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*, without mispricing. Expected returns vary cross-sectionally, depending on firms' investment, expected profitability, and expected investment growth. Our economic model also offers an appealing alternative to two workhorse accounting models. Empirically, many anomaly variables are associated with future investment growth, in the same direction with future returns. An expected growth factor earns on average 0.56% per month ($t = 6.66$), and adding it to the q-factor model improves the model's performance substantially. In all, value investing is consistent with efficient markets.

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1 Introduction

In their magnum opus, Graham and Dodd (1934) lay the intellectual foundation for value investing.[1] The basic philosophy is to invest in undervalued securities that are selling well below the intrinsic value. The intrinsic value is the value that can be justified by an issuing firm's fundamentals, such as earnings, dividends, assets, and other financial statement information. The underlying premise is that the intrinsic value is distinct from the market value. The academic literature on security analysis, pioneered by Ou and Penman (1989), has largely subscribed to the Graham-Dodd perspective.

This paper shows that the investment CAPM provides an economic foundation for Graham and Dodd (1934). We contribute to the value investing literature in finance and accounting in three important ways. First, we provide an economics-based framework and an efficient markets perspective for value investing. Second, we show that the investment CAPM offers an appealing alternative to two workhorse accounting models that dominate the security analysis literature. Finally, perhaps most important, we bring the expected growth to the front and center of empirical asset pricing. Augmenting the q-factor model with an expected growth factor greatly improves its performance.

The investment CAPM predicts that expected returns vary cross-sectionally, depending on firms' investment, expected profitability, and expected investment growth. The theory retains efficient markets, departing from the longstanding Graham-Dodd (1934) perspective. Efficient markets and security analysis have long been viewed as diametrically opposite, especially in the investment management industry (Buffett 1984). However, it is well known that time-varying expected returns are consistent with stock market predictability (Marsh and Merton 1986), without mispricing per Shiller (1981). Analogously, the investment CAPM implies *cross-sectionally varying* expected returns, which provide an economic foundation for security analysis, without mispricing per Barberis and Thaler (2003).[2] As such, the investment CAPM *validates* the practice of security analysis on

[1]We use the three terms, value investing, security analysis, and fundamental analysis interchangeably.

[2]Realized returns equal expected returns plus abnormal returns. As such, mechanically, cross-sectional predictability with any anomaly variable has two parallel interpretations. The first interpretation says that the anomaly variable forecasts abnormal returns, violating market efficiency, as in Graham and Dodd (1934). The second interpretation is

economic grounds, and directs analysts' attention to key expected return determinants, including investment, expected profitability, and expected investment growth.

Second, the investment CAPM offers an appealing alternative to the Preinreich (1938) and Ohlson (1995) residual income model. Frankel and Lee (1998) estimate the intrinsic value from the residual income model, show that the intrinsic-to-market value forecasts returns, and interpret the evidence as mispricing per Graham and Dodd (1934). In the investment CAPM, the *true* intrinsic value equals the market value (no mispricing). However, the economic model predicts that the *estimated* intrinsic-to-market value, which is a nonlinear function of investment, expected profitability, and expected investment growth, should forecast returns. In the data, investment-to-assets largely accounts for the forecasting power of the intrinsic-to-market value. Relatedly, the investment CAPM characterizes the one-period-ahead expected return, which, as noted, can vary cross-sectionally and over time. In contrast, the residual income model characterizes the internal rate of return, as typically implemented in the implied cost of capital literature (Claus and Thomas 2001, Gebhardt, Lee, and Swaminathan 2001), and rules out the time series predictability of returns.

Both the Penman-Reggiani-Richardson-Tuna (2017) model and the investment CAPM focus on the one-period-ahead expected return. Penman et al. use powerful accounting insights to relate the expected change in the market equity's deviation from the book equity to the expected earnings growth. In contrast, the economic relation between investment and the market value allows us to substitute, mathematically, the expected capital gain with the expected investment growth. As such, the investment CAPM seems even more "fundamental" than the Penman et al. model, which still has the market equity in their formulation. However, their accounting insights are missing from the investment CAPM, which, as typically done in economic modeling, assumes perfect accounting. These accounting insights are particularly important for empirical implementation.

Finally, perhaps most important, guided by theory, we bring the expected growth to the front and center of empirical asset pricing. Prior work has examined investment and profitability, but not

that the anomaly variable is related with expected returns, retaining market efficiency, as in the investment CAPM.

the expected investment growth. We show that many anomaly variables are correlated with future changes in investment-to-assets, in the same direction with future returns. Prominent examples include Sloan's (1996) operating accruals, Chan, Lakonishok, and Sougiannis's (2001) research and development expenses-to-market, Xie's (2001) discretionary accruals, Hirshleifer, Hou, Teoh, and Zhang's (2004) net operating assets, Richardson, Sloan, Soliman, and Tuna's (2005) change in net financial assets, Boudoukh, Michaely, Richardson, and Roberts's (2007) net payout yield, and Ball, Gerakos, Linnainmaa, and Nikolaev's (2016) operating cash flows-to-assets. These anomalies cannot be explained by the q-factor model that features the investment and profitability factors (Hou, Xue, and Zhang 2017). The evidence points to a missing factor related to the expected growth.

We build such an expected growth factor by using Tobin's q and Ball, Gerakos, Linnainmaa, and Nikolaev's (2016) cash flows to forecast future one-year-ahead changes in investment-to-assets. We motivate these two instruments from the longstanding investment literature in corporate finance and macroeconomics (Fazzari, Hubbard, and Petersen 1988, Erickson and Whited 2000). From January 1967 to December 2016, the expected growth factor earns on average 0.56% per month ($t = 6.66$) and a q-factor alpha of 0.53% ($t = 7.12$). The evidence suggests that the expected growth factor captures a new dimension of the expected return variation missed by the q-factor model.

We augment the q-factor model with the expected growth factor to form a new five-factor model (dubbed the Q5 model), and confront it with the 46 anomalies that the q-factor model cannot explain. The Q5 model improves on the q-factor model substantially. The average magnitude of the high-minus-low alphas is 0.34% per month in the Q5 model, but 0.52% in the q-factor model. The number of significant high-minus-low alphas is 19 in the Q5 model, including four with $t \geq 3$, but 46 in the q-factor model, including 17 with $t \geq 3$. The mean absolute alpha is also lower in the Q5 model, 0.12% versus 0.16%, and the number of rejections by the Gibbons, Ross, and Shanken (1989) test is also smaller, 18 versus 39. The Q5 model improves on the q-factor model across all anomaly categories, including momentum, value-versus-growth, investment, profitability, intangibles, and trading frictions, but especially in the investment and profitability categories.

The rest of the paper is organized as follows. Section 2 provides the background of security analysis to motivate our work. Section 3 presents the investment CAPM, discusses its implications on fundamental analysis, and compares it with two workhorse accounting models. Guided by our theory, Section 4 constructs the expected growth factor, and shows that adding it to the q-factor model greatly improves the model's performance. Finally, Section 5 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 is not exactly identified, 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 (Graham and Dodd 1934, p. 18, original emphasis)." How should an intelligent investor proceed? "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)." Graham and Dodd view a security's quality as important: "[L]ess money has been lost by the great body of investors through paying too high a price for securities of the best regarded enterprises than by trying to secure a larger income or profit from commitments in enterprises of lower grade (p. 31)." To be protected from the ambiguity in estimating the intrinsic value, Graham (1949, *The Intelligent Investor*) advocates the "margin of safety," an investing principle in which an investor only purchases a security when its market price is sufficiently below its intrinsic value.

In an article honoring the 50th anniversary of Graham and Dodd (1934), Buffett (1984) reports the successful performance of nine famous value investors. After arguing that 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)." "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 (p. 15)." Contrary to Buffett (1984), business schools have long taught value investing, often called fundamental analysis. In a prominent textbook, Penman (2013) adopts the Graham-Dodd premise.[3] The academic literature, launched by Ou and Penman (1989), has also subscribed to the Graham-Dodd perspective.[4]

Penman (1992) points out that "[u]p to 25 years ago, fundamental analysis was the primary focus of research in investment analysis (p. 465)." However, since then "research in academia has been otherwise directed. Both traditional fundamental analysis and accounting measurement theory have been judged as ad hoc and lacking the theoretical foundations required of rigorous economic analysis. 'Modern Finance' established those foundations but has not brought the theory to the question of fundamental analysis (p. 465)." The investment CAPM fills this glaring gap.[5]

The expected growth is a critical, but arguably the most speculative part of security analysis. "It is natural and proper to prefer a business which is large and well managed, has a good record,

[3] "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 (Penman 2013, p. 210, original emphasis)."

[4] "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, 1989, p. 296)."

[5] In a survey of value investing from the mispricing perspective, Lee and So (2015) warn that "none of these [behavioral] studies will provide a clean one-to-one mapping between the investor psychology literature and specific market anomalies. Rather, their goal is to simply set out the experimental evidence from psychology, sociology, and anthropology. The hope is that, thus armed, financial economists would be more attuned to, and more readily recognize, certain market phenomena as manifestations of these enduring human foibles (p. 69)." In contrast, the investment CAPM provides a detailed description on how the expected return is connected to specific anomaly variables.

and is expected to show increasing earnings in the future. But these expectations, though seemingly well-founded, often fail to be realized (Graham and Dodd 1934, p. 32)." Greenwald, Kahn, Sonkin, and van Biema (2001) echo: "[G]rowth is the most difficult to estimate, especially if we are trying to project it for a long period into the future. Uncertainty regarding future growth is usually the main reason why value estimations based on present value calculations are so prone to error. By isolating this element, we can keep it from infecting the more reliable information incorporated into the asset and earnings power valuations (p. 42)." Guided by our theory, we bring the expected investment growth to the front and center of empirical asset pricing.

3 The Investment CAPM

We set up the economic model in Section 3.1, and discuss its implications in Section 3.2. We compare the investment CAPM with the residual income model in Section 3.3 and with the Penman-Reggiani-Richardson-Tuna (2017) model in Section 3.4.

3.1 The Economic Model

Consider a dynamic stochastic general equilibrium model. Time is discrete and the horizon infinite. The economy is populated by a representative household and heterogeneous firms, indexed by $i = 1, 2, \ldots, N$. The household 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 household'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, $\beta_{it}^M \equiv -\text{Cov}(r_{it+1}^S, M_{t+1})/\text{Var}(M_{t+1})$ the consumption beta, and $\lambda_{Mt} \equiv \text{Var}(M_{t+1})/E_t[M_{t+1}]$ the price of the consumption risk. Equation (2) is the consumption CAPM, with the classic CAPM being a special case.

In the production side, 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} return on assets or profitability. The next period profitability, X_{it+1}, is stochastic, and is subject to a vector of exogenous aggregate and firm-specific shocks.

Let I_{it} denote investment and δ the depreciation rate of assets, then $A_{it+1} = I_{it} + (1-\delta)A_{it}$. Firms incur costs to install new capital or uninstall existing capital. We assume quadratic adjustment costs, $\Phi_{it} \equiv \Phi(I_{it}, A_{it}) = (a/2)(I_{it}/A_{it})^2 A_{it}$, in which $a > 0$ is a constant parameter. This functional form satisfies constant returns to scale, i.e., $\Phi_{it} = I_{it}\partial\Phi_{it}/\partial I_{it} + A_{it}\partial\Phi_{it}/\partial A_{it}$.

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 cost of debt on B_{it}, r_{it}^B, can vary across firms and over time. Taxable corporate profits equal operating profits less capital depreciation, adjustment costs, and interest expenses, $X_{it}A_{it} - \delta A_{it} - \Phi(I_{it}, A_{it}) - (r_{it}^B - 1)B_{it}$, in which adjustment costs are expensed. Let τ be the corporate tax rate. The net payout of firm i equals

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

in which $\tau\delta A_{it}$ is the depreciation tax shield, and $\tau(r_{it}^B - 1)B_{it}$ 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}. Firm i chooses optimal streams of investment, $\{I_{it+s}\}_{s=0}^{\infty}$, and new debt, $\{B_{it+s+1}\}_{s=0}^{\infty}$, to maximize the cum-dividend market equity, $V_{it} \equiv E_t \left[\sum_{s=0}^{\infty} M_{t+s} D_{it+s}\right]$, subject to a transversality condition that prevents the firm from borrowing an infinite amount to distribute to shareholders, $\lim_{T\to\infty} E_t \left[M_{t+T}\, B_{it+T+1}\right] = 0$. From equation (3), net dividends, D_{it}, are determined as a residual after investment, I_{it}, is set. As such, it is the investment policy that determines the market equity, retaining the Miller-Modigliani (1961) dividend irrelevance property.

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

$$r^I_{it+1} \equiv \frac{(1-\tau)\left[X_{it+1} + \frac{a}{2}\left(\frac{I_{it+1}}{A_{it+1}}\right)^2\right] + \tau\delta + (1-\delta)\left[1 + (1-\tau)a\left(\frac{I_{it+1}}{A_{it+1}}\right)\right]}{1 + (1-\tau)a\left(\frac{I_{it}}{A_{it}}\right)}. \tag{4}$$

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. In the numerator of the investment return, $(1-\tau)X_{it+1}$ 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.

Let the after-tax cost of debt 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. The investment return is the weighted average of the stock return and the after-tax cost of debt (Appendix A):

$$r^I_{it+1} = w_{it}\, r^{Ba}_{it+1} + (1 - w_{it})\, r^S_{it+1}, \tag{5}$$

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

Together, equations (4) and (5) 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 real investment provides an economic foundation for the weighted average cost of capital approach to capital budgeting prescribed in the Modigliani-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 (5) yields the investment CAPM:

$$r^S_{it+1} = r^I_{it+1} + \frac{w_{it}}{1 - w_{it}} \left(r^I_{it+1} - r^{Ba}_{it+1} \right), \tag{6}$$

in which $w_{it}/(1 - w_{it}) = B_{it+1}/P_{it}$ is debt-to-equity. Equations (5) and (6) express the stock return in terms of accounting variables. This expression is appealing because anomalies are relations between firm characteristics and average returns that are long missing from the consumption CAPM.

3.2 Implications for Security Analaysis

The investment CAPM predicts *cross-sectionally varying* expected returns, which depend on firms' investment, expected profitability, and expected investment growth.

3.2.1 Investment and Profitability

In a two-period model with no taxes, no debt, and full depreciation, equation (6) collapses to:

$$E_t[r^S_{it+1}] = \frac{E_t[X_{it+1}]}{1 + a\,(I_{it}/A_{it})}. \tag{7}$$

Ceteris paribus, low investment stocks and high expected profitability stocks should earn higher expected returns than high investment stocks and low expected profitability stocks, respectively. Intuitively, given expected profitability, high costs of capital imply low net present values of new projects and low investment. In addition, given investment, high expected profitability implies high discount rates, which are necessary to offset the high expected profitability to induce low net present values of new projects to keep investment constant (Hou, Xue, and Zhang 2015).

3.2.2 The Expected Investment-to-assets Growth

More generally, equation (4) says that in addition to investment-to-assets and expected profitability, the expected return is also connected to the expected investment-to-assets growth.

We can decompose the expected investment return from equation (4) into two components, the expected "dividend yield" and the expected "capital gain." The first component 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 (7), since the squared term, $(I_{it+1}/A_{it+1})^2$, is economically small. The second term, $(1-\delta)[1 + a(1-\tau)E_t[I_{it+1}/A_{it+1}]]/(1 + a(1-\tau)(I_{it}/A_{it}))$, is analogous to the expected "capital gain," which is the expected growth rate of marginal q (the market value of an extra unit of assets). With constant returns to scale, marginal q equals average q (Hayashi 1982). Although the marginal q growth involves an unobservable parameter, a, it is roughly proportional to the investment-to-assets growth, $(I_{it+1}/A_{it+1})/(I_{it}/A_{it})$ (Cochrane 1991). As such, the expected investment-to-assets growth is the third determinant of the expected return.

3.2.3 Market Leverage

With debt, equation (6) implies that the expected stock return is also positively related to the market leverage, w_{it}. A higher w_{it} implies a higher $w_{it}/(1-w_{it})$, which multiplies with the difference between the investment return, r^I_{it+1}, and the after-tax corporate bond return, r^{Ba}_{it+1}. Because r^{Ba}_{it+1} is small in magnitude relative to r^I_{it+1}, and $w_{it}/(1-w_{it}) > 0$, the relation between w_{it} and the cost of equity is positive, consistent with Modigliani and Miller (1958). Modigliani and Miller fix the investment policy, essentially treating the investment return as an exogenous parameter. With endogenous investment, higher market leverage also means lower market valuation, which, given the investment-q relation, implies lower investment-to-assets and higher investment returns. This endogenous investment mechanism reinforces the Modigliani-Miller analysis.

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 are only slightly longer, with 243 pages.

The investment CAPM also provides an economic foundation for security analysis of corporate bonds. Equation (5) implies that the after-tax cost of debt is given by:

$$r^{Ba}_{it+1} = r^{I}_{it+1} - \frac{1-w_{it}}{w_{it}}\left(r^{S}_{it+1} - r^{I}_{it+1}\right). \tag{8}$$

Since $(1-w_{it})/w_{it} > 0$, the comparative statics for the expected stock return by varying investment, profitability, and expected investment growth also apply to $E_t[r^{Ba}_{it+1}]$ in the same direction. However, these relations only subsist after holding the expected stock return constant.

The relation between the market leverage and the expected after-tax cost of debt, $E_t[r^{Ba}_{it+1}]$, tends to be positive. A higher leverage, w_{it}, or a lower $(1-w_{it})/w_{it}$, gives rise to higher $E_t[r^{Ba}_{it+1}]$, since the expected difference between the stock return and the investment return should be positive. When investment is endogenous, as noted, higher leverage gives rise to higher expected investment returns, again reinforcing the analysis with fixed investment.

3.2.5 Complementarity with the Consumption CAPM

The relation between the investment CAPM and the consumption CAPM is complementary. In equilibrium theory, the first principles of consumption and investment both hold. Consumption betas, characteristics, and expected returns are all endogenous variables determined simultaneously in equilibrium. More broadly, like any other prices in economic theory, asset prices are determined jointly by supply and demand of risky assets in equilibrium. While the consumption CAPM is derived from demand, the investment CAPM is derived from supply (Zhang 2017). As such, the investment CAPM is as fundamental as the consumption CAPM in "explaining" the expected return.

Although equivalent in theory, the investment CAPM is more tractable empirically than the consumption CAPM. 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 Comparison with the Residual Income Model

In this subsection, we compare the investment CAPM with the residual income model, which is the most dominant framework in capital markets research in accounting. Richardson, Tuna, and Wysocki (2010) use this framework to organize their influential survey on fundamental analysis.

