A Comparison of New Factor Models

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Abstract

This paper compares the Hou, Xue, and Zhang (2014) q-factor model and the Fama and French (2014a) five-factor model on both conceptual and empirical grounds. Four concerns cast doubt on the five-factor model: The internal rate of return often correlates negatively with the one-period-ahead expected return; the value factor seems redundant in the data; the expected investment tends to correlate positively with the one-period-ahead expected return; and past investment is a poor proxy for the expected investment. Empirically, the four-factor q-model outperforms the five-factor model, especially in capturing price and earnings momentum and profitability anomalies.

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1 Introduction

Hou, Xue, and Zhang (HXZ, 2014) propose an empirical q-factor model that largely describes the cross section of average stock returns. Most (but not all) of the anomalies that plague the Fama-French (1993, 1996) three-factor model can be captured. The q-factor model says that the expected return of an asset in excess of the risk-free rate is described by the sensitivities of its returns to the market factor, a size factor, an investment factor, and a profitability (return on equity, ROE) factor:

$$E[R_i] - R_f = \beta^i_{\mathrm{MKT}}\, E[\mathrm{MKT}] + \beta^i_{\mathrm{ME}}\, E[r_{\mathrm{ME}}] + \beta^i_{\mathrm{I/A}}\, E[r_{\mathrm{I/A}}] + \beta^i_{\mathrm{ROE}}\, E[r_{\mathrm{ROE}}], \tag{1}$$

in which $E[R_i] - R_f$ is the expected excess return, $E[\mathrm{MKT}]$, $E[r_{\mathrm{ME}}]$, $E[r_{\mathrm{I/A}}]$, and $E[r_{\mathrm{ROE}}]$ are expected factor premiums, and β^i_{MKT}, β^i_{ME}, $\beta^i_{\mathrm{I/A}}$, and β^i_{ROE} are the corresponding factor loadings.

Subsequent to our work, Fama and French (FF, 2014a) incorporate variables that resemble our investment and ROE factors into their three-factor model to form a five-factor model.[1] Motivating their new factors from valuation theory, FF show that the five-factor model outperforms their original three-factor model in a set of testing portfolios formed on size, book-to-market, investment, and profitability (the same variables underlying their new factors). FF (2014b) extend their set of testing portfolios to include accruals, net share issues, momentum, volatility, and the market beta, which are a small subset of the comprehensive universe of nearly 80 anomalies in HXZ (2014). However, FF do not compare the performance of their five-factor model with that of the q-factor model.

We provide a direct comparison between the q-factor model and the FF five-factor model on both conceptual and empirical grounds. The q-factors are constructed from a triple ($2\times3\times3$) sort on size, investment-to-assets, and ROE, whereas the new FF RMW (robust-minus-weak profitability)

[1]The first draft of HXZ (2014) appears in October 2012 as NBER working paper 18435. More generally, this work is a new incarnation of the previous work circulated under various titles, including "Neoclassical factors" (as NBER working paper 13282, dated July 2007), "An equilibrium three-factor model (dated January 2009)," "Production-based factors (dated April 2009)," "A better three-factor model that explains more anomalies (dated June 2009)," and "An alternative three-factor model (dated April 2010)." The economic insight that investment and profitability are fundamental forces in the cross section of expected stock returns in investment-based asset pricing first appears in NBER working paper 11322, titled "Anomalies," dated May 2005. For comparison, the FF (2013, 2014a) work is first circulated in June 2013. Their 2013 draft adds only a profitability factor to their original three-factor model, and the 2014 draft subsequently adds an investment factor.

and CMA (conservative-minus-aggressive investment) factors are from double (2×3) sorts by interacting size with operating profitability and investment. More important, whereas our ROE factor is from monthly sorts on ROE, RMW is from annual sorts on operating profitability. The benchmark construction of the q-factor model is motivated from the neoclassical q-theory of investment, which says that ROE forecasts returns to the extent that it forecasts future ROE. Because the most recently announced quarterly earnings contain the latest information on future ROE, it seems most efficient to use the latest earnings data in our monthly sorted ROE factor. In contrast, the annually formed RMW seems less efficient because it is based only on earnings from the last fiscal year end.

We raise four concerns with the motivation of the FF (2014a) five-factor model based on valuation theory. First, FF derive the relations between book-to-market, investment, and profitability only with the internal rate of return (on expected dividends), which is the long-term average expected return. These relations do not necessarily carry over to the one-period-ahead expected return. Estimating the internal rate of returns for RMW and CMA using accounting-based valuation models, we show that these estimates differ greatly from their one-period-ahead average returns. In particular, the estimates for the internal rate of return for RMW are often significantly negative.

Second, FF (2014a) argue that the value factor should be a separate factor based on valuation theory, but find it to be redundant in describing average returns in the data. However, q-theory implies that the value factor should be redundant in the presence of the investment factor. Intuitively, the first principle of investment says that the marginal costs of investment, which rise with investment, equal marginal q, which is closely related to market-to-book equity. This tight economic link implies that the value and investment factors should be highly correlated in the data.

Third, FF (2014a) motivate CMA from the negative relation between the expected investment and the internal rate of return in valuation theory. Reformulating the Miller and Modigliani (1961) valuation equation with the one-period-ahead expected return, we show that the theoretical relation between the expected investment and the expected return is more likely to be positive.[2] As

[2]This relation also tends to be positive in q-theory, an insight that can be traced back to Cochrane (1991).

such, the investment factor can only be motivated from the market-to-book term in the valuation equation, augmented with the q-theory linkage between investment and market-to-book.

