CMA from the expected investment effect, Fama and French (2015) use past investment as a proxy for the expected investment. This proxy is problematic. Whereas past profitability is a good proxy for the expected profitability, past investment is a poor proxy for the expected investment. A large literature on lumpy investment emphasizes the lack of persistence of micro-level investment data (Dixit and Pindyck 1994, Doms and Dunne 1998, Whited 1998).

To evaluate the quality of past investment as a proxy for the expected investment, we perform annual cross-sectional regressions of future book equity growth rates, $\triangle Be_{it+\tau}/Be_{it+\tau-1} \equiv (Be_{it+\tau} - Be_{it+\tau-1})/Be_{it+\tau-1}$, for $\tau = 1, 2, \ldots, 10$, on the current asset growth, $\triangle A_{it}/A_{it-1} = (A_{it} - A_{it-1})/A_{it-1}$, and, separately, on book equity growth, $\triangle Be_{it}/Be_{it-1}$. For comparison, we also report annual cross-sectional regressions of future operating profitability, $OP_{it+\tau}$, on operating profitability, OP_{it}. As in Fama and French (2006), the sample contains all common stocks traded on NYSE, Amex, and NASDAQ from 1963 to 2015, including financial firms. Book equity is measured per Davis, Fama, and French (2000), and operating profitability per Fama and French (2015).[2] Variables dated t are from the fiscal year ending in calendar year t. Per Fama and French (2006), firms with book assets (Compustat annual item AT) below \$5 million or book equity below \$2.5 million in year t are excluded in Panel A of Table 9. The cutoffs are \$25 million and \$12.5 million, respectively, in Panel B. All the variables are winsorized each year at the 1st and 99th percentiles.

[2] In particular, we measure annual book equity as stockholders' book equity, plus balance sheet deferred taxes and investment tax credit (Compustat annual item TXDITC) if available, minus the book value of preferred stock. Stockholders' equity is the value reported by Compustat (item SEQ), if available. Otherwise, we use the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTK), or the book value of assets (item AT) minus total liabilities (item LT). Depending on availability, we use redemption value (item PSTKRV), liquidating (item PSTKL), or par value (item PSTK) for the book value of preferred stock. Operating profitability is revenues (item REVT) minus cost of goods sold (item COGS), minus selling, general, and administrative expenses (item XSGA, zero if missing), minus interest expense (item XINT, zero if missing) all divided by the book equity.

Past asset growth does not predict future book equity growth. In Panel A in Table 9, the slope starts at 0.22 at the one-year forecast horizon, drops to 0.06 in year three and to 0.04 in year five. The average R^2 of the cross-sectional regressions starts at 5% in year one, drops to zero in year four, and stays at zero for the remaining years. In addition, past book equity growth does not predict future book equity growth. The slope starts at 0.21 at the one-year horizon, drops to 0.06 in year three and to 0.03 in year five. The average R^2 of the cross-sectional regressions starts at 6% in year one, drops to zero in year four, and stays at zero for the remaining years. The results with the more stringent sample criterion in Panel B are largely similar. The evidence contradicts the motivation of the investment factor from the expected investment effect, but supports our reinterpretation via the market-to-book term in the residual income model.

The last five columns in Table 9 show that profitability forecasts future profitability. In Panel A, the slope in the annual cross-sectional regressions starts with 0.79 in year one, drops to 0.58 in year three and 0.49 in year five, and remains at 0.38 even in year ten. The average R^2 starts at 54% in year one, drops to 27% in year three and 19% in year five, and remains above 10% in year ten. The evidence in Panel B is largely similar. As such, profitability is a good proxy for the expected profitability, but past investment is a poor proxy for the expected investment.

5 Comparison with the Penman-Reggiani-Richardson-Tuna (2017, PRRT) Accounting-based Characteristic Model

Section 5.1 reviews the PRRT model. Section 5.2 compares it conceptually with the investment CAPM. Finally, Section 5.3 presents some related empirical tests.

5.1 The PRRT Model

As noted, the clean surplus relation states that the book equity increases with earnings, and decreases with net dividends to shareholders, $Be_{it+1} = Be_{it} + Y_{it+1} - D_{it+1}$, in which Be_{it} is the book equity, Y_{it} earnings, and D_{it} dividends for firm i. Building on Easton, Harris, and Ohlson

(1992), PRRT use this relation to rewrite the one-period-ahead expected stock return, $E_t[r^S_{it+1}]$, as:

$$E_t[r^S_{it+1}] = E_t\left[\frac{P_{it+1} + D_{it+1} - P_{it}}{P_{it}}\right] = \frac{E_t[Y_{it+1}]}{P_{it}} + E_t\left[\frac{(P_{it+1} - Be_{it+1}) - (P_{it} - Be_{it})}{P_{it}}\right]. \quad (23)$$

PRRT argue that the expected change in the market-minus-book equity (the market equity deviation from the book equity), $E_t[(P_{it+1} - Be_{it+1}) - (P_{it} - Be_{it})]$, is driven by the expected earnings growth (Shroff 1995). Intuitively, an increase in the deviation means that price rises more than book equity. Since earnings raise book equity via the clean-surplus relation, an expected increase in the deviation means that price increases more than earnings. Finally, a lower earnings at $t+1$ relative to price, P_t, must mean higher earnings afterward, since price reflects life-long earnings for the firm. As such, an expected increase in the deviation captures higher expected earnings growth after $t+1$.

PRRT consider four specific cases. First, in the mark-to-market accounting case, the market equity equals the book equity, equation (23) implies that the expected return equals the expected earnings yield, $E_t[Y_{it+1}]/P_{it}$. Second, in the no-earnings-growth case, the expected earnings are constant, the expected return again equals $E_t[Y_{it+1}]/P_{it}$. Third, in the case with growth unrelated to risk and return, $P_{it} = E_t[Y_{it+1}]/(r - g)$, in which r is a constant expected return, and g a constant earnings growth rate. Finally, with earnings growth, PRRT adopt the parametric Ohlson-Juettner (2005) model to argue that the expected return is a weighted average of the forward earnings yield and book-to-market equity, in which the latter is a proxy for the expected earnings growth.

Motivated by the theoretical analysis, Penman and Zhu (2014) use annual Fama-MacBeth (1973) cross-sectional regressions to forecast the forward earnings yield, Y_{it+1}/P_{it}, and the two-year-ahead earnings growth rates with several anomaly variables, including accruals, growth in net operating assets, return on assets, investment, net share issuance, external finance, and momentum. Many of these variables forecast the forward earnings yield and earnings growth, in the same direction in which these variables forecast returns. Penman and Zhu (2016) estimate costs of capital by projecting future returns on anomaly variables that are a priori connected to future earnings growth.

Accounting principles also connect the expected earnings growth to risk. In Penman and Reggiani (2013), the deferral of earnings recognition raises the expected earnings growth, which might deviate from subsequent realized earnings growth, and this risk might be embedded in expected returns. Penman and Zhang (2015) emphasize accounting conservatism, which means that assets are not booked when earnings from investments such as R&D and advertising are uncertain. These investments are expensed against earnings immediately, reducing current earnings but inducing higher subsequent earnings growth, which is in turn at risk because of the uncertainty.

5.2 Comparison with the Investment CAPM

The PRRT model and the investment CAPM share many commonalities. Both models focus on the determinants of the one-period-ahead expected return. Most reassuringly, both models deliver the same insight that the one-period-ahead expected earnings and the expected growth are the two key drivers of the expected return. However, important differences exist both in terms of the underlying logic and the specific determinants of the expected return in empirical implementation.

In equation (23), the clean surplus relation decomposes the expected return into the expected earnings yield and the expected change in the market-minus-book equity. PRRT then use powerful accounting insights to connect the latter term to the expected earnings growth. By comparison, the investment CAPM in equation (7) is an economic model derived from the first principle of real investment. The first principle says that the marginal cost of investment, $1 + a(I_{it}/A_{it})$, equals the marginal q, which in turn equals average q, P_{it}/A_{it+1}. This investment-value linkage allows us to substitute the market equity out of equation (5) both in the numerator and the denominator, with (a function of) investment-to-assets, which is a fundamental variable. In contrast, the market equity remains in the PRRT model. In this sense, the investment CAPM is perhaps even more "fundamental" than the PRRT model. PRRT also use accounting principles to connect, intuitively, the value-denominated expected change in the market-minus-book equity to the expected earnings growth. In contrast, the investment-value linkage allows us to substitute, mathematically, the expected capital gain with the expected investment-to-assets growth.

The two models also differ in the specific determinants for the expected return in empirical work. PRRT pick earnings yield, Y_{it}/P_{it}, which serves as a proxy for the expected earnings yield, as well as book-to-market, which serves as a proxy for the expected earnings growth (see also Penman and Zhu 2014). By comparison, the investment CAPM zeros in on investment-to-assets, I_{it}/A_{it}, which is in the denominator of equation (5), and profitability, X_{it}, which serves as a proxy for the expected profitability, $E_t[X_{it+1}]$, in the numerator (Hou, Xue, and Zhang 2015). To the extent that profitability forecasts short-term changes in investment-to-assets, it also partially captures the expected investment growth. Due to the lack of a reliable proxy, Hou et al. do not include a separate expected growth factor in the q-factor model. Most important, earnings yield and book-to-market highlighted in the PRRT model, because of the market equity in their denominators, are viewed as equivalent to investment-to-assets in the investment CAPM.

5.3 Factor Spanning Tests

To evaluate the explanatory power of the specific determinants of returns, we perform factor spanning tests. As a standard method, the factor approach puts different models on the same empirical footing. We construct a PRRT factor model, which consists of the market factor, a size factor, an earnings yield factor, and a book-to-market factor. To make the factor models comparable, we use a triple $2 \times 3 \times 3$ sort similar to the q-factors when forming the PRRT factor model.

In particular, at the end of June of each year t, we use the median NYSE size to split NYSE, Amex, and NASDAQ stocks into two groups, small and big. Independently, we split stocks into three earnings yield groups using the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the ranking values for the fiscal year ending in calendar year $t-1$. Also independently, we break stocks into three book-to-market groups using the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the ranking values for the fiscal year ending in calendar year $t-1$.[3]

[3]Size is the market equity computed as stock price per share times shares outstanding from CRSP. Earnings yield and book-to-market are income before extraordinary items (Compustat annual item IB) and the book equity for the

Taking the intersection of the two size, three earnings yield, and three book-to-market groups, we obtain 18 benchmark portfolios. Monthly value-weighted portfolio returns are calculated from July of year t to June of year $t+1$, and the portfolios are rebalanced at the June of $t+1$.

The size factor is the difference (small-minus-big), each month, between the simple average of the returns on the nine small portfolios and that of the nine big portfolios. The earnings yield factor is the difference (high-minus-low), each month, between the simple average of the returns on the six high earnings yield portfolios and that of the six low earnings yield portfolios. Finally, the book-to-market factor is the difference (high-minus-low), each month, between the simple average of the returns on the six high book-to-market portfolios and that of the six low book-to-market portfolios.

Table 7 reports the factor spanning tests in the 1967–2015 sample. From Panel A, the earnings yield factor premium is 0.25% per month ($t = 1.97$). With earnings yield in a joint sort, the book-to-market factor loses its significance with an average premium of 0.16% ($t = 1.43$). The size premium is 0.24% ($t = 1.85$). The q-factor model fully captures the earnings yield premium, with a tiny alpha of −0.01% ($t = -0.11$). Both the investment and ROE factors contribute to this performance with loadings of 0.4 and 0.34, respectively, both of which are more than four standard errors from zero. The q-factor model also captures the book-to-market factor, with a small alpha of 0.06% ($t = 0.72$). The investment factor is the main driving force with a loading of 0.74 ($t = 12.38$), even though the Roe factor goes the wrong way with a loading of −0.31 ($t = -4.81$). Interestingly, the size factor has a significant q-factor alpha of 0.09% ($t = 2.11$). The regression R^2 is 91%, with a size factor in the q-factor model. With such precision, even an economically small alpha is significant. Finally, the Carhart model explains the size and book-to-market factors in the PRRT factor model well, but leaves a marginally significant alpha of 0.18% ($t = 1.96$) for the earnings yield factor.

fiscal year ending in calendar year $t-1$ divided by the market equity from CRSP at the end of December of year $t-1$, respectively. The book equity is stockholders' book equity, plus balance sheet deferred taxes and investment tax credit (item TXDITC) if available, minus the book value of preferred stock. Stockholders' equity is the value reported by Compustat (item SEQ), if it is available. If not, we measure stockholders' equity as the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTK), or the book value of assets (item AT) minus total liabilities (item LT). Depending on availability, we use redemption (item PSTKRV), liquidating (item PSTKL), or par value (item PSTK) for the book value of preferred stock. For firms with more than one share class, we merge the market equity for all share classes before computing earnings yield and book-to-market.

Panel B regresses the Carhart factors and q-factors on the PRRT factor model. For the Carhart factors, although the PRRT model explains the SMB and HML returns, it fails to capture the momentum factor, UMD. The average UMD return is 0.69% per month ($t = 3.82$), but the PRRT alpha is even higher, 0.86% ($t = 4.82$). The culprit is the book-to-market factor with a negative loading of -0.41 ($t = -3.23$), consistent with Fama and French (1996). The earnings yield factor loading is basically zero. The PRRT factor model also fails to explain the investment and Roe factors in the q-factor model, with alphas of 0.36% ($t = 5.72$) and 0.61% ($t = 7.78$), respectively. The book-to-market factor helps explain the investment factor, but only weakly. The earnings yield factor helps explain the Roe factor, but the book-to-market factor goes the wrong way, echoing its effect on UMD. In all, the evidence suggests that earnings yield and book-to-market in the PRRT factor model are insufficient to explain the cross section of expected stock returns.

6 Summary and Implications

This paper shows that the investment CAPM provides an economic foundation for Graham and Dodd's (1934) *Security Analysis*, without mispricing. Theoretically, the investment CAPM predicts that expected returns vary cross-sectionally, depending on firms' investment, profitability, and expected investment growth. Empirically, we show that many anomaly variables forecast future changes in investment-to-assets, in the same direction in which these variables forecast future returns. However, cross-sectional forecasts of future growth are noisy. As a result, the expected investment growth effect in portfolio sorts is weak. We also show that the investment CAPM has more appealing theoretical properties than the Miller-Modigliani (1961) and Ohlson (1995) residual income model and the Penman-Reggiani-Richardson-Tuna (2017) characteristic model.

The investment CAPM retains the efficient markets paradigm per Fama (1970). There has been much confusion on efficient markets, and it is worthwhile to revisit Fama's original definition: "The assumptions that the conditions of market equilibrium can be stated in terms of expected returns and that equilibrium expected returns are formed on the basis of (and thus 'fully reflect') the information set Φ_t have a major empirical implication—they rule out the possibility of trading systems based only on information in Φ_t that have expected profits or returns in excess of equilibrium expected profits or returns. Thus, let

$$x_{jt+1} = p_{jt+1} - E[p_{jt+1}|\Phi_t]. \tag{24}$$

Then

$$E[x_{jt+1}|\Phi_t] = 0 \tag{25}$$

which, *by definition*, says that the sequence $\{x_{jt}\}$ is a 'fair game' with respect to the information sequence $\{\Phi_t\}$. Or, equivalently, let

$$z_{jt+1} = r_{jt+1} - E[r_{jt+1}|\Phi_t], \tag{26}$$

then

$$E[z_{jt+1}|\Phi_t] = 0, \tag{27}$$

so that the sequence $\{z_{jt}\}$ is also a 'fair game' with respect to the information sequence $\{\Phi_t\}$ (p. 384–385, original emphasis)." As such, efficient markets mean that pricing errors, z_{jt+1}, are not predictable. In particular, time-varying and cross-sectionally varying expected returns, $E[r_{jt+1}|\Phi_t]$, are consistent with efficient markets. The investment CAPM provides such a model for $E[r_{jt+1}|\Phi_t]$.