The dividend discounting model says $P_{it} = \sum_{\tau=1}^{\infty} E[D_{it+\tau}]/(1+r_i)^{\tau}$, in which P_{it} is the market equity, D_{it} dividends, and r_i the internal rate of return (Williams 1938). The clean surplus relation says that dividends equal earnings minus the change in book equity, $D_{it+\tau} = Y_{it+\tau} - \triangle Be_{it+\tau}$, in which $Y_{it+\tau}$ is earnings, and $\triangle Be_{it+\tau} \equiv Be_{it+\tau} - Be_{it+\tau-1}$ the change in book equity. Combining the clean surplus relation with the dividend discounting model yields the residual income model:

$$P_{it} = \sum_{\tau=1}^{\infty} \frac{E[Y_{it+\tau} - \triangle Be_{it+\tau}]}{(1+r_i)^{\tau}} = \sum_{\tau=1}^{\infty} \frac{E[Y_{it+\tau} - r_i Be_{it+\tau}]}{(1+r_i)^{\tau}}, \tag{9}$$

in which the residual income is $Y_{it+\tau} - r_i Be_{it+\tau}$ (Preinreich 1938). Ohlson (1995) imposes linear autoregressive dynamics on the residual income to derive P_{it} as a linear function of the residual income as well as other non-accounting information that might affect future residual earnings.

3.3.1 Why Does the Intrinsic-to-Market Value Forecast Returns?

Frankel and Lee (1998) estimate the intrinsic value from the residual income model, and show that the intrinsic-to-market value forecasts returns. Within the Graham-Dodd (1934) paradigm, Frankel and Lee interpret the evidence as mispricing. When the market value is below the intrinsic value, buying the security earns an abnormal return, as the deviant market value eventually rises to converge to the intrinsic value. When the market value is above the intrinsic value, selling the security earns an abnormal return, as the market value ultimately falls to gravitate to the intrinsic value.

In the investment CAPM, the intrinsic value equals the market value (no mispricing). Why does the intrinsic-to-market value still forecast returns? The crux is that the intrinsic value is conceptually elusive, and its estimates inevitably come with specification errors. Empirically, the estimated intrinsic-to-market value is a nonlinear function of investment-to-assets, expected profitability, and expected investment growth, which, per the investment CAPM, should forecast returns.

We illustrate this insight using the intrinsic-to-market value ratios in Frankel and Lee (1998), who implement the two- and three-period versions of the residual income model:

$$V_t^h = Be_t + \frac{(E_t[\mathrm{Roe}_{t+1}] - r)}{(1+r)} Be_t + \frac{(E_t[\mathrm{Roe}_{t+2}] - r)}{(1+r)r} Be_{t+1} \tag{10}$$

$$V_t^f = Be_t + \frac{(E_t[\mathrm{Roe}_{t+1}] - r)}{(1+r)} Be_t + \frac{(E_t[\mathrm{Roe}_{t+2}] - r)}{(1+r)^2} Be_{t+1} + \frac{(E_t[\mathrm{Roe}_{t+3}] - r)}{(1+r)^2 r} Be_{t+2} \tag{11}$$

in which V_t^h is the historical Roe-based intrinsic value, V_t^f is the analysts' earnings forecast-based intrinsic value, and Be_t is the book equity. All Roe expectations are measured with the most recent Roe when estimating V_t^h, and with analysts' earnings forecasts when estimating V_t^f.

Frankel and Lee (1998) scale V^h and V^f with the market equity, and show that high intrinsic-to-market ratios forecast high returns. Conceptually, from equations (10) and (11), the book-to-market equity component of the intrinsic-to-market value connects to investment-to-assets via the investment-q relation, the Roe expectations to the current Roe, and the book equity dated $t+1$ and $t+2$ to the future investment growth in the investment CAPM. It is an empirical question which component is the main source of the forecasting power of the intrinsic-to-market value. We shed light on this empirical question later in Section 4.2.4, after we introduce the expected growth factor.

3.3.2 The Implied Cost of Capital

While the residual income model is primarily designed for equity valuation, a voluminous literature in finance and accounting launched by Claus and Thomas (2001), Gebhardt, Lee, and Swaminathan (2001), and Easton (2004) also applies the model to estimate the implied cost of capital by setting the market price to equal the intrinsic value.[6] If the implied cost of capital is a good proxy for the expected return, it should at least forecast realized returns. However, the evidence is mixed at best.[7]

We emphasize that the primary objective of the residual income model is valuation, as opposed to the cost of capital. In particular, almost all accounting-based valuation models assume an exogenously constant discount rate, which is in effect the internal rate of return. An exception is the theoretical work of Hughes, Liu, and Liu (2009), who impose an autoregressive process for the expected return, and show that its average can differ from the internal rate of return. However, virtually all existing estimates of the implied cost of capital are based on valuation models that impose a constant discount rate. Although the exogenous discount rate can in principle vary across firms, the models are silent about the economic relations between firm characteristics and the one-period-ahead expected return. More seriously, with a constant discount rate as a basic premise, which implies that returns are unpredictable in the time series, it is perhaps not surprising that the forecasting power of the implied cost of capital for future returns is fairly weak.[8]

We view the investment CAPM as more natural for addressing the cost of capital question. In

[6]Many applications have emerged, such as corporate disclosure (Botosan 1997, Botosan and Plumlee 2002), earnings restatement (Hribar and Jenkins 2004), legal institutions (Hail and Leuz 2006), aggregate risk-return relation (Pastor, Sinha, and Swaminathan 2008), international asset pricing (Lee, Ng, and Swaminathan 2009), default risk (Chava and Purnanandam 2010), and labor union (Chen, Kacperczyk, and Ortiz-Molina 2011).

[7]Easton and Monahan (2005) examine seven implied cost of capital measures, but find none have a positive correlation with future returns, even after controlling for potential biases of the average return as a proxy for the expected return. Guay, Kothari, and Shu (2011) also report that the implied cost of capital has little explanatory power of future returns, and attribute this difficulty to analysts being sluggish in updating their earnings forecasts. Hou, van Dijk, and Zhang (2012) report more positive results after replacing analysts' forecasts with regression-based earnings forecasts.

[8]Our insight on the weakness on the cost of capital in accounting models echoes Ohlson and Gao (2006): "We treat [the discount rate] as an unexplained and exogenous constant. Because of the lack of economics concerning the discount factor, one can usefully think of it as simply being the internal rate of return that equates [the present value of dividends] to an observed price (p. 9)." "Our approach to the discount rate can only be justified from the perspective that it reflects the state-of-the-art when it comes to equity valuation (p. 9)." "[The discount rate] in the [present value] formula should ultimately depend on the firm's opportunities and plans; i.e., the pricing that takes place in the equity market must be consistent with the firm's expected transactions and their economic consequences (p. 46)."

particular, equations (4) and (6) combine to provide a detailed description of how the one-period-ahead expected return is connected to accounting variables. Future work can implement equation (4) via structural estimation to develop a new fundamental cost of capital measure. This measure differs conceptually from the implied cost of capital. While the latter is an estimate of the internal rate of return, the former is a direct proxy for the one-period-ahead expected return.

3.3.3 Valuation

Although we focus on the cost of capital in this paper, we briefly show that the investment CAPM also gives rise to two valuation functions (Appendix A). The first valuation function is:

$$P_{it} + B_{it+1} = \left[1 + (1-\tau) a \left(\frac{I_{it}}{A_{it}}\right)\right] A_{it+1}, \tag{12}$$

which is the equivalence between marginal q and average q under constant returns to scale. 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, and can be inferred from, the costs of supplying the risky assets (Belo, Xue, and Zhang 2013). With quadratic adjustment costs, Tobin's q, or $(P_{it} + B_{it+1})/A_{it+1}$, is linear in investment-to-assets, I_{it}/A_{it}. With more general, non-quadratic adjustment costs, this relation is nonlinear. Another valuation function involves discounting:

$$P_{it} + B_{it+1} = \frac{(1-\tau)\left[X_{it+1} + \frac{a}{2}\left(\frac{I_{it+1}}{A_{it+1}}\right)^2\right] A_{it+1} + \tau\delta A_{it+1} + (1-\delta)\left[1 + (1-\tau)a\left(\frac{I_{it+1}}{A_{it+1}}\right)\right] A_{it+1}}{w_{it}\, r^{Ba}_{it+1} + (1-w_{it})\, r^{S}_{it+1}}. \tag{13}$$

Intuitively, the market value of the firm is the discounted value of the marginal benefit of assets next period discounted by the weighted average cost of capital.

On valuation, the investment CAPM differs from accounting-based models in at least two aspects. First, only variables dated $t+1$ (and no variables dated $t+2$ or later) appear in the numerator of equation (13). This "striking" result is in fact well known in economic theory. Technically, the Bellman principle of optimality allows one to reformulate an infinite-period economic model into a seemingly two-period model (Bellman 1957). Intuitively, forward-looking in nature, investment-to-assets, I_{it+1}/A_{it+1}, summarizes all the necessary information contained in cash flows in all subsequent periods. In fact, this forward-looking property of investment also gives rise to the first valuation function, equation (12), with right-hand side variables all known at time t.

Second, the investment policy plays essentially no role in accounting-based valuation models. The linear dynamics of the residual earnings are exogenously imposed in Ohlson (1995). The linear dynamics ignore the role of growth and abandonment options, which can give rise to nonlinear dynamics (Zhang 2000, Biddle, Chen, and Zhang 2001). In contrast, the investment policy plays a central role in the investment CAPM, which is a restatement of the first principle of real investment. In particular, since investment-to-assets increases with profitability, equation (13) implies that the relation between equity valuation and profitability is convex, echoing the real options model of Zhang (2000). However, while Zhang and Biddle et al. use a stylized three-period framework, we build on an infinite-horizon investment model, which is more general.

3.4 Complementarity with the Penman-Reggiani-Richardson-Tuna (2017, PRRT) Model

3.4.1 The PPRT 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:

$$E_t[r^S_{it+1}] = E_t\left[\frac{P_{it+1} + D_{it+1} - P_{it}}{P_{it}}\right] = \frac{E_t[Y_{it+1}]}{P_{it}} + E_t\left[\frac{(P_{it+1} - Be_{it+1}) - (P_{it} - Be_{it})}{P_{it}}\right]. \quad (14)$$

PRRT argue that the expected change in the market-minus-book equity (the market equity's 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 special cases. First, in the mark-to-market accounting case, the market equity equals the book equity, equation (14) 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.

Penman and Zhu (2014) 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 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 the expected return. Penman and Zhang (2015) emphasize accounting conservatism, which means that assets are not booked when earnings from investments such as research and developement 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.

3.4.2 Complementarity between Economics and Accounting

The PRRT model and the investment CAPM share many commonalities. Both models focus on the determinants of the one-period-ahead expected return, unlike the implied cost of capital literature based on the residual income model. Both PRRT model and the investment CAPM 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 in terms of the underlying reasoning and the specific determinants of the expected return in empirical implementation.

Equation (14) 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 (6) 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 (4) 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.

Relatedly, 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 a nonlinear function that is roughly proportional to the expected investment-to-assets growth.

The two models also differ in the specific determinants for the expected return in empirical work. PRRT focus on 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 focuses on investment-to-assets, which is in the denominator of equation (4), and profitability, which serves as a proxy for the expected profitability, as well as the expected investment growth. In particular, 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. Empirically, the q-factor model explains the book-to-market and earnings yield effects, with the investment factor being the main source of the explanatory power (Hou, Xue, and Zhang 2015, Tables 4 and 6).

Penman and Zhu (2016) emphasize that factor models do not fare well in out-of-sample forecasts of returns, echoing Fama and French (1997), and that cross-sectional forecasts from regressing future returns on firm characteristics perform better. However, this evidence is consistent with the investment CAPM. First, the main purpose of factor models is not to predict returns per se, but to facilitate "risk" (common variation) management. A typical application is to use factor models to check if a new anomaly survives the controls of existing factors. More important, dimension reduction via factor models is immensely important for practical portfolio optimization in terms of facilitating the estimation of the covariance matrix of tradable assets (Bodie, Kane, and Marcus 2014, Section 8.2).

Second, the investment CAPM justifies the approach of using characteristics to estimate the cost of capital in cross-sectional regressions. The q-factor and Q5 models are linear factor approximations to the nonlinear cost of capital in equation (4). Alternatively, one can directly regress future returns on investment-to-assets, return on equity, and accounting variables that forecast growth to estimate the cost of capital (Green, Hand, and Zhang 2017). Such cross-sectional regressions can also be interpreted as linear approximations to the nonlinear equation (4).

Finally, while the investment CAPM has more appealing properties on economic grounds, it should be emphasized that the economic model assumes perfect accounting, which does not exist in reality. In particular, profitability, X_{it}, is economic profitability, which does not capture any negative impact of accruals (or earnings management). Also, investment includes all investing activities that increase future earnings, such as research and developement, advertising, and employee training. As such, the powerful accounting insights of Penman and Reggiani (2013), Penman and

Zhu (2014, 2016), Penman and Zhang (2015), PRRT, as well as Ball, Gerakos, Linnainmaa, and Nikolaev (2015, 2016) are all missing from the investment CAPM. These insights are especially important for our empirical implementation. In fact, our attempt to improve the q-factor model with the expected growth factor in Section 4 is partially motivated by these accounting insights. As such, we view these accounting studies and the investment CAPM as largely complementary.

4 Empirical Analysis on the Expected Growth

The q-factor model features the investment and profitability factors, but not an expected growth factor. Although performing well, it still leaves 46 anomalies unexplained (Hou, Xue, and Zhang 2017). Motivated by the investment CAPM, we add an expected growth factor into the q-factor model. In Section 4.1, we construct cross-sectional forecasts of investment-to-assets growth. In Section 4.2, we construct the expected growth factor. Finally, in Section 4.3, we show that adding the expected growth factor improves the q-factor model's performance substantially.

4.1 Cross-sectional Forecasts of Investment-to-assets Growth

A technical challenge in forecasting investment-to-assets growth is that investment-to-assets can be frequently negative at the firm level, making the growth rate ill-defined. As such, we forecast future investment-to-assets changes. Our forecasting framework is annual Fama-MacBeth (1973) cross-sectional predictive regressions. At the end of June of each year t, we measure investment-to-assets from the fiscal year ending in calendar year $t-1$ as total assets (Compustat annual item AT) from the fiscal year ending in $t-1$ minus total assets from the fiscal year ending in $t-2$, scaled by total assets from the fiscal year ending in $t-2$. The left-hand side variables in the cross-sectional regressions are investment-to-assets changes, denoted $\mathrm{d}^{\tau}\mathrm{I/A}$, in which $\tau = 1, 2$, and 3. We measure $\mathrm{d}^{\tau}\mathrm{I/A}$ as investment-to-assets from the fiscal year ending in calendar year $t+\tau-1$ minus investment-to-assets from the fiscal year ending in year $t-1$. The sample is from 1961 to 2016.

4.1.1 Motivating Predictors from A Priori Conceptual Arguments

What variables should one use to forecast investment-to-assets changes? To this end, we turn to the investment literature in corporate finance and macroeconomics for conceptual guidance.

Keynes (1936) and Tobin (1969) argue intuitively that a firm should invest if the ratio of its market valuation to the replacement costs of its capital stock (Tobin's q or average q) exceeds one. Providing the neoclassical formulation of the q-theory of investment, Lucas and Prescott (1971) and Mussa (1977) show that optimal investment requires the marginal cost of investment to be equal to the shadow value of capital (marginal q), which is the present value of future cash flows generated by an additional unit of new capital. With quadratic adjustment costs, the first-order condition with respect to investment can be rewritten as a linear regression of investment-to-assets on marginal q. Although marginal q is unobservable, as noted, Hayashi (1982) shows that under constant returns to scale, marginal q equals average q, which is observable.

Although marginal q should theoretically summarize the impact of all other variables on investment, firms' internal cash flows typically have economically large and statistically significant slopes once included in the investment-q regression. For example, Fazzari, Hubbard, and Petersen (1988) and Gilchrist and Himmelberg (1995) show that the cash flow effect on investment is especially strong for firms that are more financially constrained. However, the economic interpretation of the cash flow effect is controversial. Empirically, Erickson and Whited (2000) use measurement error-consistent generalized method of moments, and find that cash flows do not matter in the investment-q regression, even for financially constrained firms. Erickson and Whited interpret the investment-cash flow relation as indicative of measurement errors in typical empirical measures of Tobin's q. Theoretically, the investment-cash flow relation can arise even without financial constraints (Gomes 2001, Alti 2003, Abel and Eberly 2011), and even in a model with financial constraints, cash flows matter only if one ignores marginal q (Gomes 2001).

Our objective is an empirically parsimonious and conceptually motivated specification for the expected investment-to-assets changes. As such, we use typical measures of Tobin's q and cash flows in the right-hand side of our cross-sectional forecasting regressions to summarize current information about future investment changes. We stand agnostic about the exact interpretation of the investment-cash flow relation, which is not directly related to our asset pricing purposes.

4.1.2 Measurement

Monthly returns are from the Center for Research in Security Prices (CRSP) and accounting information from the Compustat Annual and Quarterly Fundamental Files. We require CRSP share codes to be 10 or 11. Financial firms and firms with negative book equity are excluded.

Our measure of Tobin's q is standard. At the end of June of each year t, we measure Tobin's q as the market equity (price per share times the number of shares outstanding from CRSP) plus long-term debt (Compustat annual item DLTT) and short-term debt (item DLC) scaled by total book assets (item AT), all from the fiscal year ending in calendar year $t-1$. For firms with multiple share classes, we merge the market equity for all classes. Following Ball, Gerakos, Linnainmaa, and Nikolaev (2016), we measure (operating) cash flows, denoted Cop, as total revenue (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), scaled by book assets, all from the fiscal year ending in calendar year $t - 1$. As in Ball et al., all changes are annual changes, and the missing changes are set to zero.

We adopt this measure, Cop, because it is arguably the most accurate measure of cash flows. A more popular measure of cash flows in the investment literature is earnings before extraordinary items but after interest, depreciation, and taxes (Compustat annual item IB) plus depreciation. For instance, Li and Wang (2017) use this measure, along with Tobin's q and prior 11-month returns (momentum) to forecast capital expenditure growth. As noted in Ball, Gerakos, Linnainmaa, and Nikolaev (2016), this measure includes accruals such as changes in accounts payable, accounts receivable, and inventory, and as such, does not accurately capture the internal funds available for investment. Accruals tend to reduce internal funds, and affect future investment growth adversely. Another difference is that Cop explicitly recognizes research and development expenditures as a form of investment that induces future growth. In contrast, the more popular measure does not.

Still another measure of cash flows is operating profitability in Ball, Gerakos, Linnainmaa, and Nikolaev (2015), who calculate cash flows as sales minus cost of goods sold minus sales, general, and administrative expenses (excluding research and development). Similar to Cop, this measure captures a firm's operating performance, consistent with our economic modeling in equation (4), which is not affected by nonoperating items such as interest expenses. However, the accounting behind operating profitability is based on accruals, which, as noted, do not accurately capture the internal funds available for investment. These accruals include the changes in accounts receivable, inventory, prepaid expenses, deferred revenue, accounts payable, and accrued expenses. As such, we follow Ball et al. (2016), and remove accruals from operating profitability to form Cop.

4.1.3 Cross-sectional Forecasts

Panel A of Table 1 reports annual cross-sectional regressions of future investment-to-assets changes on Tobin's q and operating cash flows-to-assets, Cop. To alleviate the impact of microcaps, we use weighted least squares with the market equity as weights. We winsorize both the left- and right-hand side variables at the firm level in each June at the 1–99% level.