Fourth, after motivating CMA from the expected investment effect, FF (2014a) use past investment as a proxy for the expected investment. This practice is problematic. While past profitability forecasts future profitability, past investment does not forecast future investment. In the annual cross-sectional regressions of future book equity growth on asset growth, the average R^2 starts at 5% in year one, and drops quickly to zero in year three.[3] In contrast, in the annual cross-sectional regressions of future operating profitability on operating profitability, the average R^2 starts at 55% in year one, drops to 28% in year three, and remains above 10% in year ten.

Empirically, from January 1967 to December 2013, our size, investment, and ROE factors earn on average 0.34%, 0.44%, and 0.57% per month ($t = 2.51, 5.12$, and 5.21), respectively. SMB, HML, RMW, and CMA earn on average 0.28%, 0.37%, 0.27%, and 0.36% ($t = 2.02, 2.63, 2.58$, and 3.68), respectively. The five-factor model cannot capture our investment and ROE factors, leaving alphas of 0.12% ($t = 3.24$) and 0.45% ($t = 5.44$), respectively. However, the q-factor model captures the HML, RMW, and CMA returns, with tiny alphas of 0.04%, 0.04%, and 0.02%, respectively (t-statistics all less than 0.5). As such, RMW and CMA are noisy versions of the q-factors.

Most important, the q-factor model outperforms the FF five-factor model empirically. Across a list of 36 high-minus-low anomaly deciles, which earn significant average returns with New York Stock Exchange (NYSE) breakpoints and value-weighted returns, the average magnitude of the alphas is 0.20% per month in the q-factor model. This estimate is lower than 0.36% in the five-factor model and 0.33% in the Carhart (1997) model, which adds a momentum factor, UMD, to the FF three-factor model. Seven out of 36 high-minus-low alphas are significant in the q-factor model, in contrast to 19 in the five-factor model (21 in the Carhart model).

FF (2014a) argue that the most serious challenges for asset pricing models are in small stocks,

[3] This evidence on the low persistence of micro-level investment is consistent with the large empirical and theoretical literature on lumpy investment (e.g., Dixit and Pindyck (1994), Doms and Dunne (1998), and Whited (1998)).

which value-weighted portfolio returns in HXZ (2014) tend to underweight. To address this concern, we also form testing portfolios with all-but-micro breakpoints and equal-weighted returns. We exclude microcaps (stocks with market equity below the 20th NYSE percentile), use the remaining stocks to calculate breakpoints, and then equal-weight the stocks within a given portfolio to give small stocks sufficient weights. We exclude microcaps because due to transaction costs and lack of liquidity, anomalies in microcaps are unlikely to be exploitable in practice.

The q-factor model continues to outperform the FF five-factor model. Across a set of 50 high-minus-low anomaly deciles, which earn significant average returns with all-but-micro breakpoints and equal-weighted returns, the mean absolute alpha is 0.24% per month in the q-factor model and 0.41% in the five-factor model (0.40% in the Carhart model). 16 out of 50 high-minus-low q-model alphas are significant, in contrast to 34 five-factor alphas (37 Carhart alphas). Across different categories of anomalies, the q-factor model outperforms the five-factor model the most in the momentum and profitability categories. However, the mean absolute alpha across all 50 deciles is 0.13% in the q-factor model, which is slightly higher than 0.11% in the five-factor model (but lower than 0.16% in the Carhart model). Finally, the relative performance of the q-factor model over the five-factor model is robust to alternative constructions of the q-factors and the new FF factors.

Cochrane (1991) first applies q-theory in asset pricing. Berk, Green, and Naik (1999), Carlson, Fisher, and Giammarino (2004), and Da, Guo, and Jagannathan (2012) use real options theory to study expected returns. Titman, Wei, and Xie (2004) and Cooper, Gulen, and Schill (2008) show the investment effect, Loughran and Ritter (1995) show the empirical relation between equity issues and investment, and Ball and Brown (1968), Bernard and Thomas (1989), Haugen and Baker (1996), and Chan, Jegadeesh, and Lakonishok (1996) show the earnings (profitability) effect. We compare q-theory and valuation theory in terms of asset pricing implications and perform large-scale empirical horse races between the q-factor model and the FF five-factor model in "explaining" anomalies.

The rest of the paper unfolds as follows. Section 2 describes all the factors. Section 3 compares the q-factor model and the FF five-factor model on conceptual grounds, and Section 4 on empirical grounds. Section 5 concludes. A separate Internet Appendix furnishes supplementary results.

2 New Factors

We construct the new factors in Section 2.1, and document their properties in Section 2.2.

2.1 Factor Construction

Monthly returns are from the Center for Research in Security Prices (CRSP) and accounting information from the Compustat Annual and Quarterly Fundamental Files. The sample is from January 1967 to December 2013. Financial firms and firms with negative book equity are excluded.

2.1.1 The q-factor model from HXZ (2014)

The size, investment, and ROE factors are constructed from a triple ($2 \times 3 \times 3$) sort on size, investment-to-assets (I/A), and ROE. Size is the market equity, which is stock price per share times shares outstanding from CRSP, I/A is the annual change in total assets (Compustat annual item AT) divided by one-year-lagged total assets, and ROE is income before extraordinary items (Compustat quarterly item IBQ) divided by one-quarter-lagged book equity.[4]

At the end of June of each year t, we use the median NYSE size to split NYSE, Amex, and NASDAQ stocks into two groups, small and big. Independently, at the end of June of year t, we break stocks into three I/A groups using the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the ranked values of I/A for the fiscal year ending in calendar year $t-1$. Also, independently, at the beginning of each month, we sort all stocks into three groups based on the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the ranked values of ROE. Earnings data in Compustat quarterly files are used in the months immediately after the most recent public

[4]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. Depending on availability, we use stockholders' equity (item SEQQ), or common equity (item CEQQ) plus the carrying value of preferred stock (item PSTKQ), or total assets (item ATQ) minus total liabilities (item LTQ) in that order as shareholders' equity. We use redemption value (item PSTKRQ) if available, or carrying value for the book value of preferred stock. This book equity measure is the quarterly version of the annual book equity measure in Davis, Fama, and French (2000).

quarterly earnings announcement dates (Compustat quarterly item RDQ). For a firm to enter the factor construction, we require the end of the fiscal quarter that corresponds to its announced earnings to be within six months prior to the portfolio formation month.