Alas, the efficient markets hypothesis is often misinterpreted as saying that future returns are not predictable, causing much confusion in the existing fundamental analysis literature. In particular, in a widely adopted textbook on investments, Bodie, Kane, and Marcus (2014) write: "[I]f stock price movements were predictable, that would be damning evidence of stock market inefficiency, because the ability to predict prices would indicate that all available information was not already reflected in stock prices (p. 350–351)." "[T]he efficient market hypothesis predicts that *most* fundamental analysis also is doomed to failure. if the analyst relies on publicly available earnings and industry information, his or her evaluation of the firm's prospects is not likely to be significantly more accurate than those of rival analysts (p. 356, original emphasis)."

The investment CAPM validates the practice of security analysis, without contradicting efficient markets. With cross-sectionally varying expected returns, firms with low investment, high expected profitability, and high expected investment growth should earn higher expected returns than firms with high investment, low expected profitability, and low expected investment growth, respectively. Consequently, forecasting future profitability and future growth rates per traditional security analysis is equivalent to forecasting future returns. In all, the investment CAPM provides a new conceptual framework for value investing, and helps focus analysts' attention on key determinants of the expected return, including investment, expected profitability, and expected investment growth.

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Table 1 : Descriptive Statistics, January 1967–December 2015

This table reports time series averages of cross-sectional statistics, including mean, standard deviation (std), percentiles (5%, 25%, 50%, 75%, and 95%), as well as pairwise correlations. Statistics are computed with the 1%–99% winsorization. Sue is standard unexpected earnings, R^6 prior six-month returns, Ivff idiosyncratic volatility, Roe return on equity, log(Bm) log book-to-market equity, I/A investment-to-assets, Oa operating accruals, Rdm R&D expense-to-market equity, log(Me) logarithm of the market equity in millions of dollars, Ep earnings-to-price, Cop cash-based operating profitability, Abr cumulative abnormal returns around earnings announcement dates, Ilr industry lead-lag effect in prior returns, Nop net payout yield, Dac discretionary accruals, and Nsi net stock issues. Appendix B provides detailed variable definitions. All variables except for log(Bm) and log(Me) are in percent.

Panel A: Time series averages of cross-sectional statistics, the full sample

	mean	std	5%	25%	50%	75%	95%
Sue	22.11	175.55	−246.34	−47.79	18.75	97.18	301.99
R^6	6.78	32.37	−38.46	−13.23	3.10	21.35	65.60
Ivff	2.88	1.98	0.84	1.53	2.35	3.60	6.84
Roe	0.56	8.99	−13.69	−0.17	2.28	4.14	8.64
log(Bm)	−0.46	0.77	−1.87	−0.94	−0.40	0.07	0.72
I/A	15.84	34.67	−17.47	−0.34	8.07	20.41	76.81
Oa	−3.51	11.02	−20.13	−8.51	−3.78	1.00	14.19
Rdm	7.55	9.77	0.42	1.74	4.11	9.17	27.23
Log(Me)	4.84	1.87	1.98	3.47	4.70	6.10	8.16
Ep	1.03	21.22	−32.68	0.43	6.22	9.77	16.85
Cop	12.71	12.89	−9.26	6.22	13.07	19.95	33.08
Abr	0.25	8.00	−12.78	−3.84	0.03	4.09	13.92
Ilr	0.96	3.67	−5.06	−1.40	0.96	3.29	7.06
Nop	0.61	8.67	−14.53	−0.49	1.12	3.89	10.22
Dac	−0.24	9.30	−15.50	−4.33	−0.16	3.91	14.75
Nsi	3.60	10.23	−4.38	−0.10	0.54	3.02	23.88

Panel B: Time series averages of cross-sectional correlations, the full sample

	R^6	Ivff	Roe	log(Bm)	I/A	Oa	Rdm	log(Me)	Ep	Cop	Abr	Ilr	Nop	Dac	Nsi
Sue	0.25	−0.11	0.38	−0.13	0.00	−0.04	−0.02	0.13	−0.05	0.07	0.18	0.01	0.01	−0.05	−0.02
R^6		−0.16	0.21	0.06	−0.06	−0.03	0.03	0.05	0.04	0.07	0.18	0.01	0.06	−0.03	−0.06
Ivff			−0.30	0.05	0.01	−0.03	0.26	−0.46	−0.31	−0.24	−0.02	0.00	−0.21	−0.02	0.13
Roe				−0.14	0.06	0.10	−0.27	0.24	0.29	0.30	0.13	0.00	0.15	0.05	−0.11
log(Bm)					−0.27	−0.07	0.31	−0.34	−0.02	−0.22	0.03	0.00	0.11	−0.01	−0.12
I/A						0.25	−0.19	0.08	0.14	−0.15	−0.03	0.00	−0.31	0.20	0.44
Oa							−0.15	−0.01	0.26	−0.33	−0.02	0.00	−0.03	0.84	0.04
Rdm								−0.31	−0.46	−0.01	0.01	0.00	−0.12	−0.13	0.05
log(Me)									0.21	0.29	−0.01	−0.01	0.13	−0.02	−0.03
Ep										0.24	0.00	0.00	0.19	0.23	−0.11
Cop											0.01	0.00	0.21	−0.31	−0.22
Abr												0.02	0.02	−0.01	−0.03
Ilr													0.00	0.00	0.00
Nop														−0.03	−0.69
Dac															0.03

Panel C: Time series averages of cross-sectional statistics, the all-but-micro sample

	mean	std	5%	25%	50%	75%	95%
Sue	44.69	185.09	−228.62	−35.27	33.29	126.66	358.08
R^6	10.58	27.43	−26.09	−6.21	6.95	22.53	59.84
Ivff	2.00	1.10	0.79	1.25	1.75	2.46	3.99
Roe	2.76	6.07	−4.16	1.55	3.10	4.78	9.28
log(Bm)	−0.68	0.72	−2.01	−1.12	−0.60	−0.17	0.36
I/A	17.97	31.63	−8.15	2.87	9.92	21.36	73.52
Oa	−3.65	8.99	−16.36	−7.68	−3.91	−0.10	10.04
Rdm	4.63	5.61	0.34	1.30	2.87	5.77	14.80
Log(Me)	6.48	1.22	4.91	5.52	6.25	7.26	8.86
Ep	5.44	10.65	−6.49	3.81	6.73	9.42	14.61
Cop	16.35	10.63	0.25	10.15	15.84	22.16	34.78
Abr	0.48	6.50	−9.80	−2.91	0.31	3.78	11.24
Ilr	0.97	3.69	−5.02	−1.45	0.95	3.35	7.07
Nop	1.63	6.57	−8.55	−0.10	1.77	4.33	9.58
Dac	−0.42	7.47	−12.03	−3.57	−0.29	2.84	10.73
Nsi	3.09	9.05	−4.23	−0.36	0.58	2.98	20.10

Panel D: Time series averages of cross-sectional correlations, the all-but-micro sample

	R^6	Ivff	Roe	log(Bm)	I/A	Oa	Rdm	log(Me)	Ep	Cop	Abr	Ilr	Nop	Dac	Nsi
Sue	0.22	−0.06	0.41	−0.17	0.03	−0.01	−0.06	0.06	−0.07	0.08	0.15	0.01	−0.02	−0.03	−0.02
R^6		0.00	0.11	0.04	−0.03	−0.03	0.09	−0.12	−0.03	0.00	0.19	0.01	−0.01	−0.03	−0.02
Ivff			−0.13	−0.14	0.15	0.00	0.14	−0.31	−0.22	−0.11	0.00	0.01	−0.20	−0.02	0.13
Roe				−0.24	0.05	0.09	−0.22	0.11	0.17	0.28	0.08	0.00	0.08	0.04	−0.08
log(Bm)					−0.27	−0.07	0.26	−0.11	0.21	−0.33	0.01	0.00	0.12	0.02	−0.05
I/A						0.20	−0.12	−0.05	0.00	−0.16	−0.01	0.00	−0.35	0.15	0.48
Oa							−0.15	−0.06	0.19	−0.34	−0.01	0.00	−0.03	0.82	0.04
Rdm								−0.12	−0.29	0.07	0.02	0.00	−0.06	−0.15	0.04
log(Me)									0.07	0.19	−0.05	−0.01	0.14	−0.03	−0.06
Ep										0.12	−0.01	0.01	0.19	0.19	−0.13
Cop											0.00	0.01	0.16	−0.32	−0.22
Abr												0.04	0.00	−0.01	−0.01
Ilr													0.00	0.00	0.00
Nop														−0.02	−0.65
Dac															0.02

Table 2 : Univariate Cross-sectional Regressions of Future Quarterly Investment-to-assets Changes, Future Quarterly Roe, and Future Cumulative Stock Returns, January 1967–December 2015

At the beginning of each month t, Panel A performs univariate Fama-MacBeth (1973) cross-sectional regressions of future changes in quarterly investment-to-assets, $\triangle \text{I/A}^q_\tau$, defined as quarterly investment-to-assets from τ quarters ahead minus quarterly investment-to-assets from at least four month ago, Panel B cross-sectional regressions of Roe from τ quarters ahead, and Panel C cross-sectional regressions of stock returns cumulated from month t to month $t+\tau\times 3-1$. All the cross-sectional regressions are estimated with weighted least squares with the market equity as weights. The table reports the Fama-MacBeth slopes (in percent), their t-statistics adjusted for heteroscedasticity and autocorrelations, and goodness-of-fit coefficients (R^2, in percent). Among the regressors, Sue is standard unexpected earnings, R^6 prior six-month returns, Ivff idiosyncratic volatility (in percent), Roe return on equity, log(Bm) log book-to-market equity, I/A investment-to-assets, Oa operating accruals, Rdm R&D expense-to-market equity, log(Me) logarithm of the market equity in millions of dollars, Ep earnings-to-price, Cop cash-based operating profitability, Abr cumulative abnormal returns around earnings announcement dates, Ilr industry lead-lag effect in prior returns, Nop net payout yield, Dac discretionary accruals, and Nsi net stock issues. Appendix B provides detailed variable definitions. To ease economic interpretation, the slope of a given regressor is rescaled by multiplying its time series average of cross-sectional standard deviations.

τ		Sue	R^6	Ivff	Roe	log(Bm)	I/A	Oa	Rdm	log(Me)	Ep	Cop	Abr	Ilr	Nop	Dac	Nsi
		Panel A: Predicting future changes in quarterly investment-to-assets, $\triangle \text{I/A}^q_\tau$, January 1973–December 2015															
1	Slope	0.14	0.73	0.34	0.26	−0.10	0.11	−0.11	0.24	0.06	−0.50	0.15	0.17	0.02	−0.07	−0.20	−0.16
	t	2.33	3.70	0.58	2.07	−0.68	0.17	−0.90	1.56	0.56	−0.69	1.38	2.48	0.11	−0.12	−1.14	−1.20
	R^2	0.76	0.69	0.51	0.83	0.99	1.08	1.43	0.70	0.42	0.44	3.15	0.42	1.12	1.20	1.41	0.60
2	Slope	0.17	0.91	0.03	−0.29	−0.05	0.27	−0.15	0.48	0.17	−0.66	0.13	0.26	0.40	−0.14	−0.24	−0.21
	t	2.84	6.35	0.05	−1.74	−0.23	0.34	−1.19	2.41	1.56	−0.66	1.18	3.28	2.36	−0.24	−1.46	−1.63
	R^2	0.59	0.89	0.64	0.68	0.93	1.17	1.46	0.83	0.45	0.43	2.73	0.45	1.17	1.27	1.59	0.70
3	Slope	0.12	0.55	−0.25	−0.09	0.08	0.13	−0.02	0.57	0.23	−0.38	0.24	0.36	0.24	1.16	0.04	−0.30
	t	2.11	2.89	−0.46	−0.51	0.49	0.15	−0.11	2.78	2.41	−0.45	2.68	5.20	2.81	1.82	0.22	−2.24
	R^2	0.58	0.76	0.65	0.71	1.12	1.47	1.55	0.72	0.44	0.57	2.93	0.46	0.98	1.35	1.67	0.75
4	Slope	0.20	0.65	−0.21	0.32	0.18	−0.43	−0.12	0.65	0.20	−0.42	0.17	0.31	0.21	0.33	−0.16	−0.39
	t	3.46	5.05	−0.28	2.10	0.98	−0.56	−1.09	3.08	2.60	−0.45	1.57	4.99	2.54	0.84	−1.32	−2.90
	R^2	0.70	0.85	0.96	0.63	1.09	1.55	1.63	0.75	0.56	0.56	3.04	0.49	1.15	1.40	2.01	0.75
8	Slope	0.13	0.18	−0.82	−0.07	0.44	−0.30	−0.26	0.79	0.34	−0.17	0.12	0.14	0.10	0.02	−0.30	−0.43
	t	1.85	1.06	−1.36	−0.43	2.57	−0.34	−1.58	3.56	2.95	−0.19	1.12	1.99	1.17	0.02	−1.28	−2.93
	R^2	0.72	0.83	1.01	0.70	1.46	2.06	1.72	0.87	0.68	0.64	3.33	0.45	1.46	1.55	1.66	0.95
12	Slope	−0.02	−0.11	−0.77	−0.39	0.55	−0.64	−0.11	0.88	0.35	−0.11	−0.01	0.07	0.07	0.91	−0.08	−0.52
	t	−0.42	−0.56	−1.16	−2.18	3.29	−0.73	−0.93	3.39	3.07	−0.12	−0.08	0.97	0.88	2.41	−0.60	−3.43
	R^2	0.67	0.88	1.08	0.80	1.61	2.50	2.03	0.89	0.69	0.80	3.32	0.54	1.64	1.81	1.74	0.89