To evaluate the out-of-sample predictive power of the cross-sectional forecasts, at the end of June of each year t, we construct the expected investment-to-assets changes, $E_t[\mathrm{d}^\tau \mathrm{I/A}]$, in which $\tau = 1, 2$, and 3 years, using the winsorized predictors from the fiscal year ending in calendar year $t-1$ and the average slopes estimated from the prior ten-year rolling window (from year $t-\tau-9$ to $t-\tau$). We require a minimum of five years in the rolling-window regressions. We then report the time series averages of cross-sectional Pearson and rank correlations between $E_t[\mathrm{d}^\tau\mathrm{I/A}]$ and the actual investment-to-assets changes realized in the subsequent fiscal year ending in calendar year $t+\tau-1$.

Panel A shows that when used alone, Tobin's q is a weak predictor of future investment changes. At the 1-year horizon, the slope, 0.023, is economically small, albeit statistically significant. The R^2 is also small, 0.95%. The out-of-sample correlations between the expected investment changes and the subsequent realized changes are basically zero. At the 2- and 3-year horizons, the slopes are small and insignificant, and the R^2s are slightly above 1%. However, the out-of-sample correlations are significant, around 4% at the 2-year horizon and 10% at the 3-year horizon.

Cash flows perform better than Tobin's q in forecasting investment changes. When used alone, Cop has slopes from 0.44 to 0.48 (t-values all above five). The in-sample R^2s range from 3.46% to 4.41%, which are higher than those with Tobin's q. More important, the out-of-sample correlations are substantially higher than those with Tobin's q. At the 1-year horizon, for example, the Pearson and rank correlations are 15.3% and 18.2%, respectively, both of which are significant at the 1% level. The out-of-sample predictive power of Cop is stronger in short horizons. The predictive power decreases somewhat as we move from the 1-year to the 3-year horizon. In contrast, as noted, the out-of-sample predictive power of Tobin's q increases with the forecasting horizon.

In our benchmark specification with both Tobin's q and Cop, at the 1-year horizon, the Cop slope remains large and significant, 0.55 ($t = 6.44$), but the q slope becomes weakly negative, -0.03 ($t = -3.38$). The in-sample R^2 is 4.78%, and the out-of-sample Pearson and rank correlations are 0.15% and 0.19%, both of which are highly significant. At the 3-year horizon, the q and Cop slopes both increase in magnitude, -0.09 and 0.76 ($t = -6.46$ and 6.09), respectively. The in-sample R^2 rises to 7.77%, and the out-of-sample correlations to 17% and 21%, respectively.

The remaining panels in Table 1 show that Cop is the best cash flow measure in forecasting investment changes. From Panel B, the more popular measure (Cfa, earnings plus depreciation) has a large and significant slope, 0.31 ($t = 4.17$), when used alone at the 1-year horizon. The slope barely changes in bivariate regressions with Tobin's q, but the q slope is close to zero, 0.006 ($t = 0.77$). The evidence is largely consistent with prior investment literature (Fazzari, Hubbard, and Petersen 1988). However, the out-of-sample correlations between expected and subsequently realized investment changes are close to zero across all horizons in bivariate regressions.

From Panel C, not removing accruals from Cop as in Ball, Gerakos, Linnainmaa, and Nikolaev's (2015) operating profitability, Opa, also limits the out-of-sample predictive power. In bivariate regressions with Tobin's q, the out-of-sample Pearson and rank correlations are again close to zero at the 1-year horizon, and only rise to 2.5% and 5%, respectively, at the 3-year horizon. The Opa slopes are all economically large and statistically significant in both univariate and bivariate regressions. Finally, Panel D shows that research and development expenses only add a modest amount to Cop's out-of-sample predictive power. Using an alterative measure without research and development, the out-of-sample Pearson and rank correlations are 12.7% and 17.8% in bivariate regressions, which are only slightly lower than 15.2% and 18.9%, respectively, in our benchmark specification.

4.2 The Expected Growth Effect in Portfolio Sorts

Armed with the cross-sectional forecasts of investment-to-assets changes, we examine the expected growth effect in portfolio sorts. We study the expected growth deciles, construct an expected growth factor, and then use it to augment the q-factor model to form the Q5 model.

4.2.1 Deciles

As noted, our benchmark specification uses the log of Tobin's q and operating cash flows-to-assets, Cop, to form the expected investment-to-assets changes, $E_t[\mathrm{d}^\tau \mathrm{I/A}]$, with τ ranging from one to three years. At the end of June of each year t, we compute $E_t[\mathrm{d}^\tau \mathrm{I/A}]$ with the $\log(q)$ and Cop values winsorized at the 1–99% level from the fiscal year ending in calendar year $t-1$ and the Fama-MacBeth slopes estimated from the prior ten-year rolling window from year $t-\tau-9$ to $t-\tau$, with a minimum of five years. We winsorize both the left- and right-hand side variables at the firm level in each June at the 1–99% level, and estimate the cross-sectional regressions via weighted least squares with the market equity as weights. We sort all stocks into deciles based on the NYSE breakpoints of $E_t[\mathrm{d}^\tau\mathrm{I/A}]$, and calculate the value-weighted decile returns from July of year t to June of $t+1$. The deciles are rebalanced in June of year $t+1$.

Panel A of Table 2 shows that the expected growth effect is reliable in portfolio sorts. The high-minus-low $E_t[\mathrm{d}^1\mathrm{I/A}]$ decile earns on average 0.76% per month ($t = 4.71$). The expected investment-to-assets changes at the longer horizon are associated with even larger return spreads. The high-minus-low deciles on $E_t[\mathrm{d}^2\mathrm{I/A}]$ and $E_t[\mathrm{d}^3\mathrm{I/A}]$ earn on average 0.82% and 1.01% ($t = 5.26$ and 5.93), respectively. From Panel B, the expected growth effect cannot be explained by the q-factor model. The high-minus-low q-factor alphas are 0.78%, 0.82%, and 0.81% ($t = 5.4, 5.03$, and 4.08) across the 1-, 2-, and 3-year horizons, respectively. In addition, at the 1-year horizon, the mean absolute alpha is 0.18%, and the q-factor model is strongly rejected by the Gibbons, Ross, and Shanken (1989, GRS) test on the null that the alphas are jointly zero across the $E_t[\mathrm{d}^1\mathrm{I/A}]$ deciles. The results for the $E_t[\mathrm{d}^2\mathrm{I/A}]$ and $E_t[\mathrm{d}^3\mathrm{I/A}]$ deciles are largely similar.

Panel C reports the expected investment-to-assets changes, and Panel D the average subsequently realized changes across the deciles formed on $E_t[\mathrm{d}^\tau\mathrm{I/A}]$, for $\tau = 1, 2$, and 3. Both the expected and realized changes are value-weighted at the portfolio level, with the market equity as the weights. Reassuringly, the expected changes track the subsequently realized changes closely. For example, at the 1-year horizon, the expected changes rise monotonically from -13.41% per annum for decile one to 5.82% for decile ten, and the average realized changes from -16.26% for decile one to 4.84% for decile ten. Except for decile five, the increase in the average realized changes is strictly monotonic. The time series average of cross-sectional correlations between the expected and realized changes is 0.61, which is highly significant. The evidence for the 2- and 3-year horizons is largely similar, with average cross-sectional correlations of 0.66 and 0.67, respectively.

4.2.2 A Common Factor

In view of the expected growth effect largely unexplained by the q-factor model, we set out to construct an expected growth factor, denoted R_{Eg}. We construct R_{Eg} from an independent 2×3 sort on the market equity and the expected one-year-ahead investment-to-assets change, $E_t[\mathrm{d}^1\mathrm{I/A}]$.

At the end of June of each year t, we use the median NYSE market equity to split stocks into two groups, small and big. Independently, at the end of June of each year t, we split all stocks into three groups, low, median, and high, based on the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the ranked values of $E_t[\mathrm{d}^1\mathrm{I/A}]$ calculated for the fiscal year ending in calendar year $t-1$. Taking the intersection of the two size and three $E_t[\mathrm{d}^1\mathrm{I/A}]$ groups, we form six 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 end of June of $t+1$. Designed to mimic the common variation related to $E_t[\mathrm{d}^1\mathrm{I/A}]$, the expected growth factor, R_{Eg}, is the difference (high-minus-low), each month, between the simple average of the returns on the two high $E_t[\mathrm{d}^1\mathrm{I/A}]$ portfolios and the simple average of the returns on the two low $E_t[\mathrm{d}^1\mathrm{I/A}]$ portfolios.

Panel A of Table 3 reports descriptive statistics of the six size-expected growth benchmark portfolios. The small-high portfolio earns the highest average return of 1.13% per month ($t = 4.31$), whereas the big-low portfolio earns the lowest, 0.26% ($t = 1.07$). The average June-end market equity across firms within a given portfolio is the smallest, 0.14 billions of dollars, in the small-low portfolio, which also has the highest number of stocks on average, 961. The average June-end size across firms is the highest, 8.95 billions of dollars, in the big-high portfolio. The lowest number of stocks on average, 141, belongs to the big-low portfolio. The total market equity aggregated across all firms within a portfolio as a fraction of the entire market equity is the lowest for the small-high portfolio, 2.11%, and the highest for the big-high portfolio, 34.73%.

The low, 2, and high portfolios show a large dispersion in the expected one-year-ahead investment-to-assets changes, $E_t[\mathrm{d}^1\mathrm{I/A}]$, 13.63% per annum in small firms, and 11.25% in big firms.

The corresponding dispersions in the average realized changes, d^1I/A, are 14.9% and 12.08%, respectively. $E_t[d^1I/A]$ is inversely related to current investment-to-assets, indicating its mean-reversion in annual frequency. $E_t[d^1I/A]$ is also positively related to current Roe, but only weakly. Finally, $E_t[d^1I/A]$ is only weakly related to Tobin's q, but its relation with Cop is strongly positive.

Panel B reports the properties of the expected growth factor, R_{Eg}. From January 1967 to December 2016, its average return is 0.56% per month ($t = 6.66$). The existing workhorse factor models cannot explain the expected growth premium. The q-factor regression of R_{Eg} yields an economically large alpha of 0.53% ($t = 7.12$), suggesting that the expected growth factor premium might be a new dimension of the expected return missed by the q-factor model. Similarly, the Carhart (1997) alpha of R_{Eg} is 0.58% ($t = 8.75$), and the Fama-French (2015) five-factor alpha of R_{Eg} is 0.56% ($t = 7.59$). Finally, the expected growth factor has positive correlations of 0.32 and 0.33 with the investment and Roe factors, but negative correlations of -0.53 and -0.32 with the market and size factors in the q-factor model. All the correlations are significantly different from zero.

4.2.3 Augmenting the q-factor Model with the Expected Growth Factor

We augment the q-factor model with the expected growth factor to form the Q5 model. The expected excess return of an asset, denoted $E[r^i - r^f]$, is described by the loadings of its returns to five factors, including the market factor, R_{Mkt}, the size factor, R_{Me}, the investment factor, $R_{\mathrm{I/A}}$, the return on equity factor, R_{Roe}, and the expected growth factor, R_{Eg}. The first four factors are identical to those in the q-factor model. Formally, the Q5 model says that:

$$E[r^i - r^f] = \beta^i_{\mathrm{Mkt}}\, E[R_{\mathrm{Mkt}}] + \beta^i_{\mathrm{Me}}\, E[R_{\mathrm{Me}}] + \beta^i_{\mathrm{I/A}}\, E[R_{\mathrm{I/A}}] + \beta^i_{\mathrm{Roe}}\, E[R_{\mathrm{Roe}}] + \beta^i_{\mathrm{Eg}}\, E[R_{\mathrm{Eg}}], \qquad (15)$$

in which $E[R_{\mathrm{Mkt}}], E[R_{\mathrm{Me}}], E[R_{\mathrm{I/A}}]$, $E[R_{\mathrm{Roe}}]$, and $E[R_{\mathrm{Eg}}]$ are the expected factor premiums, and β^i_{Mkt}, β^i_{Me}, $\beta^i_{\mathrm{I/A}}$, β^i_{Roe}, and β^i_{Eg} are their factor loadings, respectively.

As its first test, we use the Q5 model to explain the expected growth deciles from Table 2. Panel C of Table 3 reports the details. It is not surprising that the expected growth factor in the Q5 model helps explain the $E_t[\mathrm{d}^1\mathrm{I/A}]$ deciles, since the new factor is formed on $E_t[\mathrm{d}^1\mathrm{I/A}]$. However, it is reassuring that the expected growth factor also helps explain the $E_t[\mathrm{d}^2\mathrm{I/A}]$ and $E_t[\mathrm{d}^3\mathrm{I/A}]$ deciles. The high-minus-low $E_t[\mathrm{d}^1\mathrm{I/A}]$ decile has a Q5-alpha of virtually zero, in contrast to its q-factor alpha of 0.78% per month ($t = 5.4$, Table 2). The mean absolute Q5-alpha is only 0.1%, down from 0.18% from the q-factor model, but the Q5 model is still rejected by the GRS test ($p = 0.02$). In addition, the Q5-alphas of the high-minus-low $E_t[\mathrm{d}^2\mathrm{I/A}]$ and $E_t[\mathrm{d}^3\mathrm{I/A}]$ deciles are again close to zero, -0.05% ($t = -0.49$) and -0.07 ($t = -0.62$), respectively. The mean absolute alphas are only 0.05% and 0.07%, and the Q5 model cannot be rejected by the GRS test.

4.2.4 Explaining the Intrinsic-to-Market Value Anomaly

We next examine empirically which driver of the expected return in the investment CAPM explains the Frankel-Lee (1998) intrinsic-to-market anomaly (first discussed conceptually in Section 3.3.1).

At the end of June of each year t, we sort stocks into deciles based on NYSE breakpoints of the historical Roe-based intrinsic-to-market value, V_t^h/P_t, and the analysts' earnings forecast-based intrinsic-to-market value, V_t^f/P_t, for the fiscal year ending in calendar year $t-1$, in which P_t is the market equity (from CRSP) at the end of December of year $t-1$. We detail the empirical procedure for estimating V_t^h and V_t^f in equations (10) and (11), respectively, in Appendix B. Monthly value-weighted decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$. Because analysts' forecasts data begin in 1976, the V^f/P deciles start in July 1976. The V^h/P deciles start in January 1967. Both samples end in December 2016.

Table 4 reports the results. Consistent with Frankel and Lee (1998), the intrinsic-to-market value predicts returns. The high-minus-low V^h/P decile earns on average 0.38% per month ($t = 2.05$), and the high-minus-low V^f/P decile on average 0.47% ($t = 2.18$). Both the q-factor and Q5 models explain the intrinsic-to-market anomaly. In particular, the Q5 alpha of the high-minus-low V^h/P decile is -0.23% ($t = -1.24$), and the Q5 alpha of the high-minus-low V^f/P decile 0.03% ($t = 0.15$). However, while the Q5 model is not rejected by the GRS test across the

V^f/P deciles ($p = 0.07$), it is rejected across the V^h/P deciles ($p = 0.02$).

The investment factor is the key driving force behind the explanatory power. In the Q5 regression, the investment factor loading of the high-minus-low V^h/P decile is 0.84 ($t = 4.97$), and that of the high-minus-low V^f/P decile 0.52 ($t = 3.22$). The Roe factor loadings are both insignificant. The expected growth factor helps explain the V^h/P effect with a loading of 0.45 ($t = 2.23$), but its loading for the high-minus-low V^f/P decile is insignificant, albeit positive. Finally, high intrinsic-to-market value stocks have significantly lower investment-to-assets, as well as significantly higher expected one-year-ahead investment-to-assets changes than low intrinsic-to-market value stocks. The evidence is largely consistent with the predictions of our theory (Section 3.3.1).

4.3 Using the Q5 Model to Explain q-anomalies

The most stringent test of the Q5 model is to confront it with the 46 anomalies that the q-factor model cannot explain (Hou, Xue, and Zhang 2017). Table 5 provides the detailed list, which includes eight, four, nine, 12, 11, and two across the momentum, value-versus-growth, investment, profitability, intangibles, and trading frictions categories.

Prominent examples include cumulative abnormal stock returns around earnings announcements from Chan, Jegadeesh, and Lakonishok (1996), customer momentum from Cohen and Frazzini (2008), and segment momentum from Cohen and Lou (2012) in the momentum category; cash flow-to-price from Desai, Rajgopal, and Venkatachalam (2004) and net payout yield from Boudoukh, Michaely, Richardson, and Roberts (2007) in the value-versus-growth category; operating accruals from Sloan (1996), discretionary accruals from Xie (2001), net operating assets from Hirshleifer, Hou, Teoh, and Zhang (2004), and net stock issues from Pontiff and Woodgate (2008) in the investment category; operating profits-to-assets from Ball, Gerakos, Linnainmaa, and Nikolaev (2015) and operating cash flows-to-assets from Ball, Gerakos, Linnainmaa, and Nikolaev (2016) in the profitability category; R&D-to-market from Chan, Lakonishok, and Sougiannis (2001) and seasonalities from Heston and Sadka (2006) in the intangibles category; as well as idiosyncratic skewness in the trading frictions category. Appendix C details variable definition and portfolio construction.

4.3.1 Overall Performance

Table 6 reports the overall performance of the q-factor model and the Q5 model. From Panel A, all the 46 high-minus-low q-factor alphas are significant at the 5% level, and 17 alphas have t-values greater than or equal to three. The average magnitude of the high-minus-low q-alphas is 0.52% per month. Across all 46 sets of deciles, the mean absolute alpha is 0.16%, and the q-factor model is rejected by the GRS test at the 5% level in 39 out of 46 sets of deciles.

The Q5 model improves on the q-factor model substantially. The average magnitude of the high-minus-low Q5-alphas is only 0.34% per month, which represents a reduction of 35% from the average magnitude of 0.52% in the q-factor model. The number of the high-minus-low Q5-alphas that are significant at the 5% level is 19, which represents a reduction of 59% from 46 in the q-factor model. The number of the high-minus-low Q5-alphas with t-values greater than or equal to three is only four, which represents a reduction of 76% from 17 in the q-factor model. The mean absolute Q5-alpha across all 46 sets of deciles is 0.12%, which is lower than 0.16% in the q-factor model. Finally, the Q5 model is rejected by the GRS test at the 5% level in 18 sets of deciles. The number of rejections represents a reduction of 54% relative to 39 in the q-factor model.

The remaining panels of Table 6 show that the Q5 model improves on the q-factor model across all the six categories of anomalies, especially in the investment and profitability categories. From Panel B, the improvement in the momentum category is limited. Across the eight momentum anomalies, the average magnitude of the high-minus-low Q5-alphas is 0.52% per month, which is only slightly lower than 0.55% in the q-factor model. The comparison between the mean absolute alpha is small: 0.12% versus 0.14%. The number of significant high-minus-low alphas at the 5% level is six in the Q5 model, and is only slightly lower than eight in the q-factor model.

The improvement in the value-versus-growth category is modest. The average absolute high-minus-low alpha is 0.28% per month in the Q5 model, relative to 0.39% in the q-factor model.

The number of significant high-minus-low alphas is only one in the Q5 model, but four in the q-factor model. Although the mean absolute alpha across all the deciles is 0.14% in both models, the number of rejections by the GRS test is two for the Q5 model, but four for the q-factor model.