Taking the intersection of the two size, three I/A, and three ROE groups, we form 18 portfolios. Monthly value-weighted portfolio returns are calculated for the current month, and the portfolios are rebalanced monthly. The size factor is the difference (small-minus-big), each month, between the simple average of the returns on the nine small size portfolios and the simple average of the returns on the nine big size portfolios. The investment factor is the difference (low-minus-high), each month, between the simple average of the returns on the six low I/A portfolios and the simple average of the returns on the six high I/A portfolios. Finally, the ROE factor is the difference (high-minus-low), each month, between the simple average of the returns on the six high ROE portfolios and the simple average of the returns on the six low ROE portfolios.

HXZ (2014) start their sample in January 1972, which is restricted by the limited coverage of earnings announcement dates and book equity in Compustat quarterly files. We construct the q-factors following their procedure from January 1972 to December 2013. Because FF (2014a) start their sample in July 1963 using only Compustat annual files, to make the samples more comparable, we extend the starting point of the q-factors sample to January 1967.

In particular, to overcome the lack of coverage for quarterly earnings announcement dates, we use the most recent quarterly earnings from the fiscal quarter ending at least four months prior to the portfolio formation month. To expand the coverage for quarterly book equity, we use book equity from Compustat annual files and impute quarterly book equity with clean surplus accounting. We first use quarterly book equity from Compustat quarterly files whenever available. We then supplement the coverage for fiscal quarter four with book equity from Compustat annual files.[5]

[5] 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. Otherwise, we use the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTK), or the book value of assets (item AT) minus total liabilities (item LT). Depending on availability, we use redemption

If neither estimate is available, we apply the clean surplus relation to impute the book equity. We first backward impute the beginning-of-quarter book equity as the end-of-quarter book equity minus quarterly earnings plus quarterly dividends.[6] 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 relative to the portfolio formation month.

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 $\text{BEQ}_{t-j}, 1 \leq j \leq 4$, denote the latest available quarterly book equity as of quarter t, and $\text{IBQ}_{t-j+1,t}$ and $\text{DVQ}_{t-j+1,t}$ be the sum of quarterly earnings and quarterly dividends from quarter $t-j+1$ to t, respectively. BEQ_t can then be imputed as $\text{BEQ}_{t-j} + \text{IBQ}_{t-j+1,t} - \text{DVQ}_{t-j+1,t}$. We do not use prior book equity from more than four quarters ago ($1 \leq j \leq 4$) to reduce imputation errors. We start the sample in January 1967 to ensure that all the 18 benchmark portfolios from the triple sort on size, I/A, and ROE have at least ten firms.

2.1.2 The FF Five-factor Model

FF (2014a) propose a five-factor model:

$$E[R_i] - R_f = b_i\, E[\text{MKT}] + s_i\, E[\text{SMB}] + h_i\, E[\text{HML}] + r_i\, E[\text{RMW}] + c_i\, E[\text{CMA}]. \tag{2}$$

MKT, SMB, and HML are the market, size, and value factors that first appear in the FF (1993) three-factor model. The two new factors resemble our q-factors. RMW is the difference between the returns on diversified portfolios of stocks with robust and weak profitability, and CMA is the difference between the returns on diversified portfolios of low and high investment stocks.

Following Novy-Marx (2013), FF (2014a) measure (operating) profitability (OP) as revenues

value (item PSTKRV), liquidating (item PSTKL), or par value (item PSTK) for the book value of preferred stock.

[6] 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).

(Compustat annual item REVT) minus cost of goods sold (item COGS), minus selling, general, and administrative expenses (item XSGA, zero if missing), minus interest expense (item XINT, zero if missing) all divided by book equity for the fiscal year ending in calendar year $t-1$. Essentially, OP is $\mathrm{OI}_{t-1}/\mathrm{BE}_{t-1}$, in which OI_{t-1} is operating income for the fiscal year ending in calendar year $t-1$, and BE_{t-1} is the book equity. However, $\mathrm{OI}_{t-1}/\mathrm{BE}_{t-1} = (\mathrm{OI}_{t-1}/\mathrm{BE}_{t-2})/(\mathrm{BE}_{t-1}/\mathrm{BE}_{t-2})$, and the growth in book equity tends to be highly correlated with the growth in total assets, $\mathrm{TA}_{t-1}/\mathrm{TA}_{t-2}$. As such, OP is a combination of annual ROE and I/A variables. Also, FF measure investment (Inv) in the same way as our I/A, i.e., as the change in total assets from the fiscal year ending in year $t-2$ to the fiscal year ending in $t-1$, divided by total assets from the fiscal year ending in $t-2$.

FF (2014a) construct their factors in three different ways. The benchmark approach is based on independent (2×3) sorts by interacting size with book-to-market (B/M), and separately, with OP and Inv. The size breakpoint is NYSE median market equity, and the B/M, OP, and Inv breakpoints are their respective 30th and 70th percentiles for NYSE stocks. HML is the average of the two high B/M portfolio returns minus the average of the two low B/M portfolio returns. RMW is the average of the two high OP portfolio returns minus the average of the two low OP portfolio returns. CMA is the average of the two low Inv portfolio returns minus the average of the two high Inv portfolio returns. Finally, SMB is the average of the returns on the nine small stock portfolios from the three separate 2×3 sorts minus the average of the returns on the nine big stock portfolios.