τ		Sue	R^6	Ivff	Roe	log(Bm)	I/A	Oa	Rdm	log(Me)	Ep	Cop	Abr	Ilr	Nop	Dac	Nsi
Panel B: Predicting future quarterly Roe, January 1967–December 2015																	
1	Slope	0.98	1.23	−2.32	5.77	−1.96	0.14	0.51	−2.34	1.47	1.95	1.95	0.48	0.11	1.17	0.01	−0.74
	t	24.95	13.63	−17.77	71.78	−26.15	1.83	7.95	−12.68	19.64	5.64	26.08	13.47	4.17	8.94	0.29	−11.73
	R^2	8.04	4.07	4.87	36.78	19.21	2.22	1.07	4.57	5.35	4.16	13.31	0.85	1.78	2.31	0.97	1.96
2	Slope	0.93	1.25	−2.37	5.07	−1.88	0.05	0.48	−2.34	1.49	1.87	1.94	0.48	0.19	1.23	0.00	−0.77
	t	20.23	14.12	−17.64	52.89	−24.51	0.68	7.01	−11.78	19.91	5.36	24.95	12.75	6.68	8.92	0.01	−11.80
	R^2	6.97	4.26	5.02	28.22	18.20	2.04	1.10	4.45	5.64	3.96	13.27	0.88	1.98	2.46	1.06	2.09
3	Slope	0.91	1.25	−2.49	5.00	−1.83	0.11	0.44	−2.36	1.55	1.79	1.92	0.40	0.21	1.27	0.00	−0.80
	t	20.59	12.38	−15.16	55.67	−23.55	0.85	6.42	−10.30	17.71	4.95	22.71	10.37	5.30	9.02	−0.08	−11.78
	R^2	6.69	3.95	4.85	26.23	16.79	1.86	0.97	4.17	5.64	3.79	12.48	0.69	2.00	2.37	1.02	2.01
4	Slope	0.98	1.21	−2.43	5.88	−1.75	−0.03	0.38	−2.28	1.49	1.51	1.83	0.56	0.19	1.33	−0.05	−0.78
	t	23.89	12.08	−16.52	59.31	−23.96	−0.49	5.92	−11.65	19.97	4.36	26.89	11.78	6.06	8.54	−1.11	−12.01
	R^2	8.04	3.84	4.72	37.28	16.01	1.59	0.87	4.47	5.61	3.64	12.08	0.95	2.03	2.63	0.97	2.02
8	Slope	0.84	0.83	−2.35	4.99	−1.59	−0.17	0.22	−2.30	1.49	0.94	1.66	0.32	0.12	1.25	−0.20	−0.79
	t	21.27	10.30	−18.10	47.51	−21.68	−3.38	4.02	−9.18	20.39	3.23	28.18	7.43	3.99	9.82	−4.58	−15.04
	R^2	5.88	2.61	4.31	24.63	12.88	1.08	0.73	4.43	5.47	3.34	10.32	0.75	1.83	2.20	1.09	1.89
12	Slope	0.74	0.58	−2.28	4.32	−1.50	−0.28	0.20	−2.28	1.46	0.66	1.54	0.32	0.12	1.28	−0.20	−0.79
	t	18.03	7.38	−18.66	39.37	−21.63	−4.54	4.63	−8.37	20.03	2.70	26.23	6.86	3.41	10.76	−5.25	−15.94
	R^2	4.59	1.89	3.91	17.84	10.88	1.16	0.61	4.16	5.25	2.58	9.50	0.69	1.84	2.11	1.03	1.75
Panel C: Predicting future cumulative stock returns from month t to month $t+\tau \times 3-1$, January 1967–December 2015																	
1	Slope	0.28	0.59	−0.64	0.47	0.34	−0.59	−0.31	1.00	−0.33	1.25	0.32	0.33	0.23	0.68	−0.36	−0.51
	t	3.20	2.03	−1.51	1.41	1.92	−2.98	−2.00	2.50	−1.45	1.84	1.98	2.85	2.16	2.50	−2.53	−4.39
	R^2	1.48	3.22	3.88	1.70	3.59	1.73	1.19	2.36	3.54	2.01	2.19	0.69	2.92	1.51	1.15	0.89
2	Slope	0.43	1.80	−1.08	0.70	0.78	−1.18	−0.70	1.94	−0.62	2.35	0.59	0.73	0.28	1.37	−0.72	−1.01
	t	3.05	3.52	−1.50	1.29	2.59	−3.60	−2.65	2.93	−1.58	2.04	2.05	3.94	1.77	2.98	−2.83	−5.24
	R^2	1.35	3.40	3.82	1.75	3.88	1.74	1.21	2.48	3.67	2.19	2.43	0.62	2.96	1.69	1.23	1.03
3	Slope	0.46	2.70	−1.18	0.46	1.19	−1.65	−1.09	2.74	−0.89	3.16	0.91	1.01	0.51	2.02	−1.05	−1.48
	t	2.48	4.12	−1.28	0.66	3.04	−4.05	−3.33	3.19	−1.68	2.13	2.32	3.98	2.56	3.43	−3.19	−5.95
	R^2	1.31	3.55	3.68	1.80	4.22	1.66	1.16	2.41	3.75	2.44	2.67	0.64	3.09	1.72	1.24	1.10
4	Slope	0.42	2.76	−1.32	0.20	1.59	−2.06	−1.36	3.63	−1.20	3.80	1.18	1.18	0.89	2.53	−1.33	−1.91
	t	1.82	3.55	−1.20	0.22	3.33	−4.17	−3.60	3.41	−1.84	2.20	2.42	3.74	3.47	3.61	−3.46	−6.50
	R^2	1.28	3.23	3.53	1.84	4.41	1.67	1.11	2.51	3.67	2.46	2.77	0.67	3.05	1.72	1.17	1.13
8	Slope	0.40	1.66	−0.23	−1.32	2.85	−3.60	−1.97	5.25	−2.37	6.56	2.00	1.68	0.62	5.33	−2.62	−3.65
	t	1.08	1.52	−0.13	−0.81	3.25	−3.74	−3.50	3.36	−2.12	2.42	2.14	3.06	1.64	4.89	−3.96	−8.24
	R^2	1.23	2.31	2.99	1.77	5.07	1.75	1.05	2.47	3.96	2.42	3.04	0.66	2.88	1.80	1.07	1.16
12	Slope	0.14	1.75	1.10	−3.32	3.75	−3.99	−1.96	6.81	−3.48	11.35	2.98	1.62	0.09	8.02	−3.94	−5.93
	t	0.25	1.32	0.47	−1.42	2.84	−2.74	−2.85	3.71	−2.17	3.15	2.17	2.40	0.18	5.20	−4.46	−10.38
	R^2	1.28	1.97	2.32	1.65	5.35	1.61	0.79	2.11	4.01	2.53	3.01	0.57	2.60	1.89	0.87	1.06

Table 3 : Univariate Cross-sectional Regressions of Future Quarterly Investment-to-assets Changes, Future Quarterly Roe, and Future Cumulative Stock Returns, the All-but-micro Sample, January 1967–December 2015

At the beginning of each month t, Panel A performs univariate Fama-MacBeth (1973) cross-sectional regressions of future changes in quarterly investment-to-assets, $\triangle \text{I/A}^q_\tau$, defined as quarterly investment-to-assets from τ quarters ahead minus quarterly investment-to-assets from at least four month ago, Panel B cross-sectional regressions of Roe from τ quarters ahead, and Panel C cross-sectional regressions of stock returns cumulated from month t to month $t + \tau \times 3 - 1$. Cross-sectional regressions are estimated with ordinary least squares. The table reports the Fama-MacBeth slopes (in percent), their t-statistics adjusted for heteroscedasticity and autocorrelations, and goodness-of-fit coefficients (R^2, in percent). Among the regressors, Sue is standard unexpected earnings, R^6 prior six-month returns, Ivff idiosyncratic volatility (in percent), Roe return on equity, log(Bm) log book-to-market equity, I/A investment-to-assets, Oa operating accruals, Rdm R&D expense-to-market equity, log(Me) logarithm of the market equity in millions of dollars, Ep earnings-to-price, Cop cash-based operating profitability, Abr cumulative abnormal returns around earnings announcement dates, Ilr industry lead-lag effect in prior returns, Nop net payout yield, Dac discretionary accruals, and Nsi net stock issues. Appendix B provides detailed variable definitions. To ease economic interpretation, the slope of a given regressor is rescaled by multiplying its time series average of cross-sectional standard deviations.

τ		Sue	R^6	Ivff	Roe	log(Bm)	I/A	Oa	Rdm	log(Me)	Ep	Cop	Abr	Ilr	Nop	Dac	Nsi
		Panel A: Predicting future changes in quarterly investment-to-assets, $\triangle \text{I/A}^q_\tau$, January 1973–December 2015															
1	Slope	0.17	0.67	0.00	−0.01	0.00	−0.19	−0.15	0.28	−0.22	−0.15	0.12	0.16	−0.05	0.24	−0.06	−0.10
	t	4.98	3.56	0.02	−0.12	0.00	−0.79	−1.28	4.55	−1.91	−0.52	1.04	5.28	−0.43	1.52	−1.01	−0.73
	R^2	0.27	0.71	0.32	0.48	0.35	0.74	1.34	0.27	0.19	0.24	3.74	0.15	0.37	0.50	0.68	0.39
2	Slope	0.10	0.97	0.07	−0.63	0.11	−0.12	−0.15	0.41	−0.21	−0.37	0.15	0.31	0.21	0.06	−0.15	−0.23
	t	2.59	5.89	0.29	−6.78	0.50	−0.30	−2.62	4.98	−2.20	−1.01	1.34	7.89	3.21	0.44	−2.42	−2.01
	R^2	0.21	1.09	0.49	0.66	0.48	0.83	0.70	0.36	0.23	0.30	3.56	0.22	0.39	0.54	0.85	0.44
3	Slope	0.09	0.63	−0.26	−0.35	0.34	−0.21	−0.09	0.43	−0.05	−0.31	0.17	0.35	0.24	0.59	−0.05	−0.39
	t	2.32	3.64	−1.36	−4.11	1.68	−0.48	−1.20	4.48	−0.63	−0.87	2.49	9.71	3.12	2.28	−0.57	−3.78
	R^2	0.23	0.76	0.60	0.55	0.66	1.07	0.64	0.40	0.25	0.37	3.62	0.24	0.39	0.58	0.77	0.51
4	Slope	0.09	0.56	−0.09	−0.02	0.32	−0.77	−0.15	0.42	0.04	−0.53	0.17	0.26	0.23	0.41	−0.14	−0.53
	t	2.80	4.61	−0.21	−0.32	0.94	−1.87	−3.17	4.66	0.46	−0.91	1.78	8.01	4.06	6.29	−2.90	−4.15
	R^2	0.23	0.61	0.71	0.43	0.91	1.22	0.56	0.41	0.26	0.45	3.82	0.23	0.47	0.61	1.05	0.54
8	Slope	−0.05	0.12	−0.74	−0.20	0.88	−0.74	−0.22	0.43	0.24	−0.13	0.29	0.18	0.09	0.62	−0.22	−0.72
	t	−1.45	0.87	−3.31	−2.67	3.99	−1.76	−3.95	5.18	2.53	−0.34	3.09	5.68	1.19	4.84	−4.11	−6.58
	R^2	0.23	0.47	0.91	0.47	1.31	1.71	0.68	0.51	0.34	0.49	3.86	0.16	0.52	0.83	0.86	0.75
12	Slope	−0.24	−0.17	−0.78	−0.43	1.02	−0.86	−0.33	0.47	0.30	−0.13	0.15	0.07	0.09	0.77	−0.25	−0.77
	t	−7.34	−1.03	−3.27	−5.05	4.44	−2.05	−3.54	5.45	2.99	−0.31	1.72	2.23	1.17	8.59	−4.77	−6.76
	R^2	0.24	0.55	1.04	0.56	1.55	1.87	2.13	0.54	0.42	0.54	3.95	0.16	0.65	0.96	0.80	0.78

τ		Sue	R^6	Ivff	Roe	log(Bm)	I/A	Oa	Rdm	log(Me)	Ep	Cop	Abr	Ilr	Nop	Dac	Nsi
		Panel B: Predicting future quarterly Roe, January 1967–December 2015															
1	Slope	1.18	0.81	−0.99	3.73	−1.01	0.08	0.49	−1.84	0.70	1.39	1.46	0.46	0.04	0.77	0.28	−0.61
	t	33.39	14.62	−15.75	76.16	−19.96	1.46	11.87	−12.82	14.75	10.42	25.49	22.27	1.97	10.43	7.16	−10.73
	R^2	6.04	3.59	3.16	32.75	8.02	1.61	1.05	5.30	1.48	4.21	7.30	0.85	0.68	1.79	0.62	1.55
2	Slope	1.06	0.81	−1.02	3.07	−0.93	−0.01	0.46	−1.80	0.72	1.35	1.42	0.39	0.13	0.80	0.25	−0.63
	t	28.44	16.56	−15.81	48.03	−17.22	−0.21	8.03	−11.65	15.36	9.75	25.56	21.26	6.07	10.14	6.10	−10.91
	R^2	4.97	3.53	3.24	21.87	7.08	1.39	0.99	4.98	1.60	3.95	7.15	0.71	0.78	1.84	0.72	1.59
3	Slope	0.94	0.91	−1.11	3.00	−0.87	0.02	0.41	−0.77	0.74	1.32	1.42	0.33	0.06	0.80	0.25	−0.68
	t	15.03	7.10	−14.54	56.51	−14.43	0.15	7.97	−0.83	13.97	9.45	21.37	9.30	0.71	10.56	5.72	−11.31
	R^2	4.32	3.24	3.27	20.38	6.07	1.33	0.78	4.60	1.69	3.43	6.53	0.59	0.87	1.82	0.57	1.61
4	Slope	0.96	0.78	−1.08	3.62	−0.79	−0.14	0.52	−1.73	0.74	1.19	1.26	0.46	0.05	0.83	0.24	−0.74
	t	7.04	15.06	−15.86	54.19	−14.12	−2.78	2.96	−11.58	15.96	9.15	12.60	17.06	0.63	10.77	4.54	−8.19
	R^2	5.56	3.05	3.33	30.21	5.57	1.23	0.85	4.85	1.81	3.11	6.45	1.05	0.94	1.95	0.66	1.87
8	Slope	0.89	0.44	−1.14	2.93	−0.64	−0.31	0.27	−1.59	0.84	1.06	1.28	0.33	0.07	0.91	0.14	−0.76
	t	25.58	8.78	−16.80	47.72	−11.13	−7.18	5.29	−10.93	17.05	9.34	25.83	11.18	2.79	12.96	4.36	−14.72
	R^2	3.22	1.63	3.20	17.40	3.59	1.05	0.59	3.54	1.96	2.40	5.34	0.58	0.66	1.93	0.50	1.82
12	Slope	0.72	0.29	−1.09	2.44	−0.55	−0.43	0.19	−1.42	0.84	0.93	1.20	0.20	0.06	0.83	0.52	−0.64
	t	24.03	5.87	−18.21	40.39	−11.85	−5.18	4.13	−10.10	17.11	8.74	20.15	7.17	2.33	12.88	1.23	−7.02
	R^2	2.05	1.17	2.70	11.38	2.74	1.04	0.44	3.02	1.87	1.73	4.71	0.31	0.67	1.51	0.59	1.52
		Panel C: Predicting future cumulative stock returns from month t to month $t+\tau\times 3-1$, January 1967–December 2015															
1	Slope	0.53	0.72	−0.58	0.79	0.49	−0.59	−0.25	0.64	−0.29	0.58	0.47	0.50	0.50	0.33	−0.25	−0.60
	t	6.12	3.60	−2.86	4.61	2.82	−4.41	−2.70	3.09	−2.02	2.25	4.75	7.54	4.80	2.50	−3.61	−6.73
	R^2	0.76	2.19	2.85	1.11	2.14	1.22	0.70	1.29	1.62	1.33	0.81	0.37	1.49	0.98	0.40	0.77
2	Slope	0.76	1.64	−1.07	1.30	1.06	−1.18	−0.50	1.10	−0.49	1.28	0.89	0.83	0.67	0.68	−0.45	−1.21
	t	5.32	4.61	−3.09	4.45	3.69	−5.34	−3.30	3.36	−2.05	3.01	5.10	8.11	4.10	3.14	−3.77	−8.35
	R^2	0.75	2.39	2.85	1.14	2.36	1.24	0.73	1.24	1.63	1.53	0.96	0.35	1.53	1.06	0.44	0.90
3	Slope	0.81	2.30	−1.49	1.27	1.58	−1.69	−0.81	1.46	−0.65	1.87	1.37	1.12	0.93	1.07	−0.71	−1.80
	t	4.46	4.87	−3.40	3.37	4.32	−5.92	−4.21	3.39	−2.02	3.28	5.60	7.96	4.76	3.75	−4.40	−9.89
	R^2	0.67	2.61	2.85	1.12	2.52	1.32	0.72	1.23	1.63	1.65	1.12	0.36	1.61	1.11	0.48	1.00
4	Slope	0.81	2.38	−1.82	1.21	2.02	−2.14	−1.08	1.88	−0.77	2.29	1.82	1.23	1.31	1.40	−0.97	−2.33
	t	3.90	4.27	−3.52	2.56	4.55	−6.07	−4.76	3.61	−1.94	3.27	5.99	7.09	5.36	4.02	−4.90	−10.70
	R^2	0.56	2.38	2.82	1.05	2.54	1.33	0.72	1.34	1.63	1.65	1.20	0.35	1.62	1.14	0.49	1.05
8	Slope	1.07	1.69	−2.72	1.23	3.70	−3.85	−2.04	3.08	−1.08	3.82	3.38	1.65	1.05	3.12	−2.04	−4.57
	t	3.44	2.23	−3.16	1.61	4.73	−6.13	−5.73	3.70	−1.75	3.33	6.00	5.77	2.80	5.68	−5.68	−14.13
	R^2	0.47	1.58	2.40	0.85	2.61	1.25	0.75	1.45	1.64	1.35	1.38	0.29	1.47	1.18	0.56	1.07
12	Slope	0.86	1.79	−3.26	0.16	5.40	−4.59	−3.01	5.60	−1.98	6.31	5.03	1.74	0.77	4.38	−3.30	−6.31
	t	1.64	1.94	−2.74	0.14	5.24	−4.48	−5.92	4.67	−2.14	5.39	6.19	4.66	1.67	5.71	−6.31	−11.94
	R^2	0.52	1.33	2.02	0.81	2.56	1.31	0.74	1.43	1.68	1.16	1.56	0.26	1.31	1.19	0.53	1.02