The Q5 model improves on the q-factor model substantially in the investment category. The average absolute high-minus-low alpha is 0.15% per month in the Q5 model, which represents a reduction of 65% from 0.43% in the q-factor model. Only two high-minus-low Q5-alphas are significant at the 5% level, and none have t-values greater than or equal to three. In contrast, all nine high-minus-low q-factor alphas are significant at the 5% level, and four with $t \geq 3$. The mean absolute Q5-alpha across all the deciles is 0.09%, which is lower than the mean absolute q-alpha of 0.12%. Finally, the Q5 model is rejected by the GRS test in two sets of deciles, but the q-factor model is rejected in eight.

The improvement of the Q5 over the q-factor model is also substantial in the profitability category. The average absolute high-minus-low alpha is 0.11% per month in the Q5 model, which represents a reduction of 75% relative to 0.44% in the q-factor model. Only one high-minus-low Q5-alpha is significant at the 5% level, and none with $t \geq 3$. In contrast, 12 high-minus-low q-alphas are significant at the 5% level, and four with $t \geq 3$. The Q5 model also lowers the mean absolute alpha across all the deciles to 0.08% from 0.11% in the q-factor model. More important, the GRS test rejects the q-factor model in nine sets of deciles, but fails to reject the Q5 model in any set.

Finally, the Q5 model improves on the q-factor model in the intangibles and trading frictions categories. Across the two categories, the average absolute high-minus-low alphas are 0.64% and 0.21% per month in the Q5 model, which are lower than 0.77% and 0.28% in the q-factor model. The number of significant high-minus-low alphas is lower in the Q5 model than in the q-factor model, eight versus 11 for intangibles, and one versus two for trading frictions. The Q5 model reduces the mean absolute alpha across all the intangibles deciles from 0.26% in the q-factor model to 0.2%, and the number of GRS test rejections from ten to nine, as well as the mean absolute alpha across the frictions deciles from 0.09% to 0.08%, and the number of GRS test rejections from two to zero.

4.3.2 Individual Factor Regressions

Table 7 details individual factor regressions of the 46 q-anomalies. From Panel A, the improvement of the Q5 model over the q-factor model in explaining momentum is minimal. The loadings of the high-minus-low deciles on the expected growth factor, R_{Eg}, are mostly small, and all of them are insignificant. As such, the Q5 alphas are close to the q-alphas. For instance, the high-minus-low decile formed on Abr1 (cumulative abnormal stock returns around earnings announcements with 1-month holding period) earns a q-alpha of 0.62% per month ($t = 4.25$), which is close to its Q5-alpha of 0.65% ($t = 4.58$). Its R_{Eg}-loading is close to zero, despite a weakly positive spread in future realized investment-to-assets changes. The Q5 model does reduce the alpha of the high-minus-low decile on Cim1 (customer industries momentum with 1-month holding period) from 0.64% ($t = 2.36$) to 0.46% ($t = 1.63$). However, its R_{Eg}-loading is insignificant, 0.32 ($t = 1.67$).

Panel B shows that the Q5 model explains the q-anomaly formed on Nop (net payout yield). The high-minus-low alpha in the q-factor model is 0.35% per month ($t = 2.42$), but the Q5 model reduces it to 0.08% ($t = 0.58$). The high-minus-low decile has an economically large and statistically significant R_{Eg}-loading of 0.49 ($t = 3.4$). This large loading accords well with the large spreads in subsequently realized investment changes, ranging from 18.4% per annum at the 1-year horizon to 26.6% at the 3-year horizon, all of which are more than 13 standard errors from zero. The evidence suggests that high net payout yields signal high expected growth going forward.

From Panel C, the Q5 model helps explain many investment anomalies that the q-factor model cannot explain. The high-minus-low decile on Noa (net operating assets) has a q-alpha of −0.45% per month ($t = -2.59$), but a Q5-alpha of only −0.12% ($t = -0.79$). Its expected growth factor loading, β_{Eg}, is economically large and statistically significant, −0.62 ($t = -5.58$), which accords well with the large, negative spreads in subsequently realized investment changes. The spreads range from −49.2% to −54.4% per annum, all of which are more than 18 standard errors from zero. Intuitively, a large base of net operating assets strongly signals low expected 1- to 3-year growth.

The high-minus-low decile on Nsi (net stock issues) earns a q-alpha of -0.29% per month ($t = -2.32$), but a Q5-alpha of only -0.12% ($t = -0.79$). Its R_{Eg}-loading is -0.33 ($t = -3.14$), which is also consistent with the negative spreads in the future realized investment changes. The spreads vary from -34.3% to -40.2% per annum, all of which are more than 14.5 standard errors from zero. Intuitively, high net stock issues signal low expected growth in the subsequent 1–3 years.

The Q5 model helps explain the accrual anomaly. The high-minus-low decile on Oa (operating accruals) earns a large q-alpha of -0.56% per month ($t = -4.1$). The Q5 model reduces the alpha to -0.26% ($t = -1.85$) via an economically large R_{Eg}-loading of -0.56 ($t = -5.31$). However, the subsequent investment changes, although all negative, are relatively small, ranging only from -2.3% ($t = -1.15$) to -8.4% per annum ($t = -3.89$). Another challenging q-anomaly is discretionary accruals (Dac). The high-minus-low Dac decile has a large q-alpha of -0.67% ($t = -4.73$), and the Q5 model reduces it to -0.32%, albeit still significant ($t = -2.22$). The high-minus-low R_{Eg}-loading is -0.65 ($t = -6.81$), which accords well with the negative spreads in subsequent investment changes. The spreads range from -6.2% to -9.9% per annum, all of which are more than four standard errors from zero. As such, high operating and discretionary accruals signal low expected growth.

Another success story for the Q5 model is the dFin (change in net financial assets) anomaly. The high-minus-low decile has a q-alpha of 0.43% per month ($t = 3$), but a Q5-alpha of only 0.17% ($t = 1.22$). Its expected growth factor loading is large and positive, 0.49 ($t = 5.61$), which accords well with the significantly positive spreads in subsequent investment-to-assets changes around 36.5% per annum. Intuitively, large increases in net financial assets mean more internal funds available for investment, which in turn strongly signal high expected 1- to 3-year growth.

Panel D shows that the Q5 model helps explain the profitability anomalies. For example, the high-minus-low decile on Opa (operating profits-to-assets) earns a q-alpha of 0.46% per month ($t = 2.96$). The Q5 model largely erases the alpha to -0.06% ($t = -0.42$) via a large expected growth factor loading of 0.97 ($t = 10.19$), which accords well with the spreads in subsequent investment-to-assets changes. The spreads range from 10.9% to 13.2% per annum, all of which are more than 4.5 standard errors from zero. In addition, the high-minus-low decile on Cop earns a q-alpha of 0.69% ($t = 5.04$), and the Q5 model reduces it to 0.12% ($t = 1.11$) via a large R_{Eg}-loading of 1.09 ($t = 14.53$). The evidence is not surprising, since Cop is one of the two predictors that we use to forecast subsequent investment changes. Reassuringly, Panel D shows that the high-minus-low Cop decile indeed exhibits large spreads in subsequent investment-to-assets changes, ranging from 20.5% to 28.6% per annum, all of which are more than 10.5 standard errors from zero. As such, we provide an economic foundation for the Opa and Cop premiums based on the expected growth.

From Panel E, the Q5 model helps explain the R&D-to-market (Rdm) anomaly. The high-minus-low Rdm decile earns a q-alpha of 0.72% per month ($t = 3.11$). The Q5 model reduces it to 0.27% ($t = 1.22$) via a large expected growth factor loading of 0.86 ($t = 5.12$). However, Rdm is related to significant subsequent investment-to-assets changes only in years two and three, but is weakly negatively related to the changes in year one. Also, the improvement of the Q5 model is small for the high-minus-low decile on Rdm^{q}1 (quarterly R&D-to-market with 1-month holding period). The improvement becomes more visible at the six- and 12-month holding periods. Intuitively, R&D is long-term investment that might not create immediate growth opportunities. In the short term, R&D depresses earnings due to expensing per accounting rules, and does not add assets to the balance sheet. As such, R&D is more related to the expected growth in the long horizons.

Finally, we emphasize that the Q5 model, despite offering a substantial improvement over the q-factor model, still leaves 19 high-minus-low alphas with $t \geq 1.96$, including four with $t \geq 3$. In particular, three Heston-Sadka (2008) seasonality variables, $R_a^{[2,5]}, R_a^{[6,10]}$, and $R_a^{[11,15]}$, have high-minus-low Q5-alphas of 0.79%, 1%, and 0.57% per month ($t = 3.82, 4.78$, and 3.4), respectively. We should also point out that the R_{Eg}-loadings typically accord well with subsequent investment-to-assets changes, but there are exceptions. The high-minus-low decile on dRoe1 (change on return on equity with 1-month holding period) has a weakly negative R_{Eg}-loading of -0.14 ($t = -1.09$), despite significantly positive spreads in subsequent investment changes (5–14.4% per annum).

5 Conclusion

This paper shows that the investment CAPM provides an economic foundation for Graham and Dodd (1934), without mispricing. Expected returns vary cross-sectionally, depending on firms' investment, expected profitability, and expected investment growth. In our model, returns are predictable, but abnormal returns are not, retaining efficient markets. The investment CAPM also has more appealing theoretical properties than the residual income model and the Penman-Reggiani-Richardson-Tuna (2017) model that currently dominate the fundamental analysis literature.

Empirically, many anomaly variables are associated with future changes in investment-to-assets, in the same direction with future returns. With Tobin's q and operating cash flows as instruments, an expected growth factor earns on average 0.56% per month ($t = 6.66$). Augmenting the q-factor model with the expected growth factor improves its performance substantially.

Finally, it should be emphasized that our work does not rule out mispricing. For instance, Lee and Li (2017) argue that high-investment-low-profitability firms earn abnormally low returns not because of their low risk, but overpricing. Future work can shed further light on the economic mechanisms of the investment, profitability, and expected growth premiums in the Q5 model.

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Table 1 : Annual Fama-MacBeth (1973) Cross-sectional Regressions of Future Investment-to-assets Changes, 1961–2016

At the end of June of each year t, we report bivariate and univariate regressions of annual investment-to-assets changes, d^τI/A, in which $\tau = 1, 2, 3$, on the logarithm of Tobin's q, $\log(q)$, and cash flows. We measure d^τI/A as investment-to-assets from the fiscal year ending in calendar year $t+\tau-1$ minus investment-to-assets from the fiscal year ending in calendar year $t-1$. All the cross-sectional regressions are estimated with weighted least squares with the market equity as weights. We winsorize the cross section of each variable in each June at the 1–99% level. We report the Fama-MacBeth slopes, their t-values adjusted for heteroscedasticity and autocorrelations (in parentheses), and goodness-of-fit coefficients (R^2, in percent). In addition, at the end of June of year t, we construct the expected I/A changes, $E_t[\mathrm{d}^\tau\mathrm{I/A}]$, using the (winsorized) predictors from the fiscal year ending in $t-1$ and the average slopes estimated from the prior ten-year rolling window (from year $t-\tau-9$ to $t-\tau$, with a minimum of five years). We then report the time-series averages of cross-sectional Pearson and rank correlations between $E_t[\mathrm{d}^\tau\mathrm{I/A}]$ calculated at the end of June of year t and the actual I/A changes realized in the fiscal year ending in calendar year $t+\tau-1$. The p-values testing that a given correlation is zero are in brackets. In Panel A, the cash flow measure is Cop, per Ball, Gerakos, Linnainmaa, and Nikolaev (2016), calculated as total revenue (item REVT) minus cost of goods sold (item COGS), minus selling, general, and administrative expenses (item XSGA), plus research and development expenditures (R&D, 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). All changes are annual changes, and the missing changes are set to zero. In Panel B, the cash flow measure is Cfa, calculated as earnings before extraordinary items but after interest, depreciation, and taxes (item IB) plus depreciation (item DP). In Panel C, the cash flow measure is Opa, per Ball, Gerakos, Linnainmaa, and Nikolaev (2015), calculated as sales minus cost of goods sold minus sales, general, and administrative expenses (excluding R&D). In Panel D, we use Copa, which is Cop minus R&D.

Panel A: Cop

	Bivariate, $\log(q)$ and Cop					Univariate, $\log(q)$				Univariate, Cop			
τ	$\log(q)$	Cop	R^2	Pearson	Rank	$\log(q)$	R^2	Pearson	Rank	Cop	R^2	Pearson	Rank
1	−0.031	0.545	4.78	0.152	0.189	0.023	0.95	0.008	−0.002	0.440	3.46	0.153	0.182
	(−3.38)	(6.44)		[0.00]	[0.00]	(3.16)		[0.33]	[0.82]	(6.64)		[0.00]	[0.00]
2	−0.076	0.738	7.77	0.165	0.203	−0.004	1.17	0.038	0.044	0.481	4.41	0.138	0.160
	(−5.55)	(6.25)		[0.00]	[0.00]	(−0.46)		[0.01]	[0.01]	(6.04)		[0.00]	[0.00]
3	−0.091	0.757	7.77	0.174	0.211	−0.016	1.14	0.096	0.108	0.452	3.98	0.126	0.138
	(−6.46)	(6.09)		[0.00]	[0.00]	(−1.82)		[0.00]	[0.00]	(5.44)		[0.00]	[0.00]

Panel B: Cfa									
Bivariate, log(q) and Cfa						Univariate, Cfa			
τ	log(q)	Cfa	R^2	Pearson	Rank	Cfa	R^2	Pearson	Rank
1	0.006	0.315	1.89	−0.025	0.023	0.313	1.07	−0.030	0.017
	(0.77)	(3.82)		[0.06]	[0.03]	(4.17)		[0.04]	[0.15]
2	−0.028	0.470	2.80	−0.036	0.008	0.309	1.34	−0.063	−0.039
	(−2.56)	(3.67)		[0.06]	[0.63]	(3.08)		[0.00]	[0.01]
3	−0.048	0.579	3.25	−0.032	0.006	0.302	1.49	−0.099	−0.088
	(−3.92)	(3.77)		[0.13]	[0.74]	(2.62)		[0.00]	[0.00]

Panel C: Opa									
Bivariate, log(q) and Opa						Univariate, Opa			
τ	log(q)	Opa	R^2	Pearson	Rank	Opa	R^2	Pearson	Rank
1	−0.010	0.328	2.28	−0.005	0.023	0.282	1.40	0.011	0.034
	(−1.20)	(3.69)		[0.57]	[0.03]	(4.15)		[0.18]	[0.00]
2	−0.055	0.500	3.24	0.018	0.049	0.267	1.46	−0.022	−0.011
	(−3.79)	(3.93)		[0.25]	[0.00]	(3.29)		[0.08]	[0.27]
3	−0.070	0.515	3.30	0.025	0.050	0.218	1.34	−0.037	−0.037
	(−4.62)	(3.84)		[0.13]	[0.00]	(2.59)		[0.01]	[0.01]

Panel D: Copa									
Bivariate, log(q) and Copa						Univariate, Copa			
τ	log(q)	Copa	R^2	Pearson	Rank	Copa	R^2	Pearson	Rank
1	−0.016	0.541	4.71	0.127	0.178	0.484	3.53	0.127	0.174
	(−1.95)	(6.46)		[0.00]	[0.00]	(6.39)		[0.00]	[0.00]
2	−0.057	0.742	7.62	0.133	0.186	0.559	4.74	0.113	0.152
	(−5.12)	(6.17)		[0.00]	[0.00]	(5.66)		[0.00]	[0.00]
3	−0.074	0.787	7.77	0.142	0.193	0.549	4.49	0.102	0.131
	(−6.13)	(5.74)		[0.00]	[0.00]	(5.05)		[0.00]	[0.00]

Table 2 : Properties of the Expected Growth Deciles, January 1967–December 2016

We use the log of Tobin's q, $\log(q)$, and operating cash flow-to-assets, Cop, to form the expected investment-to-assets changes, $E_t[\mathrm{d}^\tau \mathrm{I/A}]$, with τ ranging from 1 to 3 years. At the end of June of each year t, we calculate $E_t[\mathrm{d}^\tau \mathrm{I/A}]$ with the $\log(q)$ and Cop values winsorized at the 1–99% level from the fiscal year ending in calendar year $t-1$ and the average slopes estimated from the prior ten-year rolling window from year $t-\tau-9$ to $t-\tau$, with a minimum of five years. Cross-sectional regressions are estimated with weighted least squares with the market equity as weights. At the end of June of each year t, we sort all stocks into deciles based on the NYSE breakpoints of $E_t[\mathrm{d}^\tau \mathrm{I/A}]$, and compute value-weighted decile returns from July of year t to June of $t+1$. The deciles are rebalanced at the end of June of year $t+1$. For each decile and the high-minus-low decile, we report the average excess return, m, the q-factor alpha, α_q, the expected investment-to-assets changes, $E_t[\mathrm{d}^\tau \mathrm{I/A}]$, and the average future realized growth, $\mathrm{d}^\tau \mathrm{I/A}$, as well as their corresponding heteroscedasticity-and-autocorrelation-adjusted t-statistics, denoted, t_m, t_q, t_e^τ, and t^τ, respectively. In Panel B, for $\tau = 1, 2$, and 3, $\overline{|\alpha_q^\tau|}$ is the mean absolute alpha across the $E_t[\mathrm{d}^\tau \mathrm{I/A}]$ deciles, and p_{GRS}^τ is the GRS p-value testing that the alphas from the $E_t[\mathrm{d}^\tau \mathrm{I/A}]$ deciles are jointly zero.