The second approach is similar to the first approach but with the 2×3 sorts replaced with 2×2 sorts, with NYSE medians as breakpoints for all the variables. In the third approach, FF (2014a) use an independent quadruple $(2\times2\times2\times2)$ sort on size, B/M, OP, and Inv with NYSE medians as breakpoints. Taking intersections yields 16 value-weighted portfolios. SMB is the average of the returns on the eight small stock portfolios minus the average of the returns on the eight big stock portfolios. HML is the average of the returns on the eight high B/M portfolios minus the average of the returns on the eight low B/M portfolios. RMW is the average of the returns on the eight high OP portfolios minus the average of the returns on the eight low OP portfolios. CMA is the average of the returns on the eight low Inv portfolios minus the average of the returns on the eight high Inv portfolios.

2.2 Empirical Properties

Table 1 reports the empirical properties of the new factors in the sample from January 1967 to December 2013. From Panel A, our size, investment, and ROE factors earn on average 0.34%, 0.44%, and 0.57% per month ($t = 2.51, 5.12$, and 5.21), respectively. We compute the market factor as the value-weighted market return minus the one-month Treasury bill rate from CRSP, and obtain the data for SMB, HML, RMW, CMA, and UMD from Kenneth French's Web site. Consistent with HXZ (2014), the investment and ROE premiums cannot be captured by the FF three-factor model or the Carhart four-factor model. More important, the five-factor model cannot capture the premiums either, leaving significant alphas of 0.12% and 0.45% ($t = 3.24$ and 5.44), respectively.

Panel B of Table 1 reports the results for the FF new factors from the benchmark 2×3 sorts (see Section 4.4 for their alternative sorts). Panel B shows that their SMB, HML, RMW, and CMA earn on average 0.28%, 0.37%, 0.27%, and 0.36% per month ($t = 2.02, 2.63, 2.58$, and 3.68), respectively. The Carhart alphas of RMW and CMA are 0.34% ($t = 3.36$) and 0.19% ($t = 2.82$), respectively. More important, the q-factor model captures the average RMW and CMA returns, leaving tiny alphas of 0.04% ($t = 0.49$) and 0.02% ($t = 0.45$), respectively. The q-factor model also captures the HML return, leaving an alpha of 0.04% ($t = 0.36$). From Panel C, UMD earns on average 0.68% per month ($t = 3.65$). The q-factor model captures the UMD return with a small alpha of 0.09% ($t = 0.38$) and an ROE factor loading of 0.92 ($t = 5.63$). In contrast, the FF five-factor model cannot capture the UMD return, with an alpha of 0.70% ($t = 3.02$). The RMW loading is 0.26, which is insignificant ($t = 1.26$). Panel D reports correlations among the factors. Consistent with HXZ (2014), the investment factor has a high correlation of 0.69 with HML, and the ROE factor has a high correlation of 0.50 with UMD. The investment factor has an almost perfect correlation of 0.90 with CMA, but the ROE factor has a lower correlation of 0.68 with RMW.

3 Comparison on Conceptual Grounds

With the necessary background of the new factors out of the way, we are ready to compare the q-factor model with the FF five-factor model on conceptual grounds. We first review briefly their motivation in Section 3.1, and then raise four concerns on the FF motivation in Section 3.2.

3.1 A Brief Review

Section 3.1.1 reviews the logic of the q-factor model, and Section 3.1.2 the five-factor model.

3.1.1 Motivation for the q-factor Model

Consider a two-period q-theory model. There are two dates, t and $t+1$, a representative household, and heterogenous firms, indexed by $i = 1, 2, ..., N$. Let $\Pi_{it} = \Pi(A_{it}, X_{it})$ be the operating profits of firm i at time t, in which A_{it} is productive assets, and X_t is a vector of exogenous aggregate and firm-specific shocks. Π_{it} is of constant returns to scale, i.e., $\Pi_{it} = A_{it}\partial\Pi_{it}/\partial A_{it}$, in which $\partial\Pi_{it}/\partial A_{it}$ is the first-order derivative of Π_{it} with respect to A_{it}. The firm exits at the end of date $t+1$ with a liquidation value of A_{it+1}, in which the depreciation rate of assets is assumed to be zero.

Let I_{it} denote investment for date t, then $A_{it+1} = I_{it} + A_{it}$. Investment entails quadratic adjustment costs, $(a/2)(I_{it}/A_{it})^2 A_{it}$, in which $a > 0$ is a constant parameter. Firm i uses the operating profits at date t to pay investment and adjustment costs. If the free cash flow, $D_{it} \equiv \Pi_{it} - I_{it} - (a/2)(I_{it}/A_{it})^2 A_{it}$, is positive, the firm distributes it back to the household. Otherwise, a negative D_{it} means external equity. At date $t+1$, the firm uses assets, A_{it+1}, to obtain the operating profits, Π_{it+1}, which is distributed along with A_{it+1} as dividends, D_{it+1}. With only two dates, the firm does not invest in date $t+1$, and the ex-dividend equity value, P_{it+1}, is zero.