Table 4 : Multiple Cross-sectional Regressions of Future Quarterly Investment-to-assets Changes, July 1976–December 2015

At the beginning of each month t, we perform multiple Fama-MacBeth (1973) cross-sectional regressions of future changes in quarterly investment-to-assets, $\triangle \mathrm{I/A}^q_\tau$, defined as quarterly investment-to-assets from τ quarters ahead minus quarterly investment-to-assets from at least four month ago. The cross-sectional regressions are estimated with weighted least squares with the market equity as weights in the full sample in Panel A, and with ordinary least squares in the all-but-micro sample in Panel B. We report the slopes (in percent), their t-statistics adjusted for heteroscedasticity and autocorrelations, and goodness-of-fit coefficients (R^2, in percent). Among the regressors, Sue is standard unexpected earnings, R^6 prior six-month returns, Ivff idiosyncratic volatility (in percent), Roe return on equity, log(Bm) log book-to-market equity, I/A investment-to-assets, Oa operating accruals, Rdm R&D expense-to-market equity, log(Me) logarithm of the market equity in millions of dollars, Ep earnings-to-price, Cop cash-based operating profitability, Abr cumulative abnormal returns around earnings announcement dates, Ilr industry lead-lag effect in prior returns, Nop net payout yield, Dac discretionary accruals, and Nsi net stock issues. Appendix B provides detailed variable definitions. Multiple regressions use all these variables simultaneously. The slope of a given regressor is rescaled by multiplying its average cross-sectional standard deviation.

τ		Sue	R^6	Ivff	Roe	log(Bm)	I/A	Oa	Rdm	log(Me)	Ep	Cop	Abr	Ilr	Nop	Dac	Nsi	R^2
		Panel A: The full sample, weighted least squares																
1	Slope	0.05	0.80	−0.03	0.96	0.17	−0.46	−0.14	0.04	−0.10	−0.03	−0.10	−0.02	−0.17	−0.01	−0.02	−0.02	13.40
	t	0.58	6.90	−0.26	4.17	1.25	−3.59	−0.61	0.23	−1.26	−0.18	−0.82	−0.15	−2.47	−0.10	−0.09	−0.14	
2	Slope	0.28	0.97	−0.17	−0.50	−0.08	−0.58	−0.06	0.04	−0.04	0.27	−0.03	0.16	0.07	0.08	−0.07	−0.03	13.19
	t	3.01	7.88	−1.18	−2.24	−0.50	−4.25	−0.25	0.17	−0.36	1.26	−0.18	1.73	1.05	0.58	−0.30	−0.20	
3	Slope	0.23	0.52	−0.38	−0.39	0.00	−0.64	−0.14	0.05	−0.04	−0.09	0.01	0.35	0.14	0.03	0.04	−0.10	13.25
	t	2.75	4.51	−2.65	−1.70	0.01	−4.71	−0.61	0.26	−0.41	−0.43	0.08	4.29	2.03	0.23	0.18	−0.62	
4	Slope	0.22	0.35	−0.49	0.35	0.29	−0.73	−0.32	0.16	−0.03	−0.71	0.02	0.22	−0.07	−0.08	0.13	−0.26	13.71
	t	2.71	2.66	−3.64	1.76	1.91	−5.79	−1.55	0.71	−0.27	−2.99	0.11	2.52	−1.09	−0.55	0.74	−1.81	
8	Slope	0.29	0.28	−0.56	−0.12	0.63	−0.93	0.09	−0.07	0.17	−1.21	0.31	−0.02	−0.03	0.23	0.09	−0.18	15.58
	t	2.87	2.30	−3.59	−0.55	3.83	−6.40	0.37	−0.33	1.47	−5.43	2.12	−0.22	−0.44	1.50	0.40	−1.20	
12	Slope	0.07	0.19	−0.51	−0.14	0.60	−1.08	−0.14	0.19	0.26	−1.32	0.22	−0.01	−0.03	0.72	0.25	−0.06	15.58
	t	1.02	1.39	−3.24	−0.64	3.11	−6.85	−0.56	0.86	1.78	−4.04	1.23	−0.07	−0.28	4.19	1.15	−0.37	
		Panel B: The all-but-micro sample, ordinary least squares																
1	Slope	0.03	0.71	−0.03	0.40	0.07	−0.27	−0.02	0.08	−0.04	−0.04	−0.07	0.06	−0.04	−0.04	−0.07	0.00	6.73
	t	0.58	10.23	−0.67	3.81	0.73	−3.30	−0.15	1.20	−1.00	−0.53	−0.98	1.37	−1.16	−0.53	−0.83	−0.02	
2	Slope	0.23	1.02	−0.15	−0.72	0.06	−0.28	0.04	−0.01	−0.01	−0.01	0.12	0.18	0.09	−0.02	−0.04	−0.08	7.06
	t	4.29	14.58	−2.80	−6.19	0.57	−3.22	0.31	−0.10	−0.31	−0.09	1.47	3.83	2.39	−0.29	−0.40	−0.86	
3	Slope	0.18	0.74	−0.21	−0.53	0.29	−0.37	0.09	0.03	0.05	−0.16	0.22	0.29	0.20	−0.03	−0.05	−0.10	7.33
	t	3.38	10.36	−3.36	−4.65	2.49	−4.13	0.70	0.37	0.91	−1.90	2.38	7.26	5.08	−0.31	−0.54	−1.01	
4	Slope	0.09	0.59	−0.35	−0.09	0.49	−0.40	−0.08	0.08	0.03	−0.34	0.19	0.20	0.13	−0.07	0.05	−0.22	7.17
	t	1.82	8.90	−6.51	−1.11	4.13	−4.48	−0.65	1.14	0.55	−3.88	2.11	4.72	3.29	−0.91	0.49	−2.43	
8	Slope	0.04	0.18	−0.44	−0.35	0.87	−0.49	−0.07	−0.03	0.14	−0.44	0.41	0.14	0.00	0.06	0.14	−0.34	8.06
	t	0.81	2.38	−7.85	−3.48	6.48	−5.88	−0.50	−0.39	2.76	−4.97	4.34	3.63	0.08	0.73	1.22	−3.87	
12	Slope	−0.14	0.03	−0.47	−0.45	0.91	−0.46	−0.26	0.03	0.21	−0.30	0.31	0.11	0.00	0.14	0.25	−0.38	8.83
	t	−2.61	0.36	−7.46	−4.08	6.30	−4.46	−1.87	0.37	3.60	−3.24	3.10	2.53	0.06	1.70	2.14	−4.24	

Table 5 : Deciles Formed on Expected Changes in Quarterly Investment-to-assets, July 1976–December 2015

Panel A uses all 16 predictors described in Table 1 to form expected changes in quarterly investment-to-assets, $E_t[\triangle\text{I/A}^q_\tau]$, with the forecasting horizon, τ, ranging from 1 to 12 quarters. At the beginning of each month t, we calculate $E_t[\triangle\text{I/A}^q_\tau]$ with the latest predictor values known and the average cross-sectional regression slopes estimated with the data from month $t-120-\tau\times 3$ to month $t-1-\tau\times 3$. We require a minimum of 36 months. Cross-sectional regressions are estimated with weighted least squares with the market equity as weights. With the calculated $E_t[\triangle\text{I/A}^q_\tau]$ values at the beginning of month t, we sort all stocks into deciles based on NYSE breakpoints, and compute value-weighted decile returns for month t. The deciles are rebalanced at the beginning of month $t+1$. For each decile and the high-minus-low decile (H−L), we report the average excess return, m, its t-value, t_m, the q-factor alpha, α_q, and its t-statistic, t_q. The t-values are adjusted for heteroscedasticity and autocorrelations. In Panel B, we only use anomaly variables that are significant in univariate cross-sectional regressions of $\triangle\text{I/A}^q_\tau$ for each τ horizon to form $E_t[\triangle\text{I/A}^q_\tau]$. For $\tau=1$, the set of significant predictors includes Sue, R^6, Roe, and Abr; for $\tau=2$, Sue, R^6, Rdm, Abr, and Ilr; for $\tau=3$, Sue, R^6, Rdm, log(Me), Cop, Abr, Ilr, and Nsi; for $\tau=4$, Sue, R^6, Roe, Rdm, log(Me), Abr, Ilr, and Nsi; for $\tau=8$, log(Bm), Rdm, log(Me), and Nsi; and for $\tau=12$, Roe, log(Bm), Rdm, log(Me), Nop, and Nsi. All other aspects of the test design in Panel B are identical to those in Panel A.

Panel A: Using all 16 anomaly variables to form expected changes in quarterly I/A												
τ		Low	2	3	4	5	6	7	8	9	High	H−L
1	m	0.66	0.59	0.56	0.68	0.74	0.92	0.56	0.65	0.56	1.00	0.35
	t_m	1.95	2.13	2.25	2.63	3.06	3.86	2.27	2.60	2.09	3.14	1.19
	α_q	0.61	0.35	0.08	0.12	0.16	0.41	−0.14	−0.03	−0.20	0.31	−0.30
	t_q	2.88	2.27	0.56	0.84	1.24	3.02	−1.14	−0.22	−1.33	1.51	−0.87
2	m	0.73	0.64	0.81	0.54	0.83	0.75	0.79	0.58	0.79	0.83	0.10
	t_m	2.12	2.18	2.80	1.91	3.42	3.19	3.18	2.46	3.02	2.83	0.40
	α_q	0.46	0.31	0.34	0.14	0.11	−0.10	0.05	−0.36	−0.03	0.24	−0.22
	t_q	2.59	1.70	2.02	0.80	0.73	−0.87	0.31	−2.45	−0.19	1.06	−0.69
3	m	0.57	0.74	0.80	0.87	0.86	0.49	0.73	0.73	0.70	0.60	0.03
	t_m	1.61	2.54	2.74	3.20	3.41	1.98	3.14	3.10	2.78	2.11	0.12
	α_q	0.30	0.39	0.55	0.34	0.13	−0.23	−0.14	−0.14	−0.06	−0.03	−0.33
	t_q	1.80	2.27	3.37	2.46	0.96	−1.59	−1.10	−0.97	−0.38	−0.16	−1.28
4	m	0.56	0.63	0.82	0.82	0.87	0.63	0.65	0.75	0.88	0.93	0.37
	t_m	1.65	2.02	2.96	3.11	3.61	2.45	2.86	3.00	3.48	3.22	1.43
	α_q	0.27	0.30	0.42	0.38	0.21	−0.15	−0.10	0.01	0.00	0.30	0.02
	t_q	1.71	1.67	2.75	2.71	1.25	−1.02	−0.73	0.05	0.01	1.44	0.08
8	m	0.61	0.52	0.72	0.78	0.88	0.95	0.80	0.73	0.64	0.81	0.20
	t_m	1.73	1.59	2.36	2.83	3.53	3.83	3.17	3.14	2.47	3.05	0.77
	α_q	0.42	0.23	0.27	0.23	0.22	0.23	0.01	0.04	−0.08	0.23	−0.19
	t_q	2.34	1.30	1.41	1.44	1.61	1.84	0.05	0.31	−0.42	1.41	−0.79
12	m	0.78	0.86	0.85	0.74	0.84	0.92	0.71	0.79	0.78	0.91	0.13
	t_m	2.15	2.64	2.83	2.64	3.47	3.57	2.78	3.25	2.96	3.56	0.42
	α_q	0.54	0.27	0.26	0.12	0.20	0.19	−0.06	−0.04	0.15	0.42	−0.12
	t_q	2.83	1.42	1.77	0.79	1.61	1.24	−0.39	−0.31	0.97	1.95	−0.39