τ		Low	2	3	4	5	6	7	8	9	High	H−L
		Panel A: Average excess returns, m										
1	m	−0.00	0.37	0.42	0.53	0.50	0.50	0.62	0.61	0.78	0.76	0.76
	t_m	−0.01	1.45	1.85	2.50	2.41	2.70	3.43	3.22	4.06	3.70	4.71
2	m	−0.01	0.33	0.41	0.45	0.50	0.63	0.63	0.71	0.68	0.81	0.82
	t_m	−0.03	1.38	1.97	2.12	2.58	3.50	3.41	3.64	3.59	3.56	5.26
3	m	−0.00	0.29	0.39	0.54	0.47	0.60	0.70	0.60	0.69	1.01	1.01
	t_m	−0.01	1.28	1.77	2.71	2.42	3.26	3.46	2.90	3.56	4.50	5.93
		Panel B: The q-factor alphas ($\overline{\lvert\alpha_q^1\rvert} = \overline{\lvert\alpha_q^2\rvert} = 0.18$, $\overline{\lvert\alpha_q^3\rvert} = 0.21$, $p_{\mathrm{GRS}}^1 = p_{\mathrm{GRS}}^2 = p_{\mathrm{GRS}}^3 = 0.00$)										
1	α_q	−0.35	−0.18	−0.16	−0.06	−0.18	0.00	0.10	0.07	0.29	0.44	0.78
	t_q	−3.43	−1.83	−1.36	−0.72	−2.33	−0.01	1.25	0.98	3.54	4.22	5.40
2	α_q	−0.29	−0.14	−0.20	−0.11	−0.08	0.01	0.01	0.10	0.29	0.52	0.82
	t_q	−2.96	−1.68	−2.69	−0.99	−1.10	0.14	0.18	1.31	3.33	4.03	5.03
3	α_q	−0.29	−0.10	−0.26	−0.14	−0.08	0.03	0.15	0.19	0.31	0.52	0.81
	t_q	−2.91	−1.18	−2.84	−1.72	−1.13	0.38	2.00	2.34	3.13	3.24	4.08
		Panel C: The expected growth, $E_t[\mathrm{d}^\tau \mathrm{I/A}]$										
1	$E_t[\mathrm{d}^1 \mathrm{I/A}]$	−13.41	−7.93	−6.25	−5.01	−3.95	−2.97	−1.94	−0.67	1.25	5.82	19.23
	t_e^1	−12.29	−7.82	−6.23	−5.06	−4.01	−3.04	−2.00	−0.69	1.28	5.68	24.76
2	$E_t[\mathrm{d}^2 \mathrm{I/A}]$	−17.11	−9.90	−7.53	−5.89	−4.53	−3.28	−1.91	−0.30	2.09	7.42	24.53
	t_e^2	−12.73	−7.78	−6.00	−4.74	−3.67	−2.68	−1.57	−0.25	1.72	5.83	28.93
3	$E_t[\mathrm{d}^3 \mathrm{I/A}]$	−19.06	−11.47	−9.02	−7.27	−5.82	−4.48	−3.02	−1.31	1.12	6.73	25.79
	t_e^3	−12.82	−8.18	−6.47	−5.25	−4.23	−3.27	−2.21	−0.96	0.81	4.73	29.41
		Panel D: Average future realized growth, $\mathrm{d}^\tau \mathrm{I/A}$										
1	$\mathrm{d}^1 \mathrm{I/A}$	−16.26	−9.48	−3.47	−2.93	0.67	−1.36	0.45	0.62	1.83	4.84	21.10
	t^1	−10.83	−5.32	−5.64	−4.65	1.06	−2.57	1.02	1.04	3.96	7.81	14.02
2	$\mathrm{d}^2 \mathrm{I/A}$	−21.33	−9.11	−6.63	−1.55	−2.04	−1.32	0.01	0.83	2.03	3.10	24.43
	t^2	−13.57	−9.70	−8.31	−1.97	−2.63	−2.00	0.02	1.47	3.72	5.28	14.42
3	$\mathrm{d}^3 \mathrm{I/A}$	−22.44	−10.32	−7.04	−1.71	−3.47	−3.07	−1.06	−0.04	1.10	1.68	24.12
	t^3	−14.73	−10.50	−7.87	−2.56	−5.18	−5.23	−1.80	−0.07	2.72	2.32	16.01

Table 3 : Properties of the Expected Growth Factor, R_{Eg}, January 1967–December 2016

We use the logarithm of Tobin's q, $\log(q)$, and operating cash flows-to-assets, Cop, to form the expected investment-to-assets changes, $E_t[\mathrm{d}^\tau\mathrm{I/A}]$, with the forecasting horizon, τ, ranging from 1 to 3 years. At the end of June of each year t, we calculate $E_t[\mathrm{d}^\tau\mathrm{I/A}]$ with the $\log(q)$ and Cop values winsorized at the 1–99% level from the fiscal year ending in calendar year $t-1$ and the average slopes estimated from the prior ten-year rolling window from year $t-\tau-9$ to $t-\tau$, with a minimum of five years. Cross-sectional regressions are estimated with weighted least squares with the market equity as weights. The expected growth factor, denoted R_{Eg}, is based on an independent 2×3 sort on the market equity and the expected investment-to-assets change at the one-year horizon, $E_t[\mathrm{d}^1\mathrm{I/A}]$. At the end of June of each year t, we use the median NYSE market equity to sort NYSE, Amex, and NASDAQ stocks into two groups, small and big. Independently, at the end of June of each year t, we split all stocks into three $E_t[\mathrm{d}^1\mathrm{I/A}]$ groups, low, median, and high, based on the NYSE breakpoints for the low 30%, middle 40%, and high 30% of its ranked values for the fiscal year ending in calendar year $t-1$. Taking the intersections of the two size and three expected growth groups, we form six portfolios. We calculate monthly value-weighted portfolio returns from July of year t to June of $t+1$, and rebalance the portfolios at the end of June of year $t+1$. The expected growth factor, R_{Eg}, is the difference (high-minus-low), each month, between the simple average of the returns on the two high $E_t[\mathrm{d}^1\mathrm{I/A}]$ portfolios and the simple average of the returns on the two low $E_t[\mathrm{d}^1\mathrm{I/A}]$ portfolios. Panel A reports descriptive statistics of the six size-expected growth benchmark portfolios, including average excess returns, m, their t-values, t_m, the volatilities of excess returns, σ, average firm June-end market equity (in billions of dollars), the number of stocks, total June-end market equity as a percentage of total market equity, the expected one-year-ahead investment-to-assets change, $E_t[\mathrm{d}^1\mathrm{I/A}]$, the average realized one-year-ahead investment-to-assets change, $\mathrm{d}^1\mathrm{I/A}$, as well as the latest values of investment-to-assets, I/A, return on equity, Roe, the log of Tobin's q, and operating cash flows-to-assets, Cop. For the expected growth factor, Panel B reports its average return, m, and alphas, factor loadings, and R^2s from the q-factor model, the Carhart four-factor model, and the Fama-French (2015) five-factor model. The t-statistics adjusted for heteroscedasticity and autocorrelations are in parentheses. Panel B also reports the correlations of the expected growth factor, R_{Eg}, with the market, size, investment, and Roe factors in the q-factor model ($R_{\mathrm{Mkt}}, R_{\mathrm{Me}}, R_{\mathrm{I/A}}$, and R_{Roe}, respectively), as well as SMB, HML, UMD, RMW, and CMA from the Carhart and Fama-French five-factor models. Finally, Panel C reports the factor regressions of the $E_t[\mathrm{d}^\tau\mathrm{I/A}]$ deciles on the Q5-factor model, which augments the q-factor model with the expected growth factor. At the end of June of each year t, we sort all stocks into deciles based on the NYSE breakpoints of $E_t[\mathrm{d}^\tau\mathrm{I/A}]$ for each value of $\tau = 1, 2$, and 3, and compute value-weighted decile returns from July of year t to June of $t+1$. The deciles are rebalanced at the end of June of year $t+1$. For each decile and the high-minus-low decile, we report the average excess return, m, the Q5-factor regression, including the intercept, α_Q, the loadings on the market, size, I/A, Roe, and expected growth factors, denoted $\beta_{\mathrm{Mkt}}, \beta_{\mathrm{Me}}, \beta_{\mathrm{I/A}}, \beta_{\mathrm{Roe}}$, and β_{Eg}, and their heteroscedasticity-and-autocorrelation-adjusted t-statistics, denoted t_m, t_Q, $t_{\mathrm{Mkt}}, t_{\mathrm{Me}}, t_{\mathrm{I/A}}, t_{\mathrm{Roe}}$, and t_{Eg} respectively. $\overline{|\alpha_Q|}$ is the mean absolute alpha across a given set of deciles from the Q5 model, and p_{GRS} is the GRS p-value testing that the alphas from a given set of deciles are jointly zero.

Panel A: Properties of the six size-expected growth benchmark portfolios

	Low	2	High	Low	2	High	Low	2	High
	m			t_m			σ		
Small	0.42	0.93	1.13	1.39	3.59	4.31	6.93	5.91	6.03
Big	0.26	0.49	0.67	1.07	2.72	3.62	5.67	4.44	4.48
	Average June-end size			# Stocks			% Total market cap		
Small	0.14	0.21	0.22	961	589	542	2.61	2.37	2.11
Big	4.57	6.15	8.95	141	224	203	11.97	26.91	34.73
	$E_t[\mathrm{d}^1\mathrm{I/A}]$			$\mathrm{d}^1\mathrm{I/A}$			I/A		
Small	−10.98	−3.51	2.65	−8.87	0.63	6.03	29.66	13.25	10.83
Big	−8.59	−3.24	2.66	−9.68	−0.91	2.40	29.00	12.59	12.58
	Roe			$\log(q)$			Cop		
Small	0.12	2.20	3.11	0.23	0.05	0.23	3.30	14.75	26.11
Big	2.98	3.86	5.37	0.37	0.31	0.60	8.37	17.02	28.83

Panel B: Properties of the expected growth factor, R_{Eg}

m	α	β_{Mkt}	β_{Me}	$\beta_{\mathrm{I/A}}$	β_{Roe}		R^2
0.56	0.53	−0.16	−0.08	0.14	0.14		0.37
(6.66)	(7.12)	(−8.13)	(−1.86)	(2.78)	(3.66)		
	α	β_{Mkt}	β_{SMB}	β_{HML}	β_{UMD}		R^2
	0.58	−0.17	−0.12	0.07	0.10		0.38
	(8.75)	(−8.85)	(−3.56)	(2.22)	(5.88)		
	α	β_{Mkt}	β_{SMB}	β_{HML}	β_{RMW}	β_{CMA}	R^2
	0.56	−0.15	−0.09	−0.05	0.17	0.21	0.39
	(7.59)	(−7.36)	(−2.49)	(−0.91)	(2.65)	(3.68)	

Correlations of the expected growth factor with other common factors

R_{Mkt}	R_{Me}	$R_{\mathrm{I/A}}$	R_{Roe}	SMB	HML	UMD	RMW	CMA
−0.53	−0.32	0.32	0.33	−0.36	0.21	0.28	0.35	0.34

Panel C: Deciles formed on the expected investment-to-assets changes

	Low	2	3	4	5	6	7	8	9	High	H−L
	The $E_t[\mathrm{d}^1\mathrm{I/A}]$ deciles ($\overline{\lvert\alpha_Q\rvert} = 0.1$, $p_{\mathrm{GRS}} = 0.02$)										
m	0.00	0.37	0.42	0.53	0.50	0.50	0.62	0.61	0.78	0.76	0.76
t_m	−0.01	1.45	1.85	2.50	2.41	2.70	3.43	3.22	4.06	3.70	4.71
α_Q	0.06	0.21	0.17	0.10	−0.13	0.05	0.11	−0.03	0.11	0.06	0.00
β_{Mkt}	1.04	1.05	1.03	1.00	1.06	0.97	0.97	1.03	1.01	1.05	0.01
β_{Me}	0.23	0.05	0.01	0.03	0.01	−0.15	−0.08	−0.08	0.02	−0.04	−0.27
$\beta_{\mathrm{I/A}}$	−0.46	−0.09	0.02	0.12	0.25	0.15	0.05	0.10	−0.20	−0.48	−0.02
β_{Roe}	−0.08	0.11	0.12	0.05	0.07	0.01	0.07	−0.01	0.09	−0.03	0.05
β_{Eg}	−0.76	−0.72	−0.61	−0.30	−0.09	−0.09	−0.02	0.19	0.34	0.71	1.48

	Low	2	3	4	5	6	7	8	9	High	H−L
t_Q	0.66	2.27	1.46	1.31	−1.61	0.52	1.31	−0.45	1.34	0.66	−0.02
t_{Mkt}	43.87	45.42	40.89	43.51	47.25	32.49	49.60	43.49	49.56	54.20	0.33
t_{Me}	6.80	1.08	0.28	0.66	0.42	−3.04	−2.53	−2.48	0.64	−1.34	−7.20
$t_{\mathrm{I/A}}$	−8.99	−1.03	0.27	1.96	4.23	2.55	0.73	1.96	−4.32	−7.59	−0.25
t_{Roe}	−2.02	2.01	1.97	1.06	1.52	0.08	1.54	−0.14	2.09	−0.92	1.13
t_{Eg}	−11.66	−10.31	−8.32	−4.23	−1.31	−1.27	−0.34	3.50	5.44	13.73	23.23
	The $E_t[\mathrm{d}^2\mathrm{I/A}]$ deciles ($\overline{\lvert\alpha_Q\rvert} = 0.05$, $p_{\mathrm{GRS}} = 0.79$)										
m	−0.01	0.33	0.41	0.45	0.50	0.63	0.63	0.71	0.68	0.81	0.82
t_m	−0.03	1.38	1.97	2.12	2.58	3.50	3.41	3.64	3.59	3.56	5.26
α_Q	0.14	0.14	−0.04	−0.01	0.00	−0.01	−0.01	0.00	0.01	0.10	−0.05
β_{Mkt}	1.03	1.03	1.02	1.05	0.99	0.97	0.97	1.03	1.02	1.09	0.07
β_{Me}	0.14	0.03	0.01	−0.03	−0.10	−0.05	−0.02	0.01	−0.04	0.04	−0.10
$\beta_{\mathrm{I/A}}$	−0.57	−0.17	0.05	0.07	0.12	0.20	0.24	0.12	−0.16	−0.47	0.10
β_{Roe}	0.04	0.11	0.19	0.06	0.16	0.13	0.09	0.09	−0.08	−0.15	−0.19
β_{Eg}	−0.81	−0.52	−0.30	−0.18	−0.15	0.03	0.04	0.19	0.51	0.79	1.60
t_Q	1.66	1.73	−0.55	−0.14	0.00	−0.09	−0.09	−0.04	0.17	0.95	−0.49
t_{Mkt}	51.53	50.24	34.47	35.03	43.01	43.64	41.26	44.68	45.57	49.79	2.78
t_{Me}	4.08	0.86	0.38	−0.56	−2.07	−1.74	−0.53	0.46	−1.18	0.87	−2.18
$t_{\mathrm{I/A}}$	−12.10	−3.46	1.04	1.05	2.19	4.12	3.88	1.96	−2.44	−6.22	1.51
t_{Roe}	1.02	2.41	3.97	1.13	3.93	3.63	1.94	1.67	−1.45	−2.93	−4.06
t_{Eg}	−12.43	−8.79	−4.84	−1.91	−2.57	0.63	0.58	3.24	7.62	11.08	21.20
	The $E_t[\mathrm{d}^3\mathrm{I/A}]$ deciles ($\overline{\lvert\alpha_Q\rvert} = 0.07$, $p_{\mathrm{GRS}} = 0.36$)										
m	0.00	0.29	0.39	0.54	0.47	0.60	0.70	0.60	0.69	1.01	1.01
t_m	−0.01	1.28	1.77	2.71	2.42	3.26	3.46	2.90	3.56	4.50	5.93
α_Q	0.15	0.12	−0.10	−0.05	−0.03	−0.02	0.09	0.02	0.04	0.08	−0.07
β_{Mkt}	1.04	1.00	1.03	1.03	0.98	0.96	1.01	1.03	1.03	1.10	0.06
β_{Me}	0.10	0.00	0.01	−0.07	−0.04	−0.03	−0.01	0.00	−0.07	0.17	0.08
$\beta_{\mathrm{I/A}}$	−0.56	−0.25	0.07	0.19	0.08	0.16	0.06	−0.02	−0.06	−0.19	0.37
β_{Roe}	0.07	0.09	0.26	0.25	0.11	0.10	0.07	−0.14	−0.16	−0.05	−0.12
β_{Eg}	−0.80	−0.41	−0.29	−0.17	−0.09	0.08	0.11	0.30	0.49	0.81	1.61
t_Q	1.80	1.37	−1.22	−0.52	−0.41	−0.22	1.12	0.26	0.40	0.64	−0.62
t_{Mkt}	50.86	37.48	43.18	43.82	47.11	48.47	38.88	44.22	39.78	48.93	2.20
t_{Me}	3.09	−0.11	0.19	−1.34	−1.13	−0.55	−0.33	0.04	−1.79	2.99	1.20
$t_{\mathrm{I/A}}$	−12.20	−5.31	1.19	2.68	1.66	2.44	0.83	−0.29	−0.78	−1.48	2.95
t_{Roe}	1.92	1.93	5.94	5.00	3.02	2.21	1.32	−2.53	−2.42	−0.68	−1.67
t_{Eg}	−12.89	−7.05	−4.19	−2.38	−1.66	1.18	1.69	4.40	6.00	9.67	17.21

Table 4 : Properties of the Intrinsic-to-Market Value Deciles

V^h is the historical Roe-based intrinsic value, and V^f the analysts' earnings forecasts-based intrinsic value from Frankel and Lee (1998). See Appendix B for their estimation details. At the end of June of each year t, we sort stocks into deciles based on NYSE breakpoints of V_t^h/P_t and V_t^f/P_t for the fiscal year ending in calendar year $t-1$, in which P_t is the market equity (from CRSP) at the end of December of year $t-1$. Monthly value-weighted decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$. The V^h/P deciles start in January 1967, and the V^f/P deciles in July 1976. Both samples end in December 2016. For each decile and the high-minus-low decile, we report average excess return, m, the q-factor alpha, α_q, the Q5 regression, including alpha, α_Q, the loadings on the market, size, investment, Roe, and expected growth factors, β_{Mkt}, β_{Me}, $\beta_{\mathrm{I/A}}$, β_{Roe}, and β_{Eg}, respectively, as well as the value-weighted decile investment-to-assets, I/A, Roe, and the expected 1-year ahead I/A change, $E_t[\mathrm{d}^1\mathrm{I/A}]$. All the t-values are adjusted for heteroscedasticity and autocorrelations. $\overline{|\alpha_Q|}$ is the mean absolute Q5-alpha, and p^Q_{GRS} the GRS p-value testing that the alphas are jointly zero across the deciles.