Taking the representative household's stochastic discount factor, M_{t+1}, as given, firm i chooses I_{it} to maximize the cum-dividend equity value at the beginning of date t:

$$P_{it} + D_{it} \equiv \max_{\{I_{it}\}} \Pi_{it} - I_{it} - \frac{a}{2}\left(\frac{I_{it}}{A_{it}}\right)^2 A_{it} + E_t[M_{t+1}(\Pi_{it+1} + A_{it+1})]. \tag{3}$$

The first principle for investment says:

$$1 + a\frac{I_{it}}{A_{it}} = E_t\left[M_{t+1}\left(\frac{\Pi_{it+1}}{A_{it+1}} + 1\right)\right]. \tag{4}$$

The definition of D_{it} and equation (3) imply the ex-dividend equity value $P_{it} = E_0[M_1(\Pi_{it+1} + A_{it+1})]$ at the optimum. The stock return is $r^S_{it+1} = (P_{it+1} + D_{it+1})/P_{it} = [\Pi_{it+1} + A_{it+1}]/E_t[M_{t+1}(\Pi_{it+1} + A_{it+1})] = (\Pi_{it+1}/A_{it+1} + 1)/E_t[M_{t+1}(\Pi_{it+1}/A_{it+1} + 1)]$. The first principle for investment in equation (4) then implies:

$$E_t[r^S_{it+1}] = \frac{E_t[\Pi_{it+1}/A_{it+1}] + 1}{1 + a(I_{it}/A_{it})}. \tag{5}$$

Intuitively, firm i keeps investing until the marginal costs, $1+a(I_{it}/A_{it})$, equal the expected marginal benefit of investment, $E_t[\Pi_{it+1}/A_{it+1}] + 1$, discounted to date t with the expected stock return, $E_t[r^S_{it+1}]$, as the discount rate. At the margin, the net present value of a new project is zero.

Equation (5) implies that investment and profitability (as a proxy for the expected profitability) forecast returns. The logic is really just capital budgeting. Intuitively, investment predicts stock returns because given expected cash flows, high costs of capital mean low net present values of new projects and low investment, and low costs of capital mean high net present values of new projects and high investment. Profitability predicts stock returns because high expected cash flows relative to low investment must mean high discount rates. The high discount rates are necessary to offset the high expected cash flows to induce low net present values of new projects and low investment.

The economic model in equation (5) provides useful guidance on our empirical implementation of the q-factor model. In particular, an important difference between our ROE factor and FF's RMW is that our factor is from monthly sorts on ROE, whereas RMW is from annual sorts on operating profitability. (Both our investment factor and CMA are from annual sorts on investment.) As noted in HXZ (2014), this aspect of the q-factors construction is consistent with equation (5), which says that ROE predicts returns to the extent that it predicts future ROE. Because the most recent quarterly ROE contains the most up-to-date information about future ROE, it seems most efficient to use the latest ROE in our monthly sorts.

The q-factors are based on a triple sort on size, investment, and ROE, whereas the benchmark RMW and CMA in the FF five-factor model are based on double sorts on size and operating profitability as well as on size and investment. As noted in HXZ (2014), the joint sort on investment and ROE is consistent with equation (5), which says that the investment and ROE effects are conditional in nature. The negative investment-return relation is conditional on a given level of ROE. The correlation could be positive unconditionally if large investment delivers exceptionally high ROE. Similarly, the positive ROE-return relation is conditional on a given level of investment. The correlation could be negative unconditionally if high ROE comes with exceptionally large investment. A joint sort on investment and ROE controls for these conditional relations.

3.1.2 Motivation for the FF Five-factor Model from Valuation Theory

FF (2014a) motivate their five-factor model from the Miller and Modigliani (1961) valuation theory. The dividend discounting model says that the market value of firm i's stock, P_{it}, is the present value of its expected dividends, $P_{it} = \sum_{\tau=1}^{\infty} E[D_{it+\tau}]/(1+r_i)^\tau$, in which D_{it} is dividends, and r_i is the firm's long-term average expected stock return, or the internal rate of return. The clean surplus relation says that dividends equal earnings minus the change in book equity, $D_{it+\tau} = Y_{it+\tau} - \triangle B_{it+\tau}$, in which $\triangle B_{it+\tau} \equiv B_{it+\tau} - B_{it+\tau-1}$. The dividend discounting model then becomes:

$$\frac{P_{it}}{B_{it}} = \frac{\sum_{\tau=1}^{\infty} E[Y_{it+\tau} - \triangle B_{it+\tau}]/(1+r_i)^\tau}{B_{it}}. \tag{6}$$

FF (2014a) argue that equation (6) makes three predictions. First, fixing everything except the current market value, P_{it}, and the expected stock return, r_i, a low P_{it}, or a high book-to-market equity, B_{it}/P_{it}, implies a high expected return. Second, fixing everything except the expected profitability and the expected stock return, high expected profitability implies a high expected return. Finally, fixing everything except the expected growth in book equity and the expected return, high expected growth in book equity implies a low expected return.

Crucially, FF (2014a) predict the relations between book-to-market, investment, and profitability only with the internal rate of return. FF (p. 2) argue that the difference between the one-period-ahead expected return and the internal rate of return is not important: "Most asset pricing research focuses on short-horizon returns—we use a *one-month horizon* in our tests. If each stock's short-horizon expected return is positively related to its internal rate of return—if, for example, the expected return is the same for all horizons—the valuation equation implies that the cross-section of expected returns is determined by the combination of current prices and expectations of future dividends. The decomposition of cash flows then implies that each stock's relevant expected return is determined by its price-to-book ratio and expectations of its future profitability and investment (our emphasis)." Empirically, FF use profitability as the proxy for the expected profitability and assets growth as a proxy for the expected investment to form their new factors.[7]

3.2 Four Concerns on the FF (2014a) Motivation

We argue that the FF (2014a) motivation is flawed. First, the internal rate of return can correlate negatively with the one-period-ahead expected return. Second, HML is a separate factor per the FF logic, but is redundant in describing average returns in the data. Third, the investment factor is more likely motivated from market-to-book in the valuation equation (6), not through the expected book equity growth. Finally, past investment is a poor proxy for the expected investment.