Panel B: Using only significant predictors in univariate regressions to form expected changes in quarterly I/A												
τ		Low	2	3	4	5	6	7	8	9	High	H−L
1	m	0.49	0.70	0.68	0.59	0.62	0.65	0.63	0.53	0.59	1.02	0.53
	t_m	1.48	2.67	3.17	2.86	3.03	3.27	3.18	2.50	2.54	3.45	1.81
	α_q	0.25	0.33	0.25	0.03	0.07	−0.02	−0.12	−0.23	−0.23	0.20	−0.06
	t_q	1.12	2.08	1.90	0.30	0.67	−0.19	−1.52	−2.62	−2.14	1.01	−0.14
2	m	0.56	0.78	0.70	0.76	0.83	0.65	0.52	0.65	0.63	1.11	0.54
	t_m	1.62	2.59	2.63	3.09	3.35	2.77	2.19	2.68	2.47	3.40	1.84
	α_q	0.43	0.41	0.22	0.22	0.35	−0.02	−0.34	−0.15	−0.10	0.54	0.11
	t_q	1.58	2.14	1.30	1.71	2.53	−0.16	−3.06	−1.15	−0.70	2.09	0.25
3	m	0.28	0.90	0.78	0.70	0.70	0.64	0.83	0.68	0.54	0.98	0.70
	t_m	0.86	3.14	2.88	2.59	2.76	2.52	3.39	2.83	2.06	3.53	2.93
	α_q	0.04	0.51	0.46	0.27	0.18	0.02	0.26	−0.01	−0.20	0.27	0.23
	t_q	0.21	3.03	3.06	1.79	1.35	0.18	1.74	−0.04	−1.27	1.35	0.76
4	m	0.35	0.78	0.66	0.69	0.93	0.56	0.60	0.81	0.66	0.87	0.51
	t_m	1.08	2.60	2.32	2.63	3.84	2.34	2.27	3.54	2.59	3.15	2.38
	α_q	0.12	0.37	0.34	0.19	0.35	−0.07	0.05	0.14	−0.04	0.39	0.27
	t_q	0.67	2.24	1.75	1.43	2.74	−0.65	0.42	1.04	−0.27	2.20	1.20
8	m	0.38	0.83	0.84	0.62	0.73	0.90	0.86	0.62	0.64	0.86	0.49
	t_m	1.01	2.44	2.89	2.21	2.80	3.35	3.40	2.58	2.80	3.92	1.61
	α_q	0.13	0.52	0.40	−0.18	0.14	0.48	0.28	0.01	−0.06	0.26	0.13
	t_q	0.63	3.02	2.73	−1.07	0.80	2.67	1.71	0.07	−0.51	2.06	0.51
12	m	0.86	0.73	0.66	0.89	0.82	1.02	0.80	0.78	0.88	0.69	−0.17
	t_m	2.49	2.16	2.21	3.18	3.18	3.77	3.14	3.12	3.71	2.96	−0.67
	α_q	0.24	0.22	0.14	0.08	0.08	0.24	0.06	0.14	0.12	0.12	−0.12
	t_q	1.26	1.22	0.85	0.52	0.42	1.24	0.40	0.91	0.90	0.95	−0.49

Table 6 : Deciles Formed on Expected Changes in Quarterly Investment-to-assets, the All-but-micro Sample, July 1976–December 2015

Panel A uses all 16 predictors in Table 1 to form expected changes in quarterly investment-to-assets, $E_t[\triangle \text{I/A}^q_\tau]$, with the horizon, τ, ranging from 1 to 12 quarters. At the beginning of each month t, we calculate $E_t[\triangle \text{I/A}^q_\tau]$ with the latest predictor values known and the average cross-sectional regression slopes estimated with the data from month $t-120-\tau\times 3$ to month $t-1-\tau\times 3$. We require a minimum of 36 months. Cross-sectional regressions are estimated with ordinary least squares. With the calculated $E_t[\triangle \text{I/A}^q_\tau]$ values at the beginning of month t, we sort all-but-micro stocks into deciles, and compute equal-weighted returns for month t. The deciles are rebalanced at the beginning of month $t+1$. For each decile and the high-minus-low decile (H−L), we report the average excess return, m, its t-value, t_m, the q-factor alpha, α_q, and its t-statistic, t_q. The t-values are adjusted for heteroscedasticity and autocorrelations. In Panel B, we only use anomaly variables that are significant in univariate cross-sectional regressions of $\triangle \text{I/A}^q_\tau$ for each τ to form $E_t[\triangle \text{I/A}^q_\tau]$. For $\tau = 1$, the set of significant predictors includes Sue, R^6, Rdm, and Abr; for $\tau = 2$, Sue, R^6, Roe, Oa, Rdm, log(Me), Abr, Ilr, Dac, and Nsi; for $\tau = 3$, Sue, R^6, Roe, Rdm, Cop, Abr, Ilr, Nop, and Nsi; for $\tau = 4$, Sue, R^6, Oa, Rdm, Abr, Ilr, Nop, Dac, and Nsi; for $\tau = 8$, Ivff, Roe, log(Bm), Oa, Rdm, log(Me), Cop, Abr, Nop, Dac, and Nsi; and for $\tau = 12$, Sue, Ivff, Roe, log(Bm), I/A, Oa, Rdm, log(Me), Abr, Nop, Dac, and Nsi. All other aspects of the test design in Panel B are identical to those in Panel A.

Panel A: Using all 16 anomaly variables to form expected changes in quarterly I/A

τ		Low	2	3	4	5	6	7	8	9	High	H−L
1	m	0.46	0.72	0.69	0.74	0.75	0.93	0.80	0.83	1.14	1.43	0.96
	t_m	1.15	2.13	2.33	2.69	2.82	3.51	2.97	2.90	3.67	3.78	3.52
	α_q	0.24	0.34	0.17	0.15	0.01	0.22	0.08	0.14	0.48	0.87	0.63
	t_q	1.10	1.57	1.04	1.40	0.09	2.38	0.91	1.28	2.82	3.67	1.64
2	m	0.66	0.95	0.75	0.80	0.96	0.86	0.83	0.85	0.97	1.00	0.35
	t_m	1.66	2.81	2.43	2.74	3.50	3.29	3.07	3.02	3.08	2.69	1.27
	α_q	0.34	0.57	0.19	0.16	0.28	0.11	0.08	0.16	0.32	0.49	0.15
	t_q	1.29	3.02	1.27	1.12	2.30	0.97	0.88	1.22	1.85	2.10	0.34
3	m	0.54	0.82	0.81	0.90	0.74	0.95	0.88	0.84	0.98	1.08	0.53
	t_m	1.36	2.38	2.57	3.13	2.67	3.44	3.26	2.97	3.23	2.94	2.05
	α_q	0.28	0.41	0.36	0.27	0.07	0.19	0.16	0.13	0.32	0.54	0.26
	t_q	1.16	2.21	2.23	2.09	0.59	1.58	1.78	1.05	1.91	2.30	0.65
4	m	0.36	0.86	0.75	0.95	0.84	0.94	0.89	0.91	0.94	1.31	0.95
	t_m	0.88	2.46	2.39	3.34	2.91	3.46	3.35	3.24	3.25	3.70	3.92
	α_q	0.16	0.45	0.34	0.39	0.11	0.17	0.09	0.11	0.16	0.67	0.51
	t_q	0.75	2.74	2.46	2.95	1.08	1.69	0.89	1.10	1.10	3.13	1.57
8	m	0.34	0.85	0.78	0.94	0.93	1.01	0.87	0.90	0.79	0.89	0.55
	t_m	0.83	2.35	2.30	3.13	3.18	3.60	3.16	3.11	2.82	2.83	2.35
	α_q	0.16	0.49	0.40	0.47	0.31	0.36	0.10	0.14	0.03	0.17	0.01
	t_q	0.96	3.52	2.96	4.35	3.40	3.75	1.05	1.49	0.28	1.17	0.06
12	m	0.62	0.96	0.84	0.99	1.16	0.95	1.02	0.97	0.97	0.87	0.25
	t_m	1.51	2.66	2.52	3.19	3.82	3.35	3.60	3.52	3.37	2.63	0.93
	α_q	0.24	0.44	0.33	0.42	0.47	0.24	0.23	0.13	0.15	0.07	−0.17
	t_q	1.36	3.36	3.05	3.60	3.90	2.22	2.07	1.25	1.26	0.43	−0.70

Panel B: Using only significant predictors in univariate regressions to form expected changes in quarterly I/A												
τ		Low	2	3	4	5	6	7	8	9	High	H−L
1	m	0.58	0.69	0.72	0.80	0.86	0.80	0.77	0.93	1.18	1.38	0.80
	t_m	1.44	2.09	2.46	2.80	3.11	2.89	2.70	2.97	3.40	3.38	2.52
	α_q	0.49	0.32	0.27	0.26	0.26	0.13	0.10	0.30	0.59	0.90	0.41
	t_q	1.80	1.65	1.63	1.96	3.00	1.25	0.82	1.56	2.64	3.07	0.85
2	m	0.65	0.81	0.85	0.91	0.86	0.88	0.83	0.92	0.94	1.09	0.44
	t_m	1.62	2.35	2.73	3.16	3.09	3.35	2.86	3.06	2.80	2.66	1.45
	α_q	0.34	0.37	0.37	0.29	0.24	0.23	0.23	0.32	0.39	0.72	0.38
	t_q	1.22	1.93	2.41	1.99	2.35	2.52	1.75	1.87	1.62	2.57	0.79
3	m	0.53	0.86	0.82	0.88	0.82	0.89	0.80	0.86	1.01	1.10	0.57
	t_m	1.36	2.64	2.73	3.09	2.99	3.28	2.98	2.87	3.10	2.95	2.14
	α_q	0.14	0.33	0.17	0.32	0.17	0.21	0.10	0.23	0.41	0.67	0.53
	t_q	0.54	1.71	1.19	2.08	1.65	2.22	0.98	1.60	2.45	2.83	1.28
4	m	0.46	0.59	0.89	0.81	0.85	0.85	0.92	0.95	1.13	1.27	0.80
	t_m	1.17	1.73	2.96	2.71	3.12	3.19	3.38	3.28	3.53	3.37	3.34
	α_q	0.11	0.05	0.40	0.20	0.17	0.11	0.18	0.30	0.49	0.80	0.70
	t_q	0.51	0.32	2.65	1.52	1.48	1.09	1.83	2.70	2.50	3.33	1.93
8	m	0.31	0.80	0.84	0.82	0.86	0.96	0.99	0.86	0.80	0.83	0.52
	t_m	0.73	2.07	2.47	2.58	2.99	3.40	3.57	2.96	2.88	2.76	1.92
	α_q	0.18	0.49	0.47	0.38	0.26	0.26	0.29	0.11	0.01	0.08	−0.10
	t_q	1.01	3.29	3.92	3.58	2.69	2.65	3.04	1.00	0.13	0.64	−0.44
12	m	0.57	1.00	0.95	1.02	0.97	1.03	1.11	0.86	0.92	0.90	0.33
	t_m	1.35	2.72	2.67	3.12	3.20	3.54	3.94	3.14	3.22	2.92	1.12
	α_q	0.26	0.50	0.54	0.45	0.37	0.32	0.36	0.03	0.02	0.07	−0.19
	t_q	1.32	3.65	3.32	3.77	3.36	3.21	3.46	0.27	0.19	0.49	−0.74

Table 7 : Factor Spanning Tests, The PRRT Factor Model, the q-factor Model, and the Carhart Model, January 1967–December 2015

Panel A regresses the PRRT factors on the q-factor model and on the Carhart model. $f_{\mathrm{ME}}, f_{\mathrm{EP}}$, and f_{BM} are the size, earnings yield, and book-to-market factors from the PRRT model. m denotes average returns, α_q is the q-factor alpha, α_C the Carhart alpha, and the betas are factor loadings. Panel B regresses the Carhart factors and q-factors on the PRRT factor model, consisting of the market factor, $f_{\mathrm{ME}}, f_{\mathrm{EP}}$, and f_{BM}. α_P is the PRRT alpha, and the betas are factor loadings. The Carhart factors data are from Kennenth French's Web site, and the q-factors data are from Hou, Xue, and Zhang (2015). To form the PRRT factors, at the end of June of each year t, we use the median NYSE size to split NYSE, Amex, and NASDAQ stocks into two groups, small and big. Independently, we split stocks into three earnings yield groups using the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the ranking values for the fiscal year ending in calendar year $t-1$. Also independently, we break stocks into three book-to-market groups using the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the ranking values for the fiscal year ending in calendar year $t-1$. Taking the intersection of the two size, three earnings yield, and three book-to-market groups, we obtain 18 benchmark portfolios. Monthly value-weighted portfolio returns are calculated from July of year t to June of year $t+1$, and the portfolios are rebalanced at the June of $t+1$. f_{ME} is the difference (small-minus-big), each month, between the simple average of the returns on the nine small portfolios and that of the nine big portfolios. f_{EP} is the difference (high-minus-low), each month, between the simple average of the returns on the six high earnings yield portfolios and that of the six low earnings yield portfolios. Finally, f_{BM} is the difference (high-minus-low), each month, between the simple average of the returns on the six high book-to-market portfolios and that of the six low book-to-market portfolios.

Panel A: Explaining the PRRT factors

	m	α_q	β_{MKT}	β_{ME}	$\beta_{\mathrm{I/A}}$	β_{ROE}	R^2
f_{ME}	0.24	0.09	0.01	0.88	−0.19	−0.09	0.91
	1.85	2.11	0.96	44.45	−4.77	−3.17	
f_{EP}	0.25	−0.01	−0.12	−0.12	0.40	0.34	0.38
	1.97	−0.11	−3.61	−1.74	4.60	4.33	
f_{BM}	0.16	0.06	−0.07	0.01	0.74	−0.31	0.47
	1.43	0.72	−2.59	0.16	12.38	−4.81	
		α_C	β_{MKT}	β_{SMB}	β_{HML}	β_{UMD}	R^2
f_{ME}		0.02	0.03	0.93	0.05	−0.02	0.92
		0.50	2.47	74.18	1.93	−1.14	
f_{EP}		0.18	−0.12	−0.25	0.41	0.05	0.46
		1.96	−4.83	−4.34	8.17	1.12	
f_{BM}		−0.06	−0.05	0.07	0.70	−0.02	0.71
		−0.93	−2.93	3.47	22.00	−1.21	

Panel B: The PRRT four-factor regressions

	m	α_P	β_{MKT}	β_{ME}	β_{EP}	β_{BM}	R^2
SMB	0.21	0.01	−0.02	0.97	−0.07	−0.01	0.92
	1.59	0.16	−1.35	41.62	−2.37	−0.38	
HML	0.34	0.05	0.06	0.06	0.43	0.89	0.82
	2.53	0.84	3.42	2.12	9.22	37.49	
UMD	0.69	0.86	−0.20	−0.02	0.00	−0.41	0.07
	3.82	4.82	−2.47	−0.14	0.01	−3.23	
r_{ME}	0.31	0.03	0.00	1.00	0.08	0.09	0.90
	2.34	0.76	0.14	42.80	2.15	3.96	
$r_{\mathrm{I/A}}$	0.41	0.36	−0.06	−0.06	0.10	0.39	0.45
	4.88	5.72	−3.76	−1.96	1.86	12.93	
r_{ROE}	0.57	0.61	−0.05	−0.17	0.39	−0.45	0.39
	5.36	7.78	−1.68	−3.75	5.40	−9.04	

Table 8 : Estimates of Implied Costs of Capital for the Fama-French (2015) Factors

AR, IRR, and Diff (all in annual percent) are the average return, the internal rate of return, and AR minus IRR, respectively. SMB, HML, RMW, and CMA are the Fama-French (2015) size, value, profitability, and investment factors, respectively. Panel A uses the analysts' earnings forecasts, Panel B uses the Hou-van Dijk-Zhang (2012) cross-sectional earnings forecasts, and Panel C uses the Tang-Wu-Zhang (2014) cross-sectional Roe forecasts in estimating the IRRs. GLS denotes the Gebhardt-Lee-Swaminathan model, Easton the Easton model, CT the Claus-Thomas model, OJ the Ohlson-Juettner-Nauroth model, and Average the averages across the models. Appendix C describes in detail the estimation methods.