	Low	2	3	4	5	6	7	8	9	High	H−L
	Panel A: The V^h/P deciles ($\overline{\lvert\alpha_Q\rvert} = 0.13, p^Q_{\mathrm{GRS}} = 0.02$)										
m	0.41	0.45	0.56	0.48	0.50	0.59	0.77	0.66	0.91	0.78	0.38
t_m	1.64	2.19	3.06	2.69	2.65	3.23	4.36	3.42	4.68	3.35	2.05
α_q	0.15	−0.10	−0.10	−0.13	−0.17	−0.10	0.11	0.04	0.27	0.16	0.01
t_q	1.35	−1.32	−1.33	−1.52	−1.84	−1.02	1.20	0.38	2.26	1.20	0.06
α_Q	0.27	−0.07	−0.16	−0.14	−0.18	−0.17	0.01	−0.12	0.15	0.04	−0.23
β_{Mkt}	1.02	1.03	0.98	0.93	0.97	0.96	0.95	0.97	0.96	1.05	0.04
β_{Me}	−0.04	−0.07	0.00	−0.04	−0.02	0.02	0.04	0.08	0.12	0.23	0.27
$\beta_{\mathrm{I/A}}$	−0.68	−0.17	0.13	0.21	0.25	0.39	0.33	0.22	0.31	0.16	0.84
β_{Roe}	0.09	0.22	0.22	0.11	0.15	0.06	0.04	0.01	−0.02	−0.09	−0.18
β_{Eg}	−0.23	−0.05	0.11	0.02	0.02	0.14	0.19	0.29	0.22	0.22	0.45
t_Q	2.48	−0.95	−1.93	−1.74	−1.87	−1.77	0.15	−1.30	1.33	0.35	−1.24
t_{Mkt}	35.44	46.15	42.00	37.20	39.54	38.04	36.53	31.19	27.66	24.82	0.62
t_{Me}	−1.02	−2.28	−0.08	−0.95	−0.53	0.31	0.84	1.32	1.69	2.08	1.98
$t_{\mathrm{I/A}}$	−10.20	−3.18	2.03	2.94	2.80	4.01	4.60	2.72	3.38	1.27	4.97
t_{Roe}	1.52	5.87	4.30	1.90	1.95	0.78	0.69	0.15	−0.26	−0.85	−1.26
t_{Eg}	−2.85	−0.86	1.82	0.28	0.21	1.42	2.39	2.76	1.97	1.48	2.23
I/A	24.72	17.79	13.25	12.19	12.47	11.87	13.45	12.96	12.93	18.66	−6.06
[t]	27.78	33.14	37.50	31.65	37.20	24.69	24.36	19.95	34.16	27.17	−5.30
Roe	4.12	4.76	4.67	4.13	4.08	3.83	3.98	3.65	3.80	3.97	−0.15
[t]	38.06	56.58	45.81	44.90	49.66	44.86	39.29	31.06	32.33	28.28	−0.95
$E_t[\mathrm{d}^1\mathrm{I/A}]$	−2.67	−1.93	−0.80	−1.59	−1.31	−1.13	−0.64	0.36	−0.15	0.48	3.15
[t]	−3.03	−2.09	−1.02	−1.83	−1.60	−1.49	−0.84	0.59	−0.18	0.64	9.79

	Low	2	3	4	5	6	7	8	9	High	H−L
	Panel B: The V^f/P deciles ($\overline{\lvert\alpha_Q\rvert} = 0.16, p^Q_{\mathrm{GRS}} = 0.07$)										
m	0.46	0.58	0.66	0.59	0.61	0.65	0.60	0.88	0.61	0.93	0.47
t_m	1.67	2.74	3.28	3.05	3.31	3.41	2.84	4.16	2.84	3.64	2.18
α_q	0.11	−0.17	−0.07	−0.12	−0.17	−0.10	−0.16	0.16	−0.13	0.23	0.12
t_q	0.97	−1.80	−0.83	−1.40	−1.73	−0.97	−1.39	1.26	−0.82	1.45	0.55
α_Q	0.15	−0.20	−0.12	−0.16	−0.19	−0.21	−0.16	0.08	−0.18	0.18	0.03
β_{Mkt}	1.08	0.99	0.97	0.93	0.92	0.97	0.94	1.01	0.96	1.06	−0.01
β_{Me}	−0.05	−0.02	−0.05	−0.11	−0.09	−0.05	0.05	−0.02	0.02	0.14	0.19
$\beta_{\mathrm{I/A}}$	−0.50	0.06	0.15	0.20	0.39	0.37	0.34	0.42	0.17	0.02	0.52
β_{Roe}	−0.17	0.25	0.19	0.21	0.21	0.08	0.11	−0.04	0.18	0.02	0.19
β_{Eg}	−0.07	0.05	0.09	0.06	0.04	0.21	0.01	0.15	0.10	0.10	0.17
t_Q	1.23	−1.97	−1.44	−1.59	−1.81	−2.03	−1.43	0.60	−1.15	1.19	0.15
t_{Mkt}	32.66	39.30	38.68	34.89	37.31	29.08	28.42	21.50	24.09	27.41	−0.25
t_{Me}	−1.10	−0.61	−1.57	−2.14	−1.99	−1.02	0.70	−0.28	0.22	1.71	1.81
$t_{\mathrm{I/A}}$	−7.19	0.74	2.51	2.81	3.95	3.95	3.49	4.02	1.46	0.16	3.22
t_{Roe}	−2.54	5.14	4.43	3.17	2.90	1.15	1.54	−0.51	1.96	0.23	1.48
t_{Eg}	−0.80	0.75	1.44	0.64	0.47	2.69	0.06	1.44	0.77	0.80	0.97
I/A	25.56	15.49	13.29	11.41	12.92	12.74	10.89	13.08	13.96	16.36	−9.19
$[t]$	25.73	39.65	23.82	28.52	18.68	16.25	22.11	23.29	25.93	21.30	−7.81
Roe	3.33	4.61	4.48	4.33	4.15	3.79	3.69	3.94	4.16	4.50	1.16
$[t]$	19.56	48.94	67.64	46.80	46.62	37.17	36.62	31.47	29.41	26.04	4.02
$E_t[\mathrm{d}^1\mathrm{I/A}]$	−3.01	−1.55	−1.79	−1.39	−0.94	−1.66	−1.08	−0.35	0.04	−0.87	2.14
$[t]$	−2.79	−1.54	−1.78	−1.46	−1.17	−1.65	−1.23	−0.46	0.05	−0.92	6.26

Table 5 : The List of Anomalies That the q-factor Model Cannot Explain

The q-anomalies are grouped into six categories: (i) momentum; (ii) value-versus-growth; (iii) investment; (iv) profitability; (v) intangibles; and (vi) trading frictions. The number in parenthesis in the title of a panel is the number of q-anomalies in the category. The total number of q-anomalies is 46. For each anomaly variable, we list its symbol, brief description, and its academic source. Appendix C details variable definition and portfolio construction.

Panel A: Momentum (8)			
Abr1	Cumulative abnormal stock returns around earnings announcements (1-month holding period), Chan, Jegadeesh, and Lakonishok (1996)	Abr6	Cumulative abnormal stock returns around earnings announcements (6-month holding period), Chan, Jegadeesh, and Lakonishok (1996)
Abr12	Cumulative abnormal stock returns around earnings announcements (12-month holding period), Chan, Jegadeesh, and Lakonishok (1996)	dEf1	Analysts' forecast change (1-month hold period), Hawkins, Chamberlin, and Daniel (1984)
Sm1	Segment momentum (1-month holding period), Cohen and Lou (2012)	Ilr1	Industry lead-lag effect in prior returns (1-month holding period), Hou (2007)
Cm1	Customer momentum (1-month holding period), Cohen and Frazzini (2008)	Cim1	Customer industries momentum (1-month holding period), Menzly and Ozbas (2010)
Panel B: Value-versus-growth (4)			
$\text{Bm}^{\text{q}}12$	Quarterly Book-to-market equity (12-month holding period), Asness and Frazzini (2013)	Nop	Net payout yield, Boudoukh, Michaely, Richardson, and Roberts (2007)
$\text{Em}^{\text{q}}1$	Quarterly Enterprise multiple (1-month holding period) Loughran and Wellman (2011)	Ocp	Operating cash flow-to-price, Desai, Rajgopal, and Venkatachalam (2004)
Panel C: Investment (9)			
Noa	Net operating assets, Hirshleifer, Hou, Teoh, and Zhang (2004)	Nsi	Net stock issues, Pontiff and Woodgate (2008)
Cei	Composite equity issuance, Daniel and Titman (2006)	Ivc	Inventory changes, Thomas and Zhang (2002)
Oa	Operating accruals, Sloan (1996)	dWc	Change in net non-cash working capital, Richardson, Sloan, Soliman, and Tuna (2005)
dFin	Change in net financial assets, Richardson, Sloan, Soliman, and Tuna (2005)	Dac	Discretionary accruals, Xie (2001)
Pda	Percent discretionary accruals, Hafzalla, Lundholm, and Van Winkle (2011)		

Panel D: Profitability (12)

dRoe1	Change in Roe (1-month holding period)	Ato^q1	Quarterly asset turnover (1-month holding period)
Ato^q6	Quarterly asset turnover (6-month holding period)	Ato^q12	Quarterly asset turnover (12-month holding period)
Opa	Operating profits-to-assets, Ball, Gerakos, Linnainmaa, and Nikolaev (2015)	Ola^q1	Operating profits-to-lagged assets (1-month holding period)
Ola^q12	Operating profits-to-lagged assets (12-month holding period)	Cop	Cash-based operating profitability, Ball, Gerakos, Linnainmaa, and Nikolaev (2016)
Cla	Cash-based operating profits-to-lagged assets	Cla^q1	Cash-based operating profits-to-lagged assets (1-month holding period)
Cla^q6	Cash-based operating profits-to-lagged assets (6-month holding period)	Cla^q12	Cash-based operating profits-to-lagged assets (12-month holding period)

Panel E: Intangibles (11)

Rdm	R&D-to-market, Chan, Lakonishok, and Sougiannis (2001)	Rdm^q1	Quarterly R&D-to-market (1-month holding period)
Rdm^q6	Quarterly R&D-to-market (6-month holding period)	Rdm^q12	Quarterly R&D-to-market (12-month holding period)
Rer	Real estate ratio, Tuzel (2010)	Eprd	Earnings predictability, Francis, Lafond, Olsson, and Schipper (2004)
R_{a}^{1}	12-month-lagged return, Heston and Sadka (2008)	$R_{\text{a}}^{[2,5]}$	Years 2–5 lagged returns, annual Heston and Sadka (2008)
$R_{\text{a}}^{[6,10]}$	Years 6–10 lagged returns, annual Heston and Sadka (2008)	$R_{\text{a}}^{[11,15]}$	Years 11–15 lagged returns, annual Heston and Sadka (2008)
$R_{\text{a}}^{[16,20]}$	Years 16–20 lagged returns, annual Heston and Sadka (2008)		

Panel F: Trading frictions (2)

Isff1	Idiosyncratic skewness per the FF 3-factor model, (1-month holding period)	Isq1	Idiosyncratic skewness per the q-factor model, (1-month holding period)

Table 6 : Overall Performance of the q-factor and Q5 Models Across the 46 Anomalies

For a given factor model, $\overline{|\alpha_{\mathrm{H-L}}|}$ is the average magnitude of the high-minus-low alphas, $\#_{|t^{\alpha}_{\mathrm{H-L}}|\geq 1.96}$ the number of the high-minus-low alphas with absolute t-values greater than or equal to 1.96, $\#_{|t^{\alpha}_{\mathrm{H-L}}|\geq 3}$ the number of the high-minus-low alphas with absolute t-values greater than or equal to three, $\overline{|\alpha|}$ the mean absolute alpha across all the anomalies within a given category, and $\#_{p_{\mathrm{GRS}}<5\%}$ the number of sets of deciles within a given category, with which the factor model is rejected by the GRS test at the 5% level.

	$\overline{\lvert\alpha_{\mathrm{H-L}}\rvert}$	$\#_{\lvert t^{\alpha}_{\mathrm{H-L}}\rvert\geq 1.96}$	$\#_{\lvert t^{\alpha}_{\mathrm{H-L}}\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#_{p_{\mathrm{GRS}}<5\%}$	$\overline{\lvert\alpha_{\mathrm{H-L}}\rvert}$	$\#_{\lvert t^{\alpha}_{\mathrm{H-L}}\rvert\geq 1.96}$	$\#_{\lvert t^{\alpha}_{\mathrm{H-L}}\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#_{p_{\mathrm{GRS}}<5\%}$
	Panel A: All 46 anomalies					Panel B: Momentum				
The q-factor model	0.52	46	17	0.16	39	0.55	8	1	0.14	6
The Q5 model	0.34	19	4	0.12	18	0.52	6	1	0.12	5
	Panel C: Value-versus-growth					Panel D: Investment				
The q-factor model	0.39	4	0	0.14	4	0.43	9	4	0.12	8
The Q5 model	0.28	1	0	0.14	2	0.15	2	0	0.09	2
	Panel E: Profitability					Panel F: Intangibles				
The q-factor model	0.44	12	4	0.11	9	0.77	11	8	0.26	10
The Q5 model	0.11	1	0	0.08	0	0.64	8	3	0.20	9
	Panel G: Trading frictions									
The q-factor model	0.28	2	1	0.09	2					
The Q5 model	0.21	1	0	0.08	0					

Table 7 : Individual Factor Regressions of 46 q-anomalies

For each of the 46 q-anomalies, we report the average return of the high-minus-low decile, m, and its t-value, t_m, the q-factor alpha of the high-minus-low decile, α_q, and its t-value, t_q, and the Q5-factor regression, including the intercept, α_Q, and the loadings on the market, size, investment-to-assets, Roe, and expected growth factors, denoted β_{Mkt}, β_{Me}, $\beta_{\mathrm{I/A}}$, β_{Roe}, and β_{Eg}, respectively. We also report the mean absolute alpha across a given set of deciles from the q-factor model, $\overline{|\alpha_q|}$, and the Q5 model, $\overline{|\alpha_Q|}$, as well as their p-values, denoted p^q_{GRS} and p^Q_{GRS}, respectively, from the Gibbons, Ross, and Shanken (1989) test that the alphas from a given set of deciles are jointly zero. Finally, we report the average spread in the future one-, two-, and three-year investment-to-asset changes across the extreme deciles, denoted $\mathrm{d}^1\mathrm{I/A}$, $\mathrm{d}^2\mathrm{I/A}$, and $\mathrm{d}^3\mathrm{I/A}$, as well as their t-values testing a given spread is zero, denoted t_1, t_2, and t_3, respectively. Table 5 briefly describes the anomaly symbols, and Appendix C details variable definition and portfolio construction.

	Panel A: Momentum								Panel B: Value-versus-growth			
	Abr1	Abr6	Abr12	dEf1	Sm1	Ilr1	Cm1	Cim1	$\mathrm{Bm^q12}$	Nop	$\mathrm{Em^q1}$	Ocp
The average high-minus-low decile return												
m	0.70	0.33	0.23	0.94	0.53	0.69	0.78	0.75	0.48	0.63	−0.71	0.70
t_m	5.45	3.41	2.99	4.33	2.36	3.33	3.85	3.35	2.21	3.40	−3.21	3.14
The q-factor regressions												
α_q	0.62	0.30	0.24	0.55	0.59	0.73	0.70	0.64	0.37	0.35	−0.48	0.36
t_q	4.25	2.61	2.79	2.49	2.15	2.94	2.84	2.36	2.18	2.42	−2.00	1.98
$\overline{\lvert\alpha_q\rvert}$	0.12	0.07	0.07	0.16	0.12	0.19	0.21	0.18	0.13	0.11	0.20	0.11
p^q_{GRS}	0.00	0.00	0.00	0.00	0.17	0.04	0.06	0.02	0.00	0.01	0.00	0.04
The Q5-factor regressions												
α_Q	0.65	0.30	0.24	0.53	0.55	0.68	0.76	0.46	0.38	0.08	−0.47	0.20
t_Q	4.58	2.60	2.72	2.25	1.88	2.82	2.96	1.63	2.25	0.58	−1.92	1.14
$\overline{\lvert\alpha_Q\rvert}$	0.13	0.07	0.05	0.14	0.12	0.15	0.21	0.13	0.14	0.11	0.20	0.11
p^Q_{GRS}	0.00	0.00	0.01	0.02	0.33	0.37	0.03	0.14	0.00	0.12	0.00	0.11
β_{Mkt}	−0.07	−0.03	−0.02	0.02	−0.01	−0.16	0.05	0.04	0.03	−0.08	0.05	0.05
β_{Me}	0.06	0.08	0.07	−0.06	−0.21	−0.10	−0.16	−0.15	0.32	−0.31	0.05	0.18
$\beta_{\mathrm{I/A}}$	−0.13	−0.18	−0.26	−0.16	0.15	0.08	0.27	0.12	1.25	1.00	−0.69	1.39
β_{Roe}	0.28	0.18	0.16	0.77	−0.10	0.05	−0.03	0.16	−0.95	−0.02	−0.04	−0.58
β_{Eg}	−0.06	−0.01	−0.01	0.05	0.08	0.11	−0.11	0.32	−0.03	0.49	−0.02	0.30
t_{Mkt}	−1.89	−1.27	−0.72	0.32	−0.10	−2.47	0.77	0.52	0.57	−1.97	0.85	0.94
t_{Me}	0.58	1.70	1.78	−0.63	−2.18	−1.02	−1.91	−1.60	2.91	−3.44	0.44	1.48
$t_{\mathrm{I/A}}$	−1.18	−2.42	−4.42	−1.12	0.82	0.51	1.54	0.65	9.16	9.72	−4.67	9.25
t_{Roe}	3.11	3.03	3.98	7.08	−0.61	0.37	−0.22	1.10	−8.57	−0.15	−0.28	−4.51
t_{Eg}	−0.40	−0.17	−0.14	0.29	0.40	0.63	−0.63	1.67	−0.16	3.40	−0.09	1.67
The average high-minus-low spread in the future one-, two-, and three-year I/A changes												
$\mathrm{d}^1\mathrm{I/A}$	3.36	4.48	4.43	7.68	1.21	0.37	1.84	0.94	−7.70	18.44	0.30	−1.32
$\mathrm{d}^2\mathrm{I/A}$	5.67	5.50	4.46	13.44	2.77	3.37	1.62	3.09	−5.16	24.26	−3.37	5.14
$\mathrm{d}^3\mathrm{I/A}$	4.83	4.01	2.47	9.55	2.48	2.89	2.03	2.93	−0.88	26.59	−4.98	7.70
t^1	4.66	8.17	11.49	7.15	1.49	0.65	2.21	1.20	−6.97	13.59	0.36	−1.27
t^2	7.27	9.33	11.25	11.49	3.09	5.09	1.82	4.33	−4.00	13.66	−2.99	3.82
t^3	6.26	6.69	6.12	8.72	2.63	4.54	2.00	3.97	−0.72	15.58	−5.79	6.43

	Panel C: Investment								
	Noa	Nsi	Cei	Ivc	Oa	dWc	dFin	Dac	Pda
	The average high-minus-low decile return								
m	−0.44	−0.64	−0.57	−0.44	−0.27	−0.42	0.28	−0.39	−0.48
t_m	−3.25	−4.46	−3.32	−3.33	−2.19	−3.25	2.39	−2.95	−3.91
	The q-factor regressions								
α_q	−0.45	−0.29	−0.29	−0.28	−0.56	−0.51	0.43	−0.67	−0.39
t_q	−2.59	−2.32	−2.25	−2.08	−4.10	−3.80	3.00	−4.73	−2.60
$\overline{\lvert\alpha_q\rvert}$	0.11	0.12	0.12	0.07	0.13	0.13	0.08	0.15	0.17
p^q_{GRS}	0.00	0.00	0.00	0.28	0.00	0.00	0.02	0.00	0.00
	The Q5-factor regressions								
α_Q	−0.12	−0.12	0.00	−0.02	−0.26	−0.29	0.17	−0.32	−0.09
t_Q	−0.79	−0.90	0.01	−0.13	−1.85	−2.16	1.22	−2.22	−0.61
$\overline{\lvert\alpha_Q\rvert}$	0.08	0.11	0.09	0.08	0.07	0.09	0.06	0.08	0.11
p^Q_{GRS}	0.04	0.01	0.25	0.43	0.31	0.17	0.66	0.18	0.07
β_{Mkt}	−0.11	−0.02	0.13	−0.04	−0.03	−0.05	0.05	−0.09	−0.08
β_{Me}	0.07	0.13	0.24	−0.05	0.27	0.34	−0.07	0.14	0.02
$\beta_{\mathrm{I/A}}$	0.05	−0.61	−0.93	−0.61	0.07	−0.24	−0.37	0.36	−0.18
β_{Roe}	0.09	−0.22	−0.05	0.25	0.37	0.21	−0.03	0.28	0.06
β_{Eg}	−0.62	−0.33	−0.54	−0.49	−0.56	−0.41	0.49	−0.65	−0.56
t_{Mkt}	−2.95	−0.54	3.92	−1.33	−0.81	−1.11	1.60	−2.73	−2.18
t_{Me}	0.78	1.64	3.33	−1.00	5.11	3.64	−1.57	2.59	0.31
$t_{\mathrm{I/A}}$	0.35	−7.12	−11.61	−5.66	0.70	−2.33	−3.16	3.94	−1.55
t_{Roe}	0.96	−3.57	−0.59	2.85	5.35	3.08	−0.44	4.23	0.79
t_{Eg}	−5.58	−3.14	−4.85	−5.47	−5.31	−3.50	5.61	−6.81	−5.57
The average high-minus-low spread in the future one-, two-, and three-year I/A changes									
$\mathrm{d}^1\mathrm{I/A}$	−49.21	−34.29	−8.74	−30.09	−2.29	−16.25	36.33	−6.16	−3.21
$\mathrm{d}^2\mathrm{I/A}$	−54.36	−39.42	−18.67	−35.02	−6.73	−21.13	36.28	−9.86	−8.07
$\mathrm{d}^3\mathrm{I/A}$	−53.26	−40.18	−22.51	−38.45	−8.36	−21.03	37.35	−8.92	−10.02
t^1	−18.41	−14.71	−6.29	−24.94	−1.15	−12.18	19.42	−4.40	−1.77
t^2	−19.29	−16.68	−13.26	−28.37	−3.26	−14.17	18.31	−6.23	−5.53
t^3	−18.99	−16.49	−12.69	−26.66	−3.89	−12.56	18.42	−5.30	−7.15