3.2.1 The Internal Rate of Return is Not the One-period Ahead Expected Return

With time-varying expected returns, the internal rate of return (IRR) can differ greatly from the one-period ahead expected return. The difference is most striking in the context of price and

[7]FF (2006) construct proxies of the expected profitability and the expected investment (growth in book equity or total assets) as the fitted components from first-stage annual cross-sectional regressions of future profitability and future investment on current variables. In second-stage cross-sectional regressions of returns on these proxies, FF find some evidence on the expected profitability effect, but the relation between the expected investment and expected returns is weakly positive. Performing these tests on firm-level variables instead of per share variables, Aharoni, Grundy, and Zeng (2013) report a negative relation between the expected investment and expected returns. As noted, FF (2014a) do not use the proxies from the first-stage cross-sectional regressions in forming their new factors.

earnings momentum. Chan, Jegadeesh, and Lakonishok (1996) show that momentum profits are short-lived, large and positive for up to 12 months, but turn negative afterward. In contrast, Tang, Wu, and Zhang (2014) estimate price and earnings momentum to be significantly negative, once measured with the IRRs estimated from the Gebhardt, Lee, and Swaminathan (2001) methodology.[8]

To quantify how the IRR deviates from the one-month-ahead average return in the context of the FF five-factor model, we estimate the IRRs for SMB, HML, RMW, and CMA with a wide range of accounting-based methods proposed by Gordon and Gordon (1997), Claus and Thomas (2001), Gebhardt, Lee, and Swaminathan (2001), Easton (2004), and Ohlson and Juettner-Nauroth (2005). Although differing in implementation details, these models all share the basic idea of backing out the IRR from the valuation equation (6). The baseline versions of these methods all use analysts' earnings forecasts to predict future profitability. Because analysts' forecasts are limited to a (relatively) small sample and are likely even biased, we also implement two sets of modified procedures. The Hou, van Dijk, and Zhang (2012) modification uses pooled cross-sectional regressions to forecast future earnings, and the Tang, Wu, and Zhang (2014) modification uses annual cross-sectional regressions to forecast future profitability. Appendix A describes in details all the estimation methods.

Panel A of Table 2 reports that the IRRs estimated with analysts' earnings forecasts for RMW and CMA differ significantly from their one-month-ahead average returns. The differences for RMW are significant in 14 out of the 15 experiments from intersecting the three factor construction procedures with the five IRR estimation models. The IRRs of RMW are even significantly negative in five experiments, in contrast to the average returns that are significantly positive in all experiments. Averaging across the five IRR models, the IRR for the benchmark 2×3 RMW is -0.07% per month ($t = -16.56$), whereas the one-month-ahead average return is 0.35% ($t = 2.68$). The contrast for the 2×2 RMW is similar, -0.05 ($t = -14.90$) versus 0.23 ($t = 2.69$). For the

[8] Tang, Wu, and Zhang (2014) show further that except for the size and value premiums, the estimates for the internal rate of return differ drastically from the one-period-ahead average realized returns across a wide array of anomaly portfolios. In addition to price and earnings momentum, the two estimates also have opposite signs for the high-minus-low portfolios formed on financial distress and return on assets. Using cross-sectional regressions, Hou, van Dijk, and Zhang (2012) also show that inferences about the cross-section of expected returns are sensitive to the choice of expected return proxy (the average realized return versus the internal rate of return).

$2 \times 2 \times 2 \times 2$ RMW, the IRR is virtually zero, despite an average return of 0.25% ($t = 2.91$).

Estimating the IRRs with earnings or ROE forecasts from cross-sectional regressions yields largely similar results. Panel B shows that with cross-sectional earnings forecasts, the IRRs of RMW are significantly negative in eight out of 15 experiments, and the IRR-average-return differences are significant in 14 out of 15 experiments. Averaged across the five IRR models, in particular, the IRR for the benchmark RMW is −0.13% per month ($t = -21.32$), in contrast to the average return of 0.28% ($t = 2.62$). Panel C shows that with cross-sectional ROE forecasts, the IRRs of RMW are significantly negative in ten out of 15 experiments, and the IRR-average-return differences are significant in all 15 experiments. Averaged across the five IRR models, the IRR for the benchmark RMW is −0.17% ($t = -33.97$), in contrast to the average return of 0.23% ($t = 2.32$).

Table 2 also reports important IRR-average-return differences for CMA, although not as dramatic as the differences for RMW. From Panel A, with analysts' earnings forecasts, the differences for CMA are significant for 11 out of 15 experiments. The IRRs for CMA are even negative in six experiments, although significant in only two. Although averaged across the five estimation models, the IRRs for CMA are positive, their magnitudes are substantially smaller than those of their average returns. With cross-sectional earnings forecasts, Panel B reports closer alignment between IRRs and average returns for CMA. Their differences are significant in only three out of 15 experiments, although the IRR magnitudes are still smaller than those of the average returns. With cross-sectional ROE forecasts, Panel C shows that the IRR-average-return differences for CMA are significant in six out of 15 experiments, and that the IRR magnitudes continue to be smaller. Finally, without going through the details, we can report that, consistent with Tang, Wu, and Zhang (2014), the IRR-average-return differences for HML are all insignificant.

3.2.2 HML: A Redundant Factor

FF (2014a) argue that market-to-book, expected profitability, and expected investment give rise to three separate factors in valuation theory. However, empirically, once RMW and CMA are added to their three-factor model, HML becomes redundant in describing average returns. This inconsistency between theory and evidence is so striking that FF caution that it might be specific to their sample.

The evidence that HML is redundant is consistent with q-theory. The denominator of equation (5) is the marginal costs of investment (an increasing function of investment-to-assets), which equal marginal q (the value of an additional unit of capital). With constant returns to scale, marginal q equals average q, which is in turn highly correlated with market-to-book equity (the two are identical without debt). This tight economic link between investment and market-to-book implies that HML should be highly correlated with the investment factor. This q-theory insight also implies that the investment factor in the FF five-factor model can be motivated from market-to-book, P_{it}/B_{it}, in the valuation equation (6). In particular, contrary to FF (2014a), the investment factor cannot be motivated from the expected growth of book equity, $E[\triangle B_{it+\tau}]/B_{it}$ (Section 3.2.3).