	Panel A: IBES earnings forecasts (1979–2015)					
	AR	IRR	Diff	AR	IRR	Diff
	GLS			Easton		
SMB	1.75	0.87	0.88	1.87	2.52	−0.65
[t]	0.87	4.56	0.44	0.97	14.63	−0.34
HML	3.26	3.50	−0.23	3.16	3.30	−0.14
[t]	1.48	18.39	−0.11	1.37	7.31	−0.06
RMW	3.75	−1.18	4.93	4.43	−3.29	7.72
[t]	2.59	−8.32	3.49	2.70	−9.42	4.60
CMA	3.34	0.64	2.70	3.46	2.45	1.00
[t]	2.69	4.69	2.26	2.95	7.80	0.94
	CT			OJ		
SMB	1.79	1.10	0.69	1.94	0.67	1.27
[t]	0.89	6.79	0.35	0.97	4.43	0.65
HML	3.38	0.06	3.32	2.23	0.70	1.53
[t]	1.50	0.17	1.46	1.03	3.55	0.70
RMW	3.71	0.34	3.37	4.11	−0.03	4.14
[t]	2.64	2.20	2.42	3.36	−0.17	3.36
CMA	3.31	0.08	3.23	3.03	0.07	2.96
[t]	2.71	0.58	2.65	2.59	0.42	2.53
	Average					
SMB	1.73	1.72	0.01			
[t]	0.90	10.65	0.01			
HML	3.15	2.03	1.13			
[t]	1.36	8.64	0.50			
RMW	4.47	−1.59	6.06			
[t]	2.76	−9.74	3.76			
CMA	3.26	1.15	2.11			
[t]	2.72	7.01	1.86			

	Panel B: Cross-sectional earnings forecasts (1967–2015)					
	AR	IRR	Diff	AR	IRR	Diff
	GLS			Easton		
SMB	2.85	1.53	1.32	2.85	5.05	−2.20
[t]	1.38	4.02	0.66	1.42	6.90	−1.17
HML	3.49	5.55	−2.06	3.41	7.22	−3.81
[t]	1.88	26.60	−1.14	1.81	14.99	−1.96
RMW	3.37	−1.44	4.81	3.89	−3.67	7.57
[t]	2.60	−6.58	3.86	2.60	−10.35	4.79
CMA	3.59	1.61	1.99	4.28	4.06	0.22
[t]	3.01	9.13	1.72	4.10	11.39	0.20
	CT			OJ		
SMB	2.92	2.73	0.19	3.90	3.21	0.69
[t]	1.41	4.23	0.09	2.00	5.32	0.37
HML	3.28	3.64	−0.36	2.97	4.72	−1.75
[t]	1.76	15.76	−0.19	1.72	17.96	−1.00
RMW	3.17	−0.00	3.18	3.31	−1.59	4.90
[t]	2.94	−0.01	2.95	3.30	−5.72	4.60
CMA	3.26	1.52	1.74	3.72	2.10	1.62
[t]	2.82	11.24	1.46	3.07	10.62	1.35
	Average					
SMB	2.82	3.23	−0.41			
[t]	1.36	5.59	−0.21			
HML	3.65	5.30	−1.66			
[t]	1.92	24.84	−0.88			
RMW	3.47	−1.85	5.32			
[t]	2.52	−9.41	3.88			
CMA	3.69	2.64	1.05			
[t]	3.19	19.47	0.92			

	Panel C: Cross-sectional ROE forecasts (1967–2015)					
	AR	IRR	Diff	AR	IRR	Diff
	GLS			Easton		
SMB	3.21	0.08	3.14	3.12	1.15	1.97
[t]	1.63	0.33	1.62	1.58	4.86	1.00
HML	3.80	5.20	−1.39	4.02	7.61	−3.59
[t]	2.03	31.79	−0.77	2.08	15.88	−1.96
RMW	3.00	−1.36	4.36	3.18	−6.41	9.59
[t]	2.37	−7.94	3.56	2.50	−19.65	6.99
CMA	3.37	1.11	2.26	3.32	4.58	−1.26
[t]	3.03	5.76	2.08	2.81	10.32	−1.12
	CT			OJ		
SMB	3.46	−1.13	4.59	3.44	−1.39	4.82
[t]	1.75	−3.54	2.35	1.68	−3.79	2.32
HML	3.25	2.55	0.70	3.15	4.15	−1.00
[t]	1.88	5.76	0.39	1.63	9.27	−0.51
RMW	2.55	0.00	2.54	2.11	−2.05	4.16
[t]	2.45	0.02	2.43	2.06	−9.07	3.76
CMA	2.81	0.62	2.19	3.06	0.70	2.35
[t]	2.55	4.25	1.93	2.53	3.30	1.86
	Average					
SMB	3.20	−0.22	3.42			
[t]	1.63	−0.83	1.75			
HML	3.77	5.09	−1.32			
[t]	2.01	17.26	−0.72			
RMW	3.01	−2.46	5.46			
[t]	2.37	−20.72	4.28			
CMA	3.32	2.04	1.28			
[t]	3.02	13.60	1.19			

Table 9 : Annual Cross-sectional Regressions of Future Book Equity Growth Rates and Operating Profitability, 1963–2015

The sample contains all common stocks on NYSE, Amex, and Nasdaq. We do not exclude financial firms, because these stocks are included in the construction of the Fama-French (2015) five factors. All the regressions are annual cross-sectional regressions. A_{it} is total assets for firm i at year t, $\triangle A_{it} \equiv A_{it} - A_{it-1}$, Be_{it} is book equity for firm i at year t, $\triangle Be_{it} \equiv Be_{it} - Be_{it-1}$, and Op_{it} is operating profitability for firm i at year t. Book equity is measured as in Davis, Fama, and French (2000), and operating profitability is measured as in Fama and French (2015). Variables dated t are measured at the end of the fiscal year ending in calendar year t. To avoid the excess influence of small firms, we follow Fama and French (2006) and exclude those with total assets below \$5 million or book equity below \$2.5 million in year t in Panel A. The cutoffs are \$25 million and \$12.5 million in Panel B. We winsorize all regression variables at the 1st and 99th percentiles of the cross-sectional distribution each year.

		$\frac{\triangle Be_{it+\tau}}{Be_{it+\tau-1}} = \gamma_0 + \gamma_1 \frac{\triangle A_{it}}{A_{it-1}} + \epsilon_{t+\tau}$					$\frac{\triangle Be_{it+\tau}}{Be_{it+\tau-1}} = \gamma_0 + \gamma_1 \frac{\triangle Be_{it}}{Be_{it-1}} + \epsilon_{t+\tau}$					$Op_{it+\tau} = \gamma_0 + \gamma_1 Op_{it} + \epsilon_{t+\tau}$				
τ	#firms	γ_0	$t(\gamma_0)$	γ_1	$t(\gamma_1)$	R^2	γ_0	$t(\gamma_0)$	γ_1	$t(\gamma_1)$	R^2	γ_0	$t(\gamma_0)$	γ_1	$t(\gamma_1)$	R^2
Panel A: Firms with assets $\geq$ \$5 million and book equity $\geq$ \$2.5 million																
1	3,106	0.09	14.57	0.22	14.38	0.05	0.09	13.14	0.21	8.64	0.06	0.03	4.85	0.79	43.14	0.54
2	2,844	0.10	14.57	0.10	7.58	0.01	0.10	14.65	0.10	5.23	0.02	0.06	6.67	0.66	28.82	0.36
3	2,624	0.10	14.98	0.06	6.25	0.01	0.10	14.91	0.06	4.09	0.01	0.08	8.11	0.58	25.35	0.27
4	2,429	0.10	16.19	0.05	5.47	0.00	0.10	16.20	0.05	3.73	0.00	0.09	9.47	0.52	22.93	0.22
5	2,256	0.10	15.03	0.04	3.41	0.00	0.10	16.04	0.03	1.91	0.00	0.10	11.37	0.49	23.35	0.19
6	2,099	0.10	15.26	0.05	4.57	0.00	0.10	15.01	0.03	2.24	0.00	0.11	13.05	0.45	23.72	0.16
7	1,955	0.10	15.45	0.04	4.39	0.00	0.10	15.58	0.03	2.69	0.00	0.11	14.39	0.42	21.71	0.15
8	1,821	0.09	15.36	0.03	3.98	0.00	0.10	15.65	0.01	1.60	0.00	0.12	15.82	0.40	19.09	0.13
9	1,697	0.09	15.28	0.03	3.45	0.00	0.10	15.42	0.01	1.19	0.00	0.12	15.29	0.39	18.10	0.12
10	1,584	0.09	14.57	0.04	4.50	0.00	0.09	14.77	0.02	2.17	0.00	0.13	14.61	0.38	17.48	0.11
Panel B: Firms with assets $\geq$ \$25 million and book equity $\geq$ \$12.5 million																
1	2,485	0.08	15.82	0.23	17.75	0.05	0.08	14.10	0.24	10.53	0.07	0.03	7.14	0.82	57.60	0.61
2	2,278	0.09	15.67	0.13	10.23	0.02	0.09	16.03	0.13	7.10	0.02	0.06	9.13	0.69	35.39	0.42
3	2,103	0.09	16.53	0.08	7.61	0.01	0.09	16.37	0.08	5.82	0.01	0.08	11.01	0.61	31.96	0.32
4	1,949	0.09	17.04	0.07	6.70	0.01	0.09	16.96	0.07	4.44	0.01	0.09	13.31	0.56	30.26	0.26
5	1,812	0.09	16.60	0.05	3.90	0.01	0.09	17.23	0.04	2.87	0.01	0.10	16.00	0.51	31.21	0.22
6	1,689	0.09	16.57	0.05	5.51	0.00	0.09	16.39	0.04	3.37	0.00	0.11	17.71	0.48	32.30	0.19
7	1,577	0.09	16.80	0.05	4.84	0.00	0.09	16.90	0.04	3.12	0.00	0.12	19.34	0.45	30.53	0.16
8	1,473	0.09	16.07	0.03	3.92	0.00	0.09	16.08	0.02	2.58	0.00	0.13	19.90	0.43	26.50	0.15
9	1,375	0.09	15.84	0.03	3.92	0.00	0.09	16.07	0.02	2.08	0.00	0.13	19.14	0.42	23.14	0.14
10	1,286	0.09	14.58	0.05	5.35	0.00	0.09	14.84	0.03	3.01	0.00	0.14	18.07	0.40	22.38	0.13

A Derivations

We derive the investment CAPM in equation (7), following Liu, Whited, and Zhang (2009). Let q_{it} be the Lagrangian multiplier associated with $A_{it+1} = I_{it} + (1-\delta)A_{it}$. The optimality conditions with respect to I_{it}, A_{it+1}, and B_{it+1} from maximizing equation (4) are, respectively,

$$q_{it} = 1 + (1-\tau)\frac{\partial \Phi(I_{it}, A_{it})}{\partial I_{it}} \tag{A1}$$

$$q_{it} = E_t\left[M_{t+1}\left[(1-\tau)\left[X_{it+1} - \frac{\partial \Phi(I_{it+1}, A_{it+1})}{\partial A_{it+1}}\right] + \tau\delta + (1-\delta)q_{it+1}\right]\right] \tag{A2}$$

$$1 = E_t\left[M_{t+1}\left[r^B_{it+1} - (r^B_{it+1} - 1)\tau_{t+1}\right]\right]. \tag{A3}$$

Dividing both sides of equation (A2) by q_{it} and substituting equation (A1), we obtain $E_t[M_{t+1}r^I_{it+1}] = 1$, in which r^I_{it+1} is the investment return given by equation (5), after substituting $\Phi(I_{it}, A_{it}) = (a/2)(I_{it}/A_{it})^2 A_{it}$.

Equation (A3) says that $E_t[M_{t+1}r^B_{it+1}] = 1 + E_t[M_{t+1}(r^B_{it+1} - 1)\tau]$. Intuitively, because of the tax benefit of debt, the unit price of the pre-tax bond return, $E_t[M_{t+1}r^B_{it+1}]$, is higher than one. The difference is precisely the present value of the tax benefit. Because we define the after-tax corporate bond return, $r^{Ba}_{it+1} \equiv r^B_{it+1} - (r^B_{it+1} - 1)\tau$, equation (A3) says that the unit price of the after-tax corporate bond return is one: $E_t[M_{t+1}r^{Ba}_{it+1}] = 1$.

To prove equation (6), we first show that $q_{it}A_{it+1} = P_{it} + B_{it+1}$ under constant returns to scale. We start with $P_{it} + D_{it} = V_{it}$ and expand V_{it} using equations (3) and (4):

$$\begin{aligned}
&P_{it} + (1-\tau)[\Pi(X_{it}, A_{it}) - \Phi(I_{it}, A_{it}) - r^B_{it}B_{it}] - \tau B_{it} - I_{it} + B_{it+1} + \tau\delta A_{it} = \\
&\quad (1-\tau)\left[\Pi(X_{it}, A_{it}) - \frac{\partial \Phi(I_{it}, A_{it})}{\partial I_{it}}I_{it} - \frac{\partial \Phi(I_{it}, A_{it})}{\partial A_{it}}A_{it} - r^B_{it}B_{it}\right] - \tau B_{it} - I_{it} + B_{it+1} + \tau\delta A_{it} \\
&\quad - q_{it}(A_{it+1} - (1-\delta)A_{it} - I_{it}) + E_t[M_{t+1}((1-\tau_t)\left[\Pi(X_{it+1}, A_{it+1}) - \frac{\partial \Phi(I_{it+1}, A_{it+1})}{\partial I_{it+1}}I_{it+1}\right. \\
&\quad \left. - \frac{\partial \Phi(I_{it+1}, A_{it+1})}{\partial A_{it+1}}A_{it+1} - r^B_{it+1}B_{it+1}\right] - \tau B_{it+1} - I_{it+1} + B_{it+2} \\
&\quad + \tau\delta A_{it+1} - q_{it+1}(A_{it+2} - (1-\delta)A_{it+1} - I_{it+1}) + \ldots)]
\end{aligned} \tag{A4}$$

Recursively substituting equations (A1), (A2), and (A3), and simplifying, we obtain:

$$\begin{aligned}
&P_{it} + (1-\tau)[\Pi(X_{it}, A_{it}) - \Phi(I_{it}, A_{it}) - r^B_{it}B_{it}] - \tau B_{it} - I_{it} + B_{it+1} + \tau\delta A_{it} = \\
&\quad (1-\tau)\left[\Pi(X_{it}, A_{it}) - \frac{\partial \Phi(I_{it}, A_{it})}{\partial A_{it}}A_{it} - r^B_{it}B_{it}\right] - \tau B_{it} + q_{it}(1-\delta)A_{it} + \tau\delta A_{it}
\end{aligned} \tag{A5}$$

Simplifying further and using the linear homogeneity of $\Phi(I_{it}, A_{it})$, we obtain:

$$P_{it} + B_{it+1} = (1-\tau)\frac{\partial \Phi(I_{it}, A_{it})}{\partial I_{it}}I_{it} + I_{it} + q_{it}(1-\delta)A_{it} = q_{it}A_{it+1} \tag{A6}$$

Equation (8) then follows.