	Panel D: Profitability											
	dRoe1	$\text{Ato}^{\text{q}}1$	$\text{Ato}^{\text{q}}6$	$\text{Ato}^{\text{q}}12$	Opa	$\text{Ola}^{\text{q}}1$	$\text{Ola}^{\text{q}}12$	Cop	Cla	$\text{Cla}^{\text{q}}1$	$\text{Cla}^{\text{q}}6$	$\text{Cla}^{\text{q}}12$
	The average high-minus-low decile return											
m	0.75	0.62	0.53	0.42	0.41	0.75	0.46	0.63	0.55	0.52	0.49	0.46
t_m	5.53	3.44	3.07	2.56	2.09	3.53	2.46	3.57	3.23	3.26	3.60	3.63
	The q-factor regressions											
α_q	0.34	0.35	0.34	0.32	0.46	0.40	0.32	0.69	0.75	0.46	0.41	0.45
t_q	2.37	2.06	2.09	2.03	2.96	2.64	2.49	5.04	5.23	3.02	2.97	3.63
$\overline{\lvert\alpha_q\rvert}$	0.09	0.11	0.07	0.07	0.13	0.13	0.07	0.17	0.14	0.19	0.10	0.11
p^q_{GRS}	0.04	0.01	0.08	0.07	0.00	0.01	0.05	0.00	0.00	0.00	0.02	0.00
	The Q5-factor regressions											
α_Q	0.42	0.07	0.09	0.09	−0.06	0.01	−0.10	0.12	0.19	0.09	0.01	0.07
t_Q	2.85	0.43	0.54	0.58	−0.42	0.06	−0.94	1.11	1.72	0.62	0.11	0.70
$\overline{\lvert\alpha_Q\rvert}$	0.08	0.11	0.09	0.10	0.09	0.07	0.07	0.08	0.07	0.06	0.05	0.04
p^Q_{GRS}	0.06	0.10	0.25	0.14	0.12	0.35	0.22	0.15	0.30	0.69	0.79	0.21
β_{Mkt}	0.00	0.19	0.17	0.15	−0.09	0.00	−0.01	−0.05	−0.03	0.03	0.08	0.04
β_{Me}	−0.06	0.45	0.40	0.35	−0.39	−0.28	−0.32	−0.52	−0.55	−0.29	−0.28	−0.27
$\beta_{\text{I/A}}$	0.24	−0.57	−0.68	−0.75	−0.49	−0.32	−0.49	−0.22	−0.46	−0.21	−0.19	−0.24
β_{Roe}	0.62	0.48	0.47	0.41	0.53	0.95	0.73	0.34	0.26	0.35	0.31	0.26
β_{Eg}	−0.14	0.52	0.47	0.42	0.97	0.72	0.77	1.09	1.06	0.68	0.72	0.69
t_{Mkt}	−0.13	3.28	3.23	2.94	−2.97	0.13	−0.44	−1.55	−0.88	0.66	2.79	1.85
t_{Me}	−0.79	6.14	6.33	6.33	−5.98	−4.57	−7.69	−11.06	−12.26	−5.43	−7.05	−8.50
$t_{\text{I/A}}$	2.66	−6.25	−7.54	−8.35	−6.09	−3.21	−6.73	−3.33	−6.55	−2.00	−2.31	−3.45
t_{Roe}	6.62	5.11	6.47	6.26	8.87	11.64	10.96	6.77	4.12	4.42	6.04	5.69
t_{Eg}	−1.09	3.79	4.13	3.99	10.19	7.22	9.46	14.53	13.88	6.53	9.90	10.65
	The average high-minus-low spread in the future one-, two-, and three-year I/A changes											
$\text{d}^1\text{I/A}$	5.02	6.83	7.83	7.31	10.88	11.50	6.47	20.49	7.33	−1.49	0.41	2.92
$\text{d}^2\text{I/A}$	14.38	11.37	10.10	7.98	12.22	12.98	5.76	27.01	12.58	6.40	6.93	7.43
$\text{d}^3\text{I/A}$	12.65	9.27	8.10	6.04	13.22	9.85	4.05	28.57	13.99	6.64	6.79	7.47
t^1	3.71	5.82	6.74	6.51	5.16	6.78	4.63	10.67	3.65	−1.85	0.59	4.12
t^2	17.09	7.87	7.69	6.81	4.75	6.94	3.93	12.73	7.05	7.77	8.48	8.50
t^3	15.38	6.22	5.94	5.00	4.83	4.94	2.47	11.99	7.18	7.04	7.38	8.12

	Panel E: Intangibles											Panel F: Frictions	
	Rdm	Rdm^{q}1	Rdm^{q}6	Rdm^{q}12	Rer	Eprd	R_a^1	$R_a^{[2,5]}$	$R_a^{[6,10]}$	$R_a^{[11,15]}$	$R_a^{[16,20]}$	Isff1	Isq1
	The average high-minus-low decile return												
m	0.70	1.11	0.80	0.82	0.34	−0.53	0.67	0.69	0.83	0.62	0.54	0.28	0.25
t_m	2.75	2.91	2.18	2.43	2.44	−2.96	3.43	4.11	5.06	4.46	3.26	3.11	2.80
	The q-factor regressions												
α_q	0.72	1.39	0.95	0.81	0.34	−0.55	0.58	0.81	1.11	0.60	0.62	0.27	0.29
t_q	3.11	3.06	2.87	3.01	2.05	−3.02	2.75	4.06	5.05	3.48	3.22	2.56	2.84
$\overline{\lvert\alpha_q\rvert}$	0.27	0.52	0.46	0.45	0.14	0.16	0.14	0.16	0.24	0.17	0.15	0.09	0.10
p^q_{GRS}	0.00	0.00	0.00	0.00	0.02	0.01	0.07	0.00	0.00	0.00	0.01	0.00	0.00
	The Q5-factor regressions												
α_Q	0.27	1.30	0.72	0.52	0.30	−0.48	0.52	0.79	1.00	0.57	0.57	0.23	0.19
t_Q	1.22	2.74	2.07	1.85	1.75	−2.97	2.47	3.82	4.78	3.40	2.64	2.02	1.74
$\overline{\lvert\alpha_Q\rvert}$	0.13	0.38	0.28	0.23	0.13	0.17	0.15	0.15	0.21	0.17	0.16	0.08	0.08
p^Q_{GRS}	0.20	0.00	0.02	0.03	0.03	0.02	0.10	0.00	0.00	0.00	0.02	0.06	0.10
β_{Mkt}	0.29	0.04	−0.01	0.01	0.08	0.09	0.23	0.07	0.00	0.00	−0.05	0.00	0.01
β_{Me}	0.67	0.17	0.54	0.63	−0.11	0.35	−0.15	−0.17	0.04	−0.06	−0.07	0.14	0.21
$\beta_{\mathrm{I/A}}$	0.05	0.57	0.63	0.76	−0.08	0.47	−0.19	−0.29	−0.39	−0.02	−0.06	−0.01	−0.07
β_{Roe}	−0.76	−1.04	−0.97	−0.80	0.04	−0.61	0.16	0.03	−0.25	0.08	−0.03	−0.06	−0.15
β_{Eg}	0.86	0.17	0.42	0.52	0.08	−0.12	0.11	0.03	0.20	0.05	0.10	0.09	0.19
t_{Mkt}	5.26	0.29	−0.06	0.15	1.66	1.80	3.95	1.27	−0.01	−0.04	−0.89	0.02	0.31
t_{Me}	8.96	0.82	3.72	5.22	−1.07	4.44	−1.24	−1.61	0.44	−0.68	−1.25	3.85	2.99
$t_{\mathrm{I/A}}$	0.31	1.92	2.98	4.22	−0.70	3.82	−1.22	−2.43	−2.32	−0.16	−0.48	−0.22	−0.94
t_{Roe}	−5.89	−3.58	−5.15	−5.58	0.38	−5.44	1.11	0.31	−2.13	0.85	−0.28	−1.09	−2.72
t_{Eg}	5.12	0.50	1.35	2.18	0.49	−0.83	0.60	0.21	1.29	0.33	0.85	1.13	2.39
	The average high-minus-low spread in the future one-, two-, and three-year I/A changes												
d^1I/A	−0.15	−6.05	−4.81	−2.54	−2.18	0.96	6.08	−2.58	−0.08	−0.94	0.40	0.10	0.35
d^2I/A	5.68	−3.05	0.47	4.65	4.30	1.56	4.32	−3.61	−1.12	0.08	0.51	0.17	0.81
d^3I/A	5.75	3.84	6.63	9.73	4.64	1.41	2.96	−5.15	−1.74	−0.69	0.85	0.23	0.72
t^1	−0.12	−2.86	−2.66	−1.84	−1.79	1.00	10.54	−4.33	−0.17	−1.81	0.98	0.23	0.92
t^2	3.11	−1.19	0.20	2.26	4.48	1.70	6.22	−6.51	−1.80	0.16	1.19	0.39	1.63
t^3	3.36	1.49	2.78	4.75	4.87	1.55	4.22	−8.52	−3.06	−1.21	1.84	0.53	1.34

A Derivations

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} 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 (4), 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 (5), 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 equation (3):

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

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 (12) then follows by combining equations (A1) and (A6).

Finally, we are ready to prove equation (5):

$$
\begin{aligned}
w_{it} r^{Ba}_{it+1} + (1 - w_{it}) r^S_{it+1} &= \frac{\left[\begin{array}{c} (1-\tau) r^B_{it+1} B_{it+1} + \tau B_{it+1} + P_{it+1} \\ +(1-\tau)[\Pi(X_{it+1}, A_{it+1}) - \Phi(I_{it+1}, A_{it+1}) - r^B_{it+1} B_{it+1}] \\ -\tau B_{it+1} - I_{it+1} + B_{it+2} + \tau\delta A_{it+1} \end{array}\right]}{P_{it} + B_{it+1}} \\
&= \frac{1}{q_{it} A_{it+1}} \left[\begin{array}{c} q_{it+1}(I_{it+1} + (1-\delta) A_{it+1}) + (1-\tau)[\Pi(X_{it+1}, A_{it+1}) \\ -\Phi(I_{it+1}, A_{it+1})] - I_{it+1} + \tau\delta A_{it+1} \end{array}\right] \\
&= \frac{q_{it+1}(1-\delta) + (1-\tau)\left[X_{it+1} - \frac{\partial \Phi(I_{it+1}, A_{it+1})}{\partial A_{it+1}}\right] + \tau\delta}{q_{it}} = r^I_{it+1}. \qquad \text{(A7)}
\end{aligned}
$$

Equation (13) then follows by rewriting equation (5) 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 Estimating the Intrinsic Values

This appendix provides the details of estimating the intrinsic values given by equations (10) and (11), following Frankel and Lee (1998). Be_t is the book equity (Compustat annual item CEQ) for the fiscal year ending in calendar year $t-1$. Future book equity is computed using the clean surplus accounting: $Be_{t+1} = (1+(1-k)E_t[\text{Roe}_{t+1}])Be_t$, and $Be_{t+2} = (1+(1-k)E_t[\text{Roe}_{t+2}])Be_{t+1}$. $E_t[\text{Roe}_{t+1}]$ and $E_t[\text{Roe}_{t+2}]$ are the return on equity expected for the current and next fiscal years. k is the dividend payout ratio, measured as common stock dividends (item DVC) divided by earnings (item IBCOM) for the fiscal year ending in calendar year $t-1$. For firms with negative earnings, we divide dividends by 6% of average total assets (item AT). r is a constant discount rate of 12%.

When estimating V^h_t, we replace all Roe expectations with most recent Roe_t: $\text{Roe}_t = Ni_t/[(Be_t + Be_{t-1})/2]$, in which Ni_t is earnings for the fiscal year ending in $t-1$, and B_t and B_{t-1} are the book equity from the fiscal years ending in $t-1$ and $t-2$. When estimating V^f_t, we use analysts' earnings forecasts from IBES to construct Roe expectations. Let Fy1 and Fy2 be the one-year-ahead and two-year-ahead consensus mean forecasts (IBES unadjusted file, item MEANEST; fiscal period indicator = 1 and 2) reported in June of year t. Let s be the number of shares outstanding 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. Then $E_t[\text{Roe}_{t+1}] = s\text{Fy1}/[(Be_{t+1} + Be_t)/2]$, in which $Be_{t+1} = (1 + s(1-k)\text{Fy1})Be_t$. Analogously, $E_t[\text{Roe}_{t+2}] = s\text{Fy2}/[(Be_{t+2} + Be_{t+1})/2]$, in which $Be_{t+2} = (1 + s(1-k)\text{Fy2})Be_{t+1}$. Let Ltg denote the long-term earnings growth rate forecast from IBES (item MEANEST; fiscal period indicator = 0). Then $E_t[\text{Roe}_{t+3}] = s\text{Fy2}(1+\text{Ltg})/[(Be_{t+3} + Be_{t+2})/2]$, in which $Be_{t+3} = (1+s(1-k)\text{Fy2}(1+\text{Ltg}))Be_{t+2}$. If Ltg is missing, we set $E_t[\text{Roe}_{t+3}]$ to $E_t[\text{Roe}_{t+2}]$. Following Frankel and Lee (1998), we exclude firms if their expected Roe or dividend payout ratio is higher than 100%. We also exclude firms with negative book equity and firms with non-positive intrinsic value.

C Variable Definitions

Abr1, Abr6, and Abr12, Cumulative abnormal returns around earnings announcement dates. We calculate cumulative abnormal stock return (Abr) around the latest quarterly earnings announcement date (Compustat quarterly item RDQ) (Chan, Jegadeesh, and Lakonishok 1996), $\mathrm{Abr}_i = \sum_{d=-2}^{+1} r_{id} - r_{md}$, in which r_{id} is stock i's return on day d (with the earnings announced on day 0), and r_{md} is the value-weighted 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.

At the beginning of each month t, we split all stocks into deciles based on their most recent past Abr. For a firm to enter our portfolio formation, we require the end of the fiscal quarter that corresponds to its most recent Abr to be within six months prior to the portfolio formation. 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. Monthly decile returns are calculated for the current month t (Abr1), and, separately, from month t to $t+5$ (Abr6) and from month t to $t+11$ (Abr12). The deciles are rebalanced monthly. The six-month holding period for Abr6 means that for a given decile in each month there exist six sub-deciles, each of which is initiated in a different month in the prior six-month period. We take the simple average of the sub-decile returns as the monthly return of the Abr6 decile. Because quarterly earnings announcement dates are largely unavailable before 1972, the Abr portfolios start in January 1972.

dEf1, Changes in analyst earnings forecasts. Following Hawkins, Chamberlin, and Daniel (1984), we define $\mathrm{dEf} \equiv (f_{it-1} - f_{it-2})/(0.5\,|f_{it-1}| + 0.5\,|f_{it-2}|)$, in which f_{it-1} is the consensus mean forecast (IBES unadjusted file, item MEANEST) issued in month $t-1$ for firm i's current fiscal year earnings (fiscal period indicator = 1). We require earnings forecasts to be denominated in US dollars (currency code = USD). We also adjust for any stock splits between months $t-2$ and $t-1$ when constructing dEf. At the beginning of each month t, we sort stocks into deciles on the prior month dEf, and calculate returns for the current month t. The deciles are rebalanced at the beginning of month $t+1$. Because analyst forecast data start in January 1976, the dEf portfolios start in March 1976.

Sm1, Segment momentum. Following Cohen and Lou (2012), we extract firms' segment accounting and financial information from Compustat segment files. Industries are based on two-digit SIC codes. Standalone firms are those that operate in only one industry with segment sales, reported in Compustat segment files, accounting for more than 80% of total sales reported in Compustat annual files. Conglomerate firms are those that operating in more than one industry with aggregate sales from all reported segments accounting for more than 80% of total sales.

At the end of June of each year, we form a pseudo-conglomerate for each conglomerate firm. The pseudo-conglomerate is a portfolio of the conglomerate's industry segments constructed with solely the standalone firms in each industry. The segment portfolios (value-weighted across standalone firms) are then weighted by the percentage of sales contributed by each industry segment within the conglomerate. At the beginning of each month t (starting in July), using segment information form the previous fiscal year, we sort all conglomerate firms into deciles based on the returns of their pseudo-conglomerate portfolios in month $t-1$. Monthly deciles are calculated for month t, and the deciles are rebalanced at the beginning of month $t+1$. Because the segment data start in 1976, the Sm portfolios start in July 1977.

Ilr1, Industry lead-lag effect in prior returns. Excluding financial firms from the Fama-French (1997) 49-industry classifications leaves 45 industries. At the beginning of each month t, we sort industries based on the month $t-1$ value-weighted return of the portfolio consisting of the 30% biggest (market equity) firms within a given industry. We form nine portfolios ($9 \times 5 = 45$), each of which contains five different industries. We define the return of a given portfolio as the simple average of the five value-weighted industry returns within the portfolio. The nine portfolio returns are calculated for the current month t, and the portfolios are rebalanced at the beginning of month $t+1$.

Cm1, Customer momentum. Following Cohen and Frazzini (2008), we extract firms' principal customers from Compustat segment files. For each firm we determine whether the customer is another company listed on the CRSP/Compustat tape, and we assign it the corresponding CRSP permno number. At the end of June of each year t, we form a customer portfolio for each firm with identifiable firm-customer relations for the fiscal year ending in calendar year $t-1$. For firms with multiple customer firms, we form equal-weighted customer portfolios. The customer portfolio returns are calculated from July of year t to June of $t+1$, and the portfolios are rebalanced in June. At the beginning of each month t, we sort all stocks into quintiles based on their customer portfolio returns, Cm, in month $t-1$. We do not form deciles because a disproportionate number of firms can have the same Cm, which leads to fewer than ten portfolios in some months. Monthly quintile returns are calculated for month t, and the quintiles are rebalanced at the beginning of month $t+1$. For sufficient data coverage, we start the Cm portfolios in July 1979.