3.2.3 Past Investment, Future Investment, and the Expected Return

Equation (6) predicts a negative relation between the expected investment and the IRR. However, this negative relation does not necessarily apply to that between the expected investment and the one-period-ahead expected return, $E_t[r_{it+1}]$. From the definition of return, $P_{it} = (E_t[D_{it+1}] + E_t[P_{it+1}])/(1 + E_t[r_{it+1}])$, and the clean surplus relation, we can reformulate equation (6) as:

$$P_{it} = \frac{E_t[Y_{it+1} - \triangle B_{it+1}] + E_t[P_{it+1}]}{1 + E_t[r_{it+1}]}. \tag{7}$$

Dividing both sides of equation (7) by B_{it} and rearranging, we obtain:

$$\frac{P_{it}}{B_{it}} = \frac{E_t\left[\frac{Y_{it+1}}{B_{it}}\right] - E_t\left[\frac{\triangle B_{it+1}}{B_{it}}\right] + E_t\left[\frac{P_{it+1}}{B_{it+1}}\left(1 + \frac{\triangle B_{it+1}}{B_{it}}\right)\right]}{1 + E_t[r_{it+1}]}, \tag{8}$$

$$\frac{P_{it}}{B_{it}} = \frac{E_t\left[\frac{Y_{it+1}}{B_{it}}\right] + E_t\left[\frac{\triangle B_{it+1}}{B_{it}}\left(\frac{P_{it+1}}{B_{it+1}} - 1\right)\right] + E_t\left[\frac{P_{it+1}}{B_{it+1}}\right]}{1 + E_t[r_{it+1}]}. \tag{9}$$

Fixing everything except $E_t\left[\triangle B_{it+1}/B_{it}\right]$ and $E_t[r_{it+1}]$, high $E_t\left[\triangle B_{it+1}/B_{it}\right]$ implies high $E_t[r_{it+1}]$, because $P_{it+1}/B_{it+1} - 1$ is more likely to be positive in the data. More generally, leading equation (9) by one period at a time and recursively substituting P_{it+1}/B_{it+1} in the same equation implies a positive $E_t\left[\triangle B_{it+\tau}/B_{it}\right]$-$E_t[r_{it+1}]$ relation for all $\tau \geq 1$. This insight helps interpret the mixed evidence on the $E_t\left[\triangle B_{it+1}/B_{it}\right]$-$E_t[r_{it+1}]$ relation in FF (2006) and Aharoni, Grundy, and Zeng (2013).

The relation between the expected investment and the expected return is also positive in q-theory. To bring back the expected investment effect, we extend equation (5) from the static to a dynamic framework (see Appendix B for detailed derivations):

$$E_t[r^S_{it+1}] = \frac{E_t[\Pi_{it+1}/A_{it+1}] + (a/2)E_t\left[(I_{it+1}/A_{it+1})^2\right] + (1 + aE_t[I_{it+1}/A_{it+1}])}{1 + a\left(I_{it}/A_{it}\right)}. \tag{10}$$

In the numerator, $E_t[\Pi_{it+1}/A_{it+1}]$ is the expected marginal product of assets, and $(a/2)E_t\left[(I_{it+1}/A_{it+1})^2\right]$ is the expected marginal reduction in adjustment costs. The last term, $1 + aE_t[I_{it+1}/A_{it+1}]$, is the expected marginal continuation value of an extra unit of assets, which equals the expected marginal costs of investment. The expected "capital gain," $(1+aE_t[I_{it+1}/A_{it+1}])/[1+a(I_{it}/A_{it})]$, is roughly proportional to $E_t[I_{it+1}/A_{it+1}]/(I_{it}/A_{it})$. Because assets do not vary much relative to investment, $E_t[I_{it+1}/A_{it+1}]/(I_{it}/A_{it})$ is in turn roughly the expected investment growth, $E_t[I_{it+1}/I_{it}]$. As such, all else equal, the expected investment (growth) and the expected return tend to be positively correlated.[9] In all, the q-theory implications are consistent with those from valuation theory on the one-period-ahead expected return.

3.2.4 Past Investment Is a Poor Proxy for the Expected Investment

Finally, as noted, after motivating the investment factor from the expected investment effect, FF (2014a) use past investment as a proxy for the expected investment. This practice is problematic. The crux is that whereas past profitability is a good proxy for the expected profitability, past investment is a poor proxy for the expected investment. Table 3 reports annual cross-sectional re-

[9] At the aggregate level, Lettau and Ludvigson (2002) document that high risk premiums forecast high long-term investment growth rates. Intuitively, high risk premiums signal economic recessions, and going forward, the economy rebounds, giving rise to high investment growth rates. In the cross section, Liu and Zhang (2014) show that the expected investment growth is an important component of price and earnings momentum predicted in the dynamic investment model, both in terms of average momentum profits as well as their short-lived dynamics (from six to twelve months).

gressions of future book equity growth rates, $\triangle\text{BE}_{it+\tau}/\text{BE}_{it+\tau-1} \equiv (\text{BE}_{it+\tau} - \text{BE}_{it+\tau-1})/\text{BE}_{it+\tau-1}$, for $\tau = 1, 2, \ldots, 10$, on the current total assets growth, $\triangle\text{TA}_{it}/\text{TA}_{it-1} = (\text{TA}_{it} - \text{TA}_{it-1})/\text{TA}_{it-1}$, and, separately, on book equity growth, $\triangle\text{BE}_{it}/\text{BE}_{it-1}$. For comparison, we also report annual cross-sectional regressions of future operating profitability, $\text{OP}_{it+\tau}$, on operating profitability, OP_{it}.