Finally, we are ready to prove equation (6):

$$w_{it}r^{Ba}_{it+1} + (1-w_{it})r^{S}_{it+1} = \frac{\left[\begin{array}{c} (1-\tau)r^{B}_{it+1}B_{it+1} + \tau B_{it+1} + P_{it+1} \\ +(1-\tau)[\Pi(X_{it+1},A_{it+1}) - \Phi(I_{it+1},A_{it+1}) - r^{B}_{it+1}B_{it+1}] \\ -\tau B_{it+1} - I_{it+1} + B_{it+2} + \tau\delta A_{it+1} \end{array}\right]}{P_{it} + B_{it+1}}$$

$$= \frac{1}{q_{it}A_{it+1}}\left[\begin{array}{c} q_{it+1}(I_{it+1} + (1-\delta)A_{it+1}) + (1-\tau)[\Pi(X_{it+1},A_{it+1}) \\ -\Phi(I_{it+1},A_{it+1})] - I_{it+1} + \tau\delta A_{it+1} \end{array}\right]$$

$$= \frac{q_{it+1}(1-\delta) + (1-\tau)\left[X_{it+1} - \frac{\partial\Phi(I_{it+1},A_{it+1})}{\partial A_{it+1}}\right] + \tau\delta}{q_{it}} = r^{I}_{it+1}. \tag{A7}$$

Equation (9) then follows by rewriting equation (6) as the marginal cost of investment equals the marginal benefit of investment discounted by the weighted average cost of capital, and then multiplying both sides of the equation by A_{it+1}.

B Variable Definitions

Sue, standardized unexpected earnings. Per Foster, Olsen, and Shevlin (1984), Sue is calculated as the change in split-adjusted quarterly earnings per share (Compustat quarterly item EPSPXQ divided by item AJEXQ) from its value four quarters ago divided by the standard deviation of this change in quarterly earnings over the prior eight quarters (six quarters minimum). Before 1972, we use the most recent Sue computed with quarterly earnings from fiscal quarters ending at least four months prior to the portfolio formation. Starting from 1972, we use Sue computed with quarterly earnings from the most recent quarterly earnings announcement dates (Compustat quarterly item RDQ). We require the end of the fiscal quarter that corresponds to its most recent Sue to be within six months prior to the month when Sue is used in monthly cross-sectional regressions. We do so to exclude stale information on earnings. To avoid potentially erroneous records, we also require the earnings announcement date to be after the corresponding fiscal quarter end.

R^6, prior six-month returns. For each month t, we measure R^6 as the prior six-month return from month $t-7$ to $t-2$, skipping month $t-1$.

Ivff, idiosyncratic volatility. Following Ang, Hodrick, Xing, and Zhang (2006), we calculate Ivff relative to the Fama-French (1993) three-factor model as the residual volatility from regressing a stock's excess returns on the Fama-French three factors. At the beginning of each month t, we estimate Ivff with daily returns from month $t-1$. We require a minimum of 15 daily returns.

Roe, return on equity. Roe is income before extraordinary items (Compustat quarterly item IBQ) divided by one-quarter-lagged book equity (Hou, Xue, and Zhang 2015). Book equity is shareholders' equity, plus balance sheet deferred taxes and investment tax credit (item TXDITCQ) if available, minus the book value of preferred stock (item PSTKQ). Depending on availability, we use stockholders' equity (item SEQQ), or common equity (item CEQQ) plus the book value of preferred stock, or total assets (item ATQ) minus total liabilities (item LTQ) in that order as shareholders' equity. Before 1972, the sample coverage is limited for quarterly book equity in Compustat quarterly files. We expand the coverage by using book equity from Compustat annual files as well as by imputing quarterly book equity with clean surplus accounting. Specifically, whenever available we first use quarterly book equity from Compustat quarterly files. We then supplement the coverage for fiscal quarter four with annual book equity from Compustat annual files. Following Davis, Fama, and French (2000), we measure annual book equity as stockholders' book equity, plus balance sheet deferred taxes and investment tax credit (Compustat annual item TXDITC) if available, minus the book value of preferred stock. Stockholders' equity is the value reported by Compustat (item SEQ), if available. If not, stockholders' equity is the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTK), or the book value of assets (item AT) minus total liabilities (item LT). Depending on availability, we use redemption (item PSTKRV), liquidating (item PSTKL), or par value (item PSTK) for the book value of preferred stock.

If both approaches are unavailable, we apply the clean surplus relation to impute the book equity. First, if available, we backward impute the beginning-of-quarter book equity as the end-of-quarter book equity minus quarterly earnings plus quarterly dividends. Quarterly earnings are income before extraordinary items (Compustat quarterly item IBQ). Quarterly dividends are zero if dividends per share (item DVPSXQ) are zero. Otherwise, total dividends are dividends per share times beginning-of-quarter shares outstanding adjusted for stock splits during the quarter. Shares outstanding are from Compustat (quarterly item CSHOQ supplemented with annual item CSHO for fiscal quarter four) or CRSP (item SHROUT), and the share adjustment factor is from Compustat (quarterly item AJEXQ supplemented with annual item AJEX for fiscal quarter four) or CRSP (item CFACSHR). Because we impose a four-month lag between earnings and the holding period month (and the book equity in the denominator of ROE is one-quarter-lagged relative to earnings), all the Compustat data in the backward imputation are at least four-month lagged prior to the portfolio formation. If data are unavailable for the backward imputation, we impute the book equity for quarter t forward based on book equity from prior quarters. Let BEQ_{t-j}, $1 \leq j \leq 4$ denote the latest available quarterly book equity as of quarter t, and $\text{IBQ}_{t-j+1,t}$ and $\text{DVQ}_{t-j+1,t}$ be the sum of quarterly earnings and quarterly dividends from quarter $t-j+1$ to t, respectively. BEQ_t can then be imputed as $\text{BEQ}_{t-j} + \text{IBQ}_{t-j+1,t} - \text{DVQ}_{t-j+1,t}$. We do not use prior book equity from more than four quarters ago (i.e., $1 \leq j \leq 4$) to reduce imputation errors.

Before 1972, for each month t we use the most recent Roe computed with quarterly earnings from fiscal quarters ending at least four months prior to month t. Starting from 1972, we use Roe computed with quarterly earnings from the most recent quarterly earnings announcement dates (Compustat quarterly item RDQ). We require the end of the fiscal quarter that corresponds to its most recent Roe to be within six months prior to month t. This restriction is imposed to exclude stale earnings information. To avoid potentially erroneous records, we also require the earnings announcement date to be after the corresponding fiscal quarter end.

log(Bm), log book-to-market equity. At the end of June of each year t, we measure Bm as the book equity for the fiscal year ending in calendar year $t-1$ divided by the market equity (from CRSP) at the end of December of $t-1$. For firms with more than one share class, we merge the market equity for all share classes before computing Bm. Following Davis, Fama, and French (2000), we measure book equity as stockholders' book equity, plus balance sheet deferred taxes and investment tax credit (Compustat annual item TXDITC) if available, minus the book value of preferred stock. Stockholders' equity is the value reported by Compustat (item SEQ), if it is available. If not, we measure stockholders' equity as the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTK), or the book value of assets (item AT) minus total liabilities (item LT). Depending on availability, we use redemption (item PSTKRV), liquidating (item PSTKL), or par value (item PSTK) for the book value of preferred stock.

I/A, investment-to-assets. At the end of June of each year t, we measure I/A as total assets

(Compustat annual item AT) for the fiscal year ending in calendar year $t-1$ divided by total assets for the fiscal year ending in $t-2$ minus one.

Oa, operating accruals. Prior to 1988, we use the balance sheet approach in Sloan (1996) to measure Oa as changes in noncash working capital minus depreciation, in which the noncash working capital is changes in noncash current assets minus changes in current liabilities less short-term debt and taxes payable. In particular, Oa equals (dCA – dCASH) – (dCL – dSTD – dTP) – DP, in which dCA is the change in current assets (Compustat annual item ACT), dCASH is the change in cash or cash equivalents (item CHE), dCL is the change in current liabilities (item LCT), dSTD is the change in debt included in current liabilities (item DLC), dTP is the change in income taxes payable (item TXP), and DP is depreciation and amortization (item DP). Missing changes in income taxes payable are set to zero. Starting from 1988, we follow Hribar and Collins (2002) to measure Oa using the statement of cash flows as net income (item NI) minus net cash flow from operations (item OANCF). Doing so helps mitigate measurement errors that can arise from nonoperating activities such as acquisitions and divestitures. Data from the statement of cash flows are only available since 1988. At the end of June of each year t, we scale Oa for the fiscal year ending in calendar year $t-1$ by total assets (item AT) for the fiscal year ending in $t-2$.

Rdm, R&D expense-to-market. At the end of June of each year t, we calculate Rdm as R&D expenses (Compustat annual item XRD) for the fiscal year ending in calendar year $t-1$ divided by the market equity (from CRSP) at the end of December of $t-1$. For firms with more than one share class, we merge the market equity for all share classes before computing Rdm. We keep only firms with positive R&D expenses. Because the accounting treatment of R&D expenses was standardized in 1975, the Rdm sample starts in July 1976.

log(Me), market equity. Me is price per share times shares outstanding from CRSP.

Ep, earnings-to-price. At the end of June of each year t, we measure Ep as income before extraordinary items (Compustat annual item IB) for the fiscal year ending in calendar year $t-1$ divided by the market equity (from CRSP) at the end of December of $t-1$. For firms with more than one share class, we merge the market equity for all share classes before computing Ep. Firms with non-positive earnings are excluded.

Cop, cash-based operating profitability. Following Ball, Gerakos, Linnainmaa, and Nikolaev (2016), we measure Cop as total revenue (Compustat annual item REVT) minus cost of goods sold (item COGS), minus selling, general, and administrative expenses (item XSGA), plus research and development expenditures (item XRD, zero if missing), minus change in accounts receivable (item RECT), minus change in inventory (item INVT), minus change in prepaid expenses (item XPP), plus change in deferred revenue (item DRC plus item DRLT), plus change in trade accounts payable (item AP), and plus change in accrued expenses (item XACC), all scaled by book assets (item AT, the denominator is current, not lagged, total assets). All changes are annual changes in balance sheet items and we set missing changes to zero. At the end of June of each year t, we calculate Cop for the fiscal year ending in calendar year $t-1$.

Abr, cumulative abnormal returns around earnings announcement dates. We calculate Abr around the latest quarterly earnings announcement date (Compustat quarterly item RDQ) (Chan, Jegadeesh, and Lakonishok 1996)) as:

$$\text{Abr}_i = \sum_{d=-2}^{+1} r_{id} - r_{md}, \tag{B1}$$

in which r_{id} is stock i's return on day d (with the earnings announced on day 0) and r_{md} is the market index return. We cumulate returns until one (trading) day after the announcement date to account for the one-day-delayed reaction to earnings news. r_{md} is the value-weighted market return for the Abr deciles with NYSE breakpoints and value-weighted returns.

For a firm to enter our sample at the beginning of month t, we require the end of the fiscal quarter that corresponds to its most recent Abr to be within six months prior to month t. We do so to exclude stale information on earnings. To avoid potentially erroneous records, we also require the earnings announcement date to be after the corresponding fiscal quarter end. Because quarterly earnings announcement dates are largely unavailable before 1972, the Abr sample starts in January 1972.

Ilr, industry lead-lag effect in prior returns. We start with the Fama-French (1997) 49-industry classifications. Excluding financial firms from the sample leaves 45 industries. Following Hou (2007), at the beginning of each month t, we calculate Ilr as the month $t-1$ value-weighted return of the portfolio consisting of the 30% biggest (market equity) firms within a given industry.

Nop, net payout yield. Per Boudoukh, Michaely, Richardson, and Roberts (2007), total payouts are dividends on common stock (Compustat annual item DVC) plus repurchases. Repurchases are the total expenditure on the purchase of common and preferred stocks (item PRSTKC) plus any reduction (negative change over the prior year) in the value of the net number of preferred stocks outstanding (item PSTKRV). Net payouts equal total payouts minus equity issuances, which are the sale of common and preferred stock (item SSTK) minus any increase (positive change over the prior year) in the value of the net number of preferred stocks outstanding (item PSTKRV). At the end of June of each year t, we measure Nop for the fiscal year ending in calendar year $t-1$ divided by the market equity (from CRSP) at the end of December of $t-1$. For firms with more than one share class, we merge the market equity for all share classes. Firms with zero net payouts are excluded. Because the data on total expenditure and the sale of common and preferred stocks start in 1971, the Nop sample starts in July 1972.

Dac, discretionary accruals. We measure Dac using the modified Jones model from Dechow, Sloan, and Sweeney (1995):

$$\frac{\mathrm{Oa}_{i,t}}{\mathrm{A}_{i,t-1}} = \alpha_1 \frac{1}{\mathrm{A}_{i,t-1}} + \alpha_2 \frac{\mathrm{dSALE}_{i,t} - \mathrm{dREC}_{i,t}}{\mathrm{A}_{i,t-1}} + \alpha_3 \frac{\mathrm{PPE}_{i,t}}{\mathrm{A}_{i,t-1}} + e_{i,t}, \tag{B2}$$

in which $\mathrm{Oa}_{i,t}$ is operating accruals for firm i, A_{t-1} is total assets (Compustat annual item AT) at the end of year $t-1$, $\mathrm{dSALE}_{i,t}$ is the annual change in sales (item SALE) from year $t-1$ to t, $\mathrm{dREC}_{i,t}$ is the annual change in net receivables (item RECT) from year $t-1$ to t, and $\mathrm{PPE}_{i,t}$ is gross property, plant, and equipment (item PPEGT) at the end of year t. We estimate the cross-sectional regression (B2) for each two-digit SIC industry and year combination, formed separately for NYSE/AMEX firms and for NASDAQ firms. We require at least six firms for each regression. The discretionary accrual for stock i is defined as the residual from the regression, $e_{i,t}$. At the end of June of each year t, we calculate Dac for the fiscal year ending in calendar year $t-1$.

Nsi, net stock issues. At the end of June of year t, we measure net stock issues, Nsi, as the natural log of the ratio of the split-adjusted shares outstanding at the fiscal year ending in calendar year $t-1$ to the split-adjusted shares outstanding at the fiscal year ending in $t-2$. The split-adjusted shares outstanding is shares outstanding (Compustat annual item CSHO) times the adjustment factor (item AJEX).

$\triangle I/A^q_\tau$, $\tau = 1, 2, 3, 4, 8, 12$*, quarterly changes in investment-to-assets.* For each month t, we measure $\triangle \mathrm{I/A}^q_\tau$ as the one-quarter asset growth for the τth quarter in the future and the one-quarter asset growth for the latest fiscal quarter ending at least four months ago. Quarterly asset growth (investment-to-assets) quarterly total assets (Compustat quarterly item ATQ) divided by one-quarter-lagged total assets minus one.

C Estimating the Implied Cost of Capital

C.1 The Gebhardt, Lee, and Swaminathan (2001) Procedure

We measure current book equity, Be_t, using the latest accounting data from the fiscal year ending between March of year $t-1$ to February of t. This practice implies that for the IRR estimates at the end of June in t, we impose at least a four-month lag to ensure that the accounting information is released to the public. The definition of book equity follows Davis, Fama, and French (2000). We apply clean surplus accounting to construct future book equity as $Be_{t+\tau} = Be_{t+\tau-1} + Be_{t+\tau-1}E_t[\mathrm{Roe}_{t+\tau}](1-k), 1 \leq \tau \leq 11$, in which k is the dividend payout ratio in year t. Dividend payout ratio is dividends (Compustat annual item DVC) divided by earnings (item IB) for profitable firms, or dividends divided by 6% of total assets (item AT) for firms with zero or negative earnings. We drop a firm if its book equity is zero or negative in any year.