Cim1, Customer industries momentum We use Benchmark Input-Output Accounts at the Bureau of Economic Analysis (BEA) to identify supplier and customer industries for a given industry. BEA Surveys are conducted roughly once every five years in 1958, 1963, 1967, 1972, 1977, 1982, 1987, 1992, 1997, 2002, and 2007. We delay the use of any data from a given survey until the end of the year in which the survey is publicly released during 1964, 1969, 1974, 1979, 1984, 1991, 1994, 1997, 2002, 2007, and 2013, respectively. The BEA industry classifications are based on SIC codes in the surveys from 1958 to 1992 and based on NAICS codes afterwards. In the surveys from 1997 to 2007, we merge three separate industry accounts, 2301, 2302, and 2303 into a single account. We also merge "Housing" (HS) and "Other Real Estate" (ORE) in the 2007 Survey. In the surveys from 1958 to 1992, we merge industry account pairs 1–2, 5–6, 9–10, 11–12, 20–21, and 33–34. We also merge industry account pairs 22–23 and 44–45 in the 1987 and 1992 surveys. We drop miscellaneous industry accounts related to government, import, and inventory adjustments. We use the cross-industry flows of goods and service from the Use Table based on producers' price.

At the end of June of each year t, we assign each stock to an BEA industry based on its reported SIC or NAICS code in Compustat (fiscal year ending in $t-1$) or CRSP (June of t). Monthly value-weighted industry returns are calculated from July of year t to June of $t+1$, and the industry portfolios are rebalanced in June of $t+1$. For each industry, we form the suppliers portfolio and the customers portfolio. The share of an industry's total purchases from other industries is used to calculate the supplier industries portfolio returns, and the share of the industry's total sales to other industries is used to calculate the customer industries portfolio returns. At the beginning of each month t, we split industries into deciles based on the customer portfolio returns, Cim, in month $t-1$. We then assign the decile rankings of each industry to its member stocks. Monthly decile returns are calculated for month t, and the deciles are rebalanced at the beginning of month $t+1$.

Bm$^{\rm q}$12, Quarterly book-to-market equity. At the beginning of each month t, we split stocks into deciles based on Bm$^{\rm q}$, which is the book equity for the latest fiscal quarter ending at least four months ago divided by the market equity (from CRSP) at the end of month $t-1$. For firms with more than one share class, we merge the market equity for all share classes before computing Bm$^{\rm q}$. We calculate decile returns from month t to $t+11$, and the deciles are rebalanced at the beginning of month $t+1$. The 12-month holding period means that for a given decile in each month there exist 12 subdeciles, each of which is initiated in a different month in the prior 12 months. We take the simple average of the subdecile returns as the monthly return of the Bm$^{\rm q}$12 decile. Book equity is shareholders' equity, plus balance sheet deferred taxes and investment tax credit (Compustat quarterly 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. Specifically, 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 $\mathrm{IBQ}_{t-j+1,t}$ and $\mathrm{DVQ}_{t-j+1,t}$ be the sum of quarterly earnings and quarterly dividends from quarter $t-j+1$ to t, respectively. BEQ_t can then be imputed as $\mathrm{BEQ}_{t-j}+\mathrm{IBQ}_{t-j+1,t}-\mathrm{DVQ}_{t-j+1,t}$. We do not use prior book equity from more than four quarters ago (i.e., $1 \leq j \leq 4$) to reduce imputation errors. 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 use quarterly book equity at least four months after the fiscal quarter end, all the Compustat data used in the imputation are at least four-month lagged prior to the portfolio formation. In addition, we do not impute quarterly book equity backward using future earnings and book equity information to avoid look-ahead bias.

Nop, net payout yield. 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.

Em$^{\mathrm{q}}$1, Quarterly enterprise multiple. Em$^{\mathrm{q}}$, is enterprise value scaled by operating income before depreciation (Compustat quarterly item OIBDPQ). Enterprise value is the market equity plus total debt (item DLCQ plus item DLTTQ) plus the book value of preferred stocks (item PSTKQ) minus cash and short-term investments (item CHEQ). At the beginning of each month t, we split stocks into deciles on Em^{q} for the latest fiscal quarter ending at least four months ago. The Market equity (from CRSP) is measured at the end of month $t-1$. For firms with more than one share class, we merge the market equity for all share classes before computing Em^{q}. Firms with non-positive enterprise value or operating income before depreciation are excluded. Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of $t+1$. For sufficient data coverage, the EM^{q} portfolios start in January 1976.

Ocp, Operating cash flow-to-price. At the end of June of each year t, we sort stocks into deciles based on Ocp, which is operating cash flows for the fiscal year ending in calendar year $t-1$ divided by the market equity (from CRSP) at the end of December of $t-1$. Operating cash flows are measured as funds from operation (Compustat annual item FOPT) minus change in working capital (item WCAP) prior to 1988, and then as net cash flows from operating activities (item OANCF) stating from 1988. For firms with more than one share class, we merge the market equity for all share classes before computing Ocp. Firms with non-positive operating cash flows are excluded. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$. Because the data on funds from operation start in 1971, the Ocp portfolios start in July 1972.

Noa, Net operating assets. We measure net operating assets as operating assets minus operating liabilities. Operating assets are total assets (Compustat annual item AT) minus cash and short-term investment (item CHE). Operating liabilities are total assets minus debt included in current liabilities (item DLC, zero if missing), minus long-term debt (item DLTT, zero if missing), minus minority interests (item MIB, zero if missing), minus preferred stocks (item PSTK, zero if missing), and minus common equity (item CEQ). Noa is net operating assets scalded by one-year-lagged total assets. At the end of June of each year t, we sort stocks into deciles based on Noa, and separately, on dNOA, for the fiscal year ending in calendar year $t-1$. Monthly decile returns are computed from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

Nsi, Net stock issues. At the end of June of year t, Nsi is 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). At the end of June of each year t, we sort stocks with negative Nsi into two portfolios (1 and 2), stocks with zero Nsi into one portfolio (3), and stocks with positive Nsi into seven portfolios (4 to 10). Monthly decile returns are from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

Cei, Composite equity issuance. At the end of June of each year t, we sort stocks into deciles based on composite equity issuance, Cei, which is the log growth rate in the market equity not attributable to stock return, $\log\left(\mathrm{ME_t}/\mathrm{ME_{t-5}}\right) - r(t-5,t)$. $r(t-5,t)$ is the cumulative log stock return from the last trading day of June in year $t-5$ to the last trading day of June in year t, and ME_t is the market equity (from CRSP) on the last trading day of June in year t. Monthly decile returns are from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

Ivc, Inventory changes. At the end of June of each year t, we sort stocks into deciles based on inventory changes, Ivc, which is the annual change in inventory (Compustat annual item INVT) scaled by the average of total assets (item AT) for the fiscal years ending in $t-2$ and $t-1$. We exclude firms that carry no inventory for the past two fiscal years. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

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 $t-2$.

dWc, Changes in net non-cash working capital. Net non-cash working capital is current operating asset (Coa) minus current operating liabilities (Col), with Coa = current assets (Compustat annual item ACT) − cash and short term investments (item CHE) and Col = current liabilities (item LCT) − debt in current liabilities (item DLC). Missing changes in debt in current liabilities are set to zero. At the end of June of each year t, we sort stocks into deciles based on dWc for the fiscal year ending in calendar year $t-1$, scaled by total assets (item AT) for the fiscal year ending in calendar year $t-2$. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

dFin, Changes in net financial assets. Net financial assets are financial assets (Fna) minus financial liabilities (Fnl), with Fna = short-term investments (Compustat annual item IVST) + long-term investments (item IVAO), and Fnl = long-term debt (item DLTT) + debt in current liabilities (item DLC) + preferred stock (item PSTK). Missing changes in debt in current liabilities, long-term investments, long-term debt, short-term investments, and preferred stocks are set to zero (at least one change has to be non-missing when constructing any variable). At the end of June of each year t, we sort stocks into deciles based on dFin for the fiscal year ending in calendar year $t-1$, scaled by total assets (item AT) for the fiscal year ending in calendar year $t-2$. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

Dac, discretionary accruals. We measure Dac using the modified Jones model:

$$\frac{\mathrm{Oa}_{i,t}}{\mathrm{A}_{i,t-1}} = \alpha_1 \frac{1}{\mathrm{A}_{i,t-1}} + \alpha_2 \frac{\mathrm{dSALE}_{i,t} - \mathrm{dREC}_{i,t}}{\mathrm{A}_{i,t-1}} + \alpha_3 \frac{\mathrm{PPE}_{i,t}}{\mathrm{A}_{i,t-1}} + e_{i,t}, \tag{C1}$$

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 winsorize the regression variables at the 1–99% level. We estimate the cross-sectional regression (C1) 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 $t-1$.

Pda, Percent discretionary accruals. At the end of June of each year t, we split stocks into deciles based on percent discretionary accruals, Pda, calculated as the discretionary accruals, Dac, for the fiscal year ending in calendar year $t-1$ multiplied with total assets (Compustat annual item AT) for the fiscal year ending in $t-2$ scaled by the absolute value of net income (item NI) for the fiscal year ending in $t-1$. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

dRoe1, Changes in return on equity. dRoe is return on equity minus its value from four quarters ago. 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 $\mathrm{IBQ}_{t-j+1,t}$ and $\mathrm{DVQ}_{t-j+1,t}$ be the sum of quarterly earnings and quarterly dividends from quarter $t-j+1$ to t, respectively. BEQ_t can then be imputed as $\mathrm{BEQ}_{t-j} + \mathrm{IBQ}_{t-j+1,t} - \mathrm{DVQ}_{t-j+1,t}$. We do not use prior book equity from more than four quarters ago (i.e., $1 \leq j \leq 4$) to reduce imputation errors.

At the beginning of each month t, we sort all stocks into deciles on their most recent past dRoe. Before 1972, we use the most recent dRoe with quarterly earnings from fiscal quarters ending at least four months ago. Starting from 1972, we use dRoe computed with quarterly earnings from the most recent quarterly earnings announcement dates (Compustat quarterly item RDQ). For a firm to enter the portfolio formation, we require the end of the fiscal quarter that corresponds to its most recent dRoe to be within six months prior to the portfolio formation. 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. Monthly decile returns are calculated for the current month t, and the deciles are rebalanced monthly.

Ato^{q}*1, Ato*^{q}*6, and Ato*^{q}*12, Quarterly asset turnover.* Quarterly net operating assets, Noa, is operating assets minus operating liabilities. Operating assets are total assets (item ATQ) minus cash and short-term investments (item CHEQ), and minus other investment and advances (item IVAOQ, zero if missing). Operating liabilities are total assets minus debt in current liabilities (item DLCQ, zero if missing), minus long-term debt (item DLTTQ, zero if missing), minus minority interests (item MIBQ, zero if missing), minus preferred stocks (item PSTKQ, zero if missing), and minus common equity (item CEQQ). Ato^{q}, is quarterly sales divided by one-quarter-lagged Noa.

At the beginning of each month t, we sort stocks into deciles based on Ato^{q} computed with quarterly sales from the most recent earnings announcement dates (item RDQ). Sales are generally announced with earnings during quarterly earnings announcements (Jegadeesh and Livnat 2006). For a firm to enter the portfolio formation, we require the end of the fiscal quarter that corresponds to its most recent Ato^{q} to be within six months prior to the portfolio formation. This restriction is imposed to exclude stale information. To avoid potentially erroneous records, we also require the earnings announcement date to be after the corresponding fiscal quarter end. Monthly decile returns are calculated for month t (Ato^{q}1), from month t to $t+5$ (Ato^{q}6), and from month t to $t+11$ (Ato^{q}12). The deciles are rebalanced at the beginning of $t+1$. The holding period that is longer than one month as in, for instance, Ato^{q}6, means that for a given decile in each month there exist six subdeciles, each of which is initiated in a different month in the prior six-month period. We take the simple average of the subdecile returns as the monthly return of the Atoq6 decile. For sufficient data coverage, the Ato^{q} portfolios start in January 1972.

Opa, Operating profits-to-assets. Opa is total revenue (Compustat annual item REVT) minus cost of goods sold (item COGS), minus selling, general, and administrative expenses (item XSGA), and plus research and development expenditures (item XRD, zero if missing), scaled by book assets (item AT). At the end of June of each year t, we sort stocks into deciles based on Opa for the fiscal year ending in calendar year $t-1$. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

Ola^{q}*1 and Ola*^{q}*12, Quarterly operating profits-to-lagged assets.* Ola^{q} is quarterly total revenue (Compustat quarterly item REVTQ) minus cost of goods sold (item COGSQ), minus selling, general, and administrative expenses (item XSGAQ), plus research and development expenditures (item XRDQ, zero if missing), scaled by one-quarter-lagged book assets (item ATQ). At the beginning of each month t, we sort stocks into deciles based on Ola^{q} for the fiscal quarter ending at least four months ago. Monthly decile returns are calculated for month t (Ola^{q}1) and from month t to $t+11$ (Ola^{q}12). The deciles are rebalanced at the beginning of $t+1$. For sufficient data coverage, the Ola^{q} portfolios start in January 1976.

Cop, cash-based operating profitability. Cop is 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 $t-1$.

Cla, Cash-based operating profits-to-lagged assets. Cla is 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 one-year-lagged book assets (item AT). 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 sort stocks into deciles based on Cla for the fiscal year ending in calendar year $t-1$. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

Cla$^{\mathrm{q}}$1, Cla$^{\mathrm{q}}$6, and Cla$^{\mathrm{q}}$12, Quarterly cash-based operating profits-to-lagged assets. Cla$^{\mathrm{q}}$ is quarterly total revenue (Compustat quarterly item REVTQ) minus cost of goods sold (item COGSQ), minus selling, general, and administrative expenses (item XSGAQ), plus research and development expenditures (item XRDQ, zero if missing), minus change in accounts receivable (item RECTQ), minus change in inventory (item INVTQ), plus change in deferred revenue (item DRCQ plus item DRLTQ), and plus change in trade accounts payable (item APQ), all scaled by one-quarter-lagged book assets (item ATQ). All changes are quarterly changes in balance sheet items and we set missing changes to zero. At the beginning of each month t, we split stocks on Cla$^{\mathrm{q}}$ for the fiscal quarter ending at least four months ago. Monthly decile returns are calculated for month t (Cla$^{\mathrm{q}}$1), from month t to $t+5$ (Cla$^{\mathrm{q}}$6), and from month t to $t+11$ (Cla$^{\mathrm{q}}$12). The deciles are rebalanced at the beginning of $t+1$. For sufficient data coverage, the Cla$^{\mathrm{q}}$ portfolios start in January 1976.

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.

Rdm$^{\mathrm{q}}$1, Rdm$^{\mathrm{q}}$6, and Rdm$^{\mathrm{q}}$12, Quarterly R&D expense-to-market. At the beginning of each month t, we split stocks into deciles based on quarterly R&D-to-market, Rdm$^{\mathrm{q}}$, which is quarterly R&D expense (Compustat quarterly item XRDQ) for the fiscal quarter ending at least four months ago scaled by the market equity (from CRSP) at the end of $t-1$. For firms with more than one share class, we merge the market equity for all share classes before computing Rdm$^{\mathrm{q}}$. We keep only firms with positive R&D expenses. We calculate decile returns for the current month t (Rdm$^{\mathrm{q}}$1), from month t to $t+5$ (Rdm$^{\mathrm{q}}$6), and from month t to $t+11$ (Rdm$^{\mathrm{q}}$12), and the deciles are rebalanced at the beginning of month $t+1$. The holding period longer than one month as in, for instance, Rdm$^{\mathrm{q}}$6, means that for a given decile in each month there exist six subdeciles, each of which is initiated in a different month in the prior six months. We take the simple average of the subdecile returns as the monthly return of the Rdm$^{\mathrm{q}}$6 decile. Because the quarterly R&D data start in late 1989, the Rdm$^{\mathrm{q}}$ portfolios start in January 1990.

Rer, Industry-adjusted real estate ratio. We measure the real estate ratio as the sum of buildings (Compustat annual item PPENB) and capital leases (item PPENLS) divided by net property, plant, and equipment (item PPENT) prior to 1983. From 1984 onward, the real estate ratio is the sum of buildings at cost (item FATB) and leases at cost (item FATL) divided by gross property, plant, and equipment (item PPEGT). Industry-adjusted real estate ratio, Rer, is the real estate ratio minus its industry average. Industries are defined by two-digit SIC codes. We winsorize the real estate ratio at the 1st and 99th percentiles of its distribution each year before computing Rer. We exclude industries with fewer than five firms. At the end of June of each year t, we sort stocks into deciles based on Rer for the fiscal year ending in calendar year $t-1$. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$. Because the real estate data start in 1969, the Rer portfolios start in July 1970.

Eprd, Earnings predictability. Following Francis, Lafond, Olsson, and Schipper (2004), we estimate earnings predictability, Eprd, from a first-order autoregressive model for annual split-adjusted earnings per share (Compustat annual item EPSPX divided by item AJEX). At the end of June of each year t, we estimate the autoregressive model in the ten-year rolling window up to the fiscal year ending in calendar year $t-1$. Only firms with a complete ten-year history are included. Eprd is measured as the residual volatility. We sort stocks into deciles based on Eprd. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

R^1_{a}, $R^{[2,5]}_{\mathrm{a}}$, $R^{[6,10]}_{\mathrm{a}}$, $R^{[11,15]}_{\mathrm{a}}$, and $R^{[16,20]}_{\mathrm{a}}$, Seasonality. Following Heston and Sadka (2008), at the beginning of each month t, we sort stocks into deciles based on various measures of past performance, including returns in month $t-12$ (R^1_{a}), average returns across months $t-24, t-36, t-48$, and $t-60$ ($R^{[2,5]}_{\mathrm{a}}$), average returns across months $t-72, t-84, t-96, t-108$, and $t-120$ ($R^{[6,10]}_{\mathrm{a}}$), average returns across months $t-132, t-144, t-156, t-168$, and $t-180$ ($R^{[11,15]}_{\mathrm{a}}$), and average returns across months $t-192, t-204, t-216, t-228$, and $t-240$ ($R^{[16,20]}_{\mathrm{a}}$). Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of month $t+1$.

Isff1, Idiosyncratic skewness per the FF 3-factor model. At the beginning of each month t, we sort stocks into deciles based on idiosyncratic skewness, Isff, calculated as the skewness of the residuals from regressing a stock's excess return on the Fama-French three factors using daily observations from month $t-1$. We require a minimum of 15 daily returns. Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of month $t+1$.

Isq1, Idiosyncratic skewness per the q-factor model. At the beginning of each month t, we sort stocks into deciles based on idiosyncratic skewness, Isq, calculated as the skewness of the residuals from regressing a stock's excess return on the q-factors using daily observations from month $t-1$. We require a minimum of 15 daily returns. Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of month $t+1$.