We construct the expected Roe for the first three years ahead, using analyst earnings forecasts from the Institutional Brokers' Estimated System (IBES) or forecasts from cross-sectional regressions. After year $t+3$, we assume that the expected firm-level Roe mean-reverts linearly to the historical industry median Roe by year $t+12$, and becomes a perpetuity afterwards. We use the Fama-French (1997) 48 industry classification. We use at least five and up to ten years of past Roe data from non-loss firms to compute the industry median Roe.

Following GLS (2001), we implement the GLS model on a per share basis with analysts' earnings forecasts. P_t is the June-end share price from CRSP. Be_t is book equity per share calculated as book equity divided by the number of shares outstanding reported in June from IBES (unadjusted file, item SHOUT). When IBES shares are not available, we use shares from CRSP (daily item SHROUT) on the IBES pricing date (item PRDAYS) that corresponds to the IBES report.

At the end of June in each year t, we construct the expected ROE for year $t+1$ to $t+3$ as $E_t[\mathrm{Roe}_{t+\tau}] = \mathrm{FEPS}_{t+\tau}/Be_{t+\tau-1}$, in which $\mathrm{FEPS}_{t+\tau}$ is the consensus mean forecast of earnings per share from IBES (unadjusted file, item MEANEST) for year $t+\tau$ (fiscal period indicator $= \tau$) reported in June of t. We require the availability of earnings forecast for years $t+1$ and $t+2$. When the forecast for year $t+3$ is not available, we use the long-term growth rate (item LTG) to compute a three-year-ahead forecast: $\mathrm{FEPS}_{t+3} = \mathrm{FEPS}_{t+2} \times (1+\mathrm{LTG})$. If the long-term growth rate is missing, we replace it with the growth rate implied by the first two forecasts: $\mathrm{FEPS}_{t+3} = \mathrm{FEPS}_{t+2} \times (\mathrm{FEPS}_{t+2}/\mathrm{FEPS}_{t+1})$, when FEPS_{t+1} and FEPS_{t+2} are both positive.

As noted, we measure current book equity Be_t based on the latest accounting data from the fiscal year ending between March of year $t-1$ and February of t. However, firms with fiscal years ending between March of t and May of t can announce their latest earnings before the IBES report in June of t. In response to earnings announcement for the current fiscal year, the analyst forecasts would "roll forward" to the next year. As such, we also need to roll forward book equity by one year for these firms to match with the updated analyst forecasts. In particular, we roll forward their book equity using clean surplus accounting as: $Be_{t-1} + Y_t - D_t$, in which Be_{t-1} is the lagged book equity (relative to the announced earnings), Y_t is the earnings announced after February of t but before the IBES report in June of t, and D_t is dividends.

In the first modified procedure, we follow Hou, van Dijk, and Zhang (2012) to estimate the IRRs at the firm level (not the per share basis), whenever regression-based earnings forecasts (not analysts' earnings forecasts) are used. We use pooled cross-sectional regressions to forecast future earnings for up to three years ahead:

$$Y_{is+\tau} = a + b_1 A_{is} + b_2 D_{is} + b_3 DD_{is} + b_4 Y_{is} + b_5 Y_{is}^{-} + b_6 AC_{is} + \epsilon_{is+\tau}, \qquad \text{(C1)}$$

for $1 \leq \tau \leq 3$, in which Y_{is} is earnings (Compustat annual item IB) of firm i for fiscal year s, A_{is} is total assets (item AT), D_{is} is dividends (item DVC), and DD_{is} is a dummy variable that equals one for dividend payers, and zero otherwise. Y_{is}^{-} is a dummy variable that equals one for negative earnings, and zero otherwise, and AC_{is} is operating accruals.

Prior to 1988, we use the balance-sheet approach of Sloan (1996) to measure operating accruals as changes in noncash working capital minus depreciation, in which the noncash working capital is changes in noncash current assets minus changes in current liabilities less short-term debt and taxes payable. In particular, $AC = (\triangle CA - \triangle CASH) - (\triangle CL - \triangle STD - \triangle TP) - DP$, in which $\triangle CA$ is the change in current assets (Compustat annual item ACT), $\triangle CASH$ is the change in cash or cash equivalents (item CHE), $\triangle CL$ is the change in current liabilities (item LCT), $\triangle STD$ is the change in debt included in current liabilities (item DLC, zero if missing), $\triangle TP$ is the change in income taxes payable (item TXP, zero if missing), and DP is depreciation and amortization (item DP, zero if missing). Starting from 1988, we follow Hribar and Collins (2002) to measure AC using the statement of cash flows as net income (item NI) minus net cash flow from operations (item OANCF).

In equation (C1), regressors with time subscript s are from the fiscal year ending between March of year s and February of $s+1$. Following Hou, van Dijk, and Zhang (2012), we winsorize all the level variables in equation (C1) at the 1st and 99th percentiles of their cross-sectional distributions each year. In June of each year t, we estimate the regressions using the pooled panel data from the previous ten years. With a minimum four-month lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. Differing from the baseline GLS procedure, we forecast the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t-1$ and February of t.

In the second modified procedure, we use annual cross-sectional regressions per Tang, Wu, and Zhang (2014) to forecast the future ROE for up to three years, $\text{Roe}_{is+\tau} \equiv Y_{is+\tau}/Be_{is+\tau-1}$:

$$\text{Roe}_{is+\tau} = a + b_1 \log\left(\frac{Be_{is}}{P_{is}}\right) + b_2 \log(P_{is}) + b_3 Y_{is}^{-} + b_4 \text{Roe}_{is} + b_5 \frac{A_{is} - A_{is-1}}{A_{is-1}} + \epsilon_{is+\tau}, \qquad \text{(C2)}$$

for $1 \leq \tau \leq 3$, in which Roe_{is} is return on equity of firm i for fiscal year s, Y_{is} is earnings (Compustat annual item IB), Be_{is} is the book equity, P_{is} is the market equity at the fiscal year end from Compustat or CRSP, Y_{is}^{-} is a dummy variable that equals one for negative earnings and zero otherwise, and A_{is} is total assets (item AT). Regression variables with time subscript s are from the fiscal year ending between March of year s and February of $s+1$. Extremely small firms tend to have extreme regression variables which can affect the Roe regression estimates significantly. To alleviate this problem, we exclude firm-years with total assets less than \$5 million or book equity less than \$2.5 million. Fama and French (2006, p. 496) require firms to have at least \$25 million total assets and \$12.5 million book equity, but state that their results are robust to using the \$5 million total assets and \$2.5 million book equity cutoff. We choose the less restrictive cutoff to enlarge the sample coverage. We also winsorize each variable (except for Y_{it}^{-}) at the 1st and 99th percentiles of its cross-sectional distribution each year to further alleviate the impact of outliers.

In June of each year t, we run the regression (C2) using the previous ten years of data. With a minimum four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. Differing from the baseline GLS procedure, we directly forecast the expected Roe, $E_t[\text{Roe}_{t+\tau}]$, as the average cross-sectional regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. We implement this modified GLS procedure at the firm level.

C.2 The Easton (2004) Procedure

Expected earnings are based on analyst forecasts from IBES or forecasts from regression models. Expected dividends are expected earnings times the current dividend payout ratio, which is computed as dividends (Compustat annual item DVC) divided by earnings (item IB) for profitable firms, or dividends divided by 6% of total assets (item AT) for firms with zero or negative earnings. When equation (15) has two positive roots (in very few cases), we use the average as the IRR estimate.

Following Easton (2004), we implement the model on the per share basis with analysts' earnings forecasts. We measure P_t as the June-end share price from CRSP. At the end of June in year t, the expected earnings per share for year $t+\tau$ is the consensus mean forecast from IBES (unadjusted file, item MEANEST) for year $t+\tau$ (fiscal period indicator = τ) reported in June of t.

Instead of analysts' earnings forecasts, we also use pooled cross-sectional regressions in equation (C1) to forecast future earnings for up to two years ahead. In June of each year t, we estimate the regression using the pooled panel data from the previous ten years. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We construct the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t-1$ and February of t. We implement the modified procedure at the firm level.

Finally, we also use annual cross-sectional regressions in equation (C2) to forecast future ROE for up to two years ahead. In June of each year t, we estimate the regression using the previous ten years of data. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We forecast the expected Roe, $E_t[\text{Roe}_{t+\tau}]$, as the average regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. Expected earnings are then constructed as: $E_t[Y_{t+\tau}] = E_t[Roe_{t+\tau}] \times Be_{t+\tau-1}$, in which $Be_{t+\tau-1}$ is the book equity in year $t+\tau-1$. We measure current book equity Be_t based on the latest accounting data from the fiscal year ending in March of $t-1$ to February of t, and impute future book equity by applying clean surplus accounting recursively. We implement the modified procedure at the firm level.

C.3 The Claus and Thomas (2001) Procedure

We measure book equity, Be_t, using the latest accounting data from the fiscal year ending between March of year $t-1$ and February of t. The definition of book equity follows Davis, Fama, and French (2000). We apply clean surplus accounting to construct future book equity as $Be_{t+\tau} = Be_{t+\tau-1} + Be_{t+\tau-1}E_t[\text{Roe}_{t+\tau}](1-k), 1 \leq \tau \leq 4$, in which k is the dividend payout ratio in year t. Dividend payout ratio is dividends (Compustat annual item DVC) divided by earnings (item IB) for profitable firms, or dividends divided by 6% of total assets (item AT) for firms with zero or negative earnings. We drop a firm if its book equity is zero or negative in any year. We construct the expected Roe, $E_t[\text{Roe}_{t+\tau}]$, for up to five years ahead, using analysts' earnings forecasts from IBES or regression-based forecasts. Following CT (2001), we set g to the ten-year Treasury bond rate minus 3%.

Following CT (2001), we implement the CT model on the per share basis when using analysts' earnings forecasts. We measure P_t as the June-end share price from CRSP. Book equity per share, B_t, is book equity divided by the number of shares outstanding reported in June from IBES (unadjusted file, item SHOUT). When IBES shares are not available, we use shares from CRSP (daily item SHROUT) on the IBES pricing date (item PRDAYS) that corresponds to the IBES report. As noted, current book equity B_t is based on the latest accounting data from the fiscal year ending between March of $t-1$ and February of t. However, firms with fiscal year ending in March of t to May of t can announce their latest earnings before the IBES report in June of t. To match the updated analyst forecasts, we roll forward their book equity using clean surplus accounting as: $B_{t-1}+Y_t-D_t$, in which B_{t-1} is the lagged book equity (relative to the announced earnings), Y_t is the earnings announced after February of t but before the IBES report in June of t, and D_t is dividends.

At the end of June in each year t, we construct the expected Roe for year $t+1$ to $t+5$ as $E_t[\text{Roe}_{t+\tau}] = \text{FEPS}_{t+\tau}/Be_{t+\tau-1}$, in which $\text{FEPS}_{t+\tau}$ is the consensus mean forecast of earnings per share from IBES (unadjusted file, item MEANEST) for year $t+\tau$ (fiscal period indicator $=\tau$) reported in June of t. We require the availability of earnings forecast for years $t+1$ and $t+2$. When the forecast after year $t+2$ is not available, we use the long-term growth rate (item LTG) to construct it as $\text{FEPS}_{t+\tau} = \text{FEPS}_{t+\tau-1} \times (1+\text{LTG})$. If the long-term growth rate is missing, we replace it with the growth rate implied by the forecasts for the previous two years: $\text{FEPS}_{t+\tau} = \text{FEPS}_{t+\tau-1} \times (\text{FEPS}_{t+\tau-1}/\text{FEPS}_{t+\tau-2})$, when $\text{FEPS}_{t+\tau-2}$ and $\text{FEPS}_{t+\tau-1}$ are both positive.

Instead of analysts' earnings forecasts, we also use pooled cross-sectional regressions in equation (C1) to forecast future earnings for up to five years ahead. In June of each year t, we estimate the regression using the pooled panel data from the previous ten years. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We forecast the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t-1$ and February of t. We implement this modified CT procedure at the firm level. Finally, we also use annual cross-sectional regressions in equation (C2) to forecast future Roe for up to five years ahead. In June of each year t, we estimate the regression using the previous ten years of data. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We directly forecast the expected Roe, $E_t[\text{Roe}_{t+\tau}]$, as the average cross-sectional regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. We implement the modified CT procedure at the firm level.

C.4 The Ohlson and Juettner-Nauroth (2005) Procedure

Expected earnings are based on analyst forecasts from IBES or forecasts from regression models. Expected dividends are expected earnings times the current dividend payout ratio, which is computed as dividends (Compustat annual item DVC) divided by earnings (item IB) for profitable firms, or dividends divided by 6% of total assets (item AT) for firms with zero or negative earnings. We follow Gode and Mohanram (2003) and use the average of forecasted near-term growth rate and five-year growth rate as an estimate of g. We require $E_t[Y_{t+2}]$ and $E_t[Y_{t+4}]$ to be positive so that g is well defined. Following Gode and Mohanram (2003), we implement the OJ model on the per share basis with analysts' earnings forecasts. We measure P_t as the June-end share price from CRSP. At the end of June in year t, the expected earnings per share for year $t+\tau$ is the consensus mean forecast from IBES (unadjusted file, item MEANEST) for year $t+\tau$ (fiscal period indicator $=\tau$) reported in June of t. We require the availability of earnings forecast for years $t+1$ and $t+2$.

When the forecast after year $t+2$ is not available, we use the long-term growth rate (item LTG) to construct it as: $\text{FEPS}_{t+\tau} = \text{FEPS}_{t+\tau-1} \times (1 + \text{LTG})$. If the long-term growth rate is missing, we replace it with the growth rate implied by the forecasts for the previous two years: $\text{FEPS}_{t+\tau} = \text{FEPS}_{t+\tau-1} \times (\text{FEPS}_{t+\tau-1}/\text{FEPS}_{t+\tau-2})$, when $\text{FEPS}_{t+\tau-2}$ and $\text{FEPS}_{t+\tau-1}$ are both positive.

Instead of analysts' earnings forecasts, we also use pooled cross-sectional regressions in equation (C1) to forecast future earnings for up to five years ahead. In June of each year t, we estimate the regression using the pooled panel data from the previous ten years. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We construct the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t-1$ and February of t. We implement the modified OJ procedure at the firm level.

We also use annual cross-sectional regressions in equation (C2) to forecast future Roe for up to five years ahead. In June of each year t, we estimate the regression using the previous ten years of data. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We forecast the expected Roe, $E_t[\text{Roe}_{t+\tau}]$, as the average cross-sectional regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. Expected earnings are then constructed as: $E_t[Y_{t+\tau}] = E_t[\text{Roe}_{t+\tau}] \times Be_{t+\tau-1}$, in which $Be_{t+\tau-1}$ is the book equity in year $t+\tau-1$. We measure current book equity Be_t based on the latest accounting data from the fiscal year ending in March of $t-1$ to February of t, and impute future book equity by applying clean surplus accounting recursively. We implement the modified OJ procedure at the firm level.