We follow the sample selection criteria in FF (2006, 2014a). The sample contains all common stocks traded on NYSE, Amex, and NASDAQ from 1963 to 2013. We do not exclude financial firms because these are included in the construction of their five factors. Book equity is measured per Davis, Fama, and French (2000), and operating profitability per FF (2014a). Variables dated t are from the fiscal year ending in calendar year t. We exclude firms with total assets (Compustat annual item AT) below \$5 million or book equity below \$2.5 million in year t in Panel A of Table 3. The cutoffs are \$25 million and \$12.5 million in Panel B. We also winsorize all the variables each year at the 1st and 99th percentiles of their cross-sectional distributions.

Table 3 shows that assets growth is a poor proxy for future book equity growth. In Panel A, the slope starts at 0.22 at the one-year forecast horizon, drops to 0.07 in year three and further to 0.05 in year five. The average R^2 of the cross-sectional regressions starts at 5% in year one, drops to zero in year four, and stays at zero for the remaining years. The results from using past book equity growth as a proxy and those with the more stringent sample selection criterion in Panel B are largely similar. The evidence casts doubt on the FF motivation of CMA from the expected investment effect, but lends support to our reinterpretation of their CMA through the market-to-book term in valuation equation based on q-theory.

The last five columns in Table 3 show that profitability forecasts future profitability. In Panel A, the slope in the annual cross-sectional regressions starts with 0.80 in year one, drops to 0.59 in year three and 0.49 in year five, and remains at 0.37 even in year ten. The average R^2 starts at 55% in year one, drops to 28% in year three and 19% in year five, and remains above 10% in year ten. As such, the use of profitability as a proxy for the expected profitability in FF (2014a) is reasonable, but their use of past asset growth as a proxy for the expected investment is problematic.

4 Comparison in Empirical Performance

We perform large-scale empirical horse races between the q-factor model and the FF five-factor model in "explaining" anomalies. Section 4.1 sets up the playing field. Section 4.2 reports factor regressions with testing portfolios with NYSE breakpoints and value-weighted returns, and Section 4.3 with all-but-micro breakpoints and equal-weighted returns. Section 4.4 shows that the relative performance of the q-factor model persists with alternative factor constructions.

4.1 The Playing Field

We work with the universe of anomalies in HXZ (2014). Table 4 reports their list of 73 anomalies, covering six major categories: momentum, value-versus-growth, investment, profitability, intangibles, and trading frictions.[10] Appendix C details the variable definition and portfolio construction. Following HXZ, we form testing portfolios with NYSE breakpoints and value-weighted returns to alleviate the impact of microcaps. Microcaps are on average only 3% of the market value of the NYSE-Amex-NASDAQ universe, but account for about 60% of the total number of stocks (e.g., FF (2008)).

However, FF (2014a) argue that value-weighted portfolio returns can be dominated by a few big stocks. More important, the most serious challenges for asset pricing models are in small stocks, which value-weighted portfolios tend to underweight. To address this concern, we also form testing portfolios with all-but-micro breakpoints and equal-weighted returns. As noted, we exclude microcaps from the NYSE-Amex-NASDAQ universe, use the remaining stocks to calculate breakpoints, and then equal-weight all the stocks within a given portfolio to give small stocks sufficient weights in the portfolio. By construction, microcaps are not included in this set of testing portfolios.

Our timing in forming testing portfolios follows HXZ (2014). For annually sorted testing portfolios, we sort all stocks at the end of June of each year t into deciles based on, for instance, book-to-

[10]HXZ (2014) also examine industry and six momentum-reversal variables (momentum with holding periods longer than six months), which we do not include because these are not primary anomaly variables.

market at the fiscal year ending in calendar year $t-1$, and calculate decile returns from July of year t to June of $t+1$. For monthly sorted portfolios involving latest earnings data, such as the ROE deciles, we follow the timing in constructing the ROE factor. In particular, earnings data in Compustat quarterly files are used in the months immediately after the quarterly earnings announcement dates. Finally, for monthly sorted portfolios involving quarterly accounting data other than earnings, such as the failure probability deciles, we impose a four-month lag between the sorting variable and holding period returns. Unlike earnings, other quarterly data items might not be available upon earnings announcement dates. The four-month lag is imposed to guard against look-ahead bias.

Table 5 shows that 37 out of 73 anomalies are insignificant with NYSE breakpoints and value-weighted returns and 23 are insignificant with all-but-micro breakpoints and equal-weighted returns. Consistent with HXZ (2014), 12 out of 13 variables in the trading frictions category are insignificant with NYSE breakpoints and value-weighted returns. The number of insignificant trading frictions anomalies reduces to eight with all-but-micro breakpoints and equal-weighted returns. Two marginally significant anomalies are Ang, Hodrick, Xing, and Zhang's (2006) idiosyncratic volatility, which earns an average high-minus-low return of -0.61% per month ($t = -1.87$), and Amihud's (2002) price impact measure, which earns 0.29% ($t = 1.92$). Finally, both Gompers, Ishii, and Metrick's (2003) corporate governance index and Francis, Lafond, Olsson, and Schipper's (2005) accrual quality earn tiny average returns regardless of the portfolio formation procedure.

4.2 NYSE Breakpoints and Value-weighted Returns

4.2.1 Pricing Errors and Tests of Overall Performance

Table 6 reports the alphas and their t-statistics for the 36 significant high-minus-low deciles, as well as the mean absolute alphas across a given set of deciles and the corresponding p-values for the Gibbons, Ross, and Shanken (1989, GRS) test on the null that the alphas across a given set of deciles are jointly zero. The q-factor model performs well relative to the FF five-factor model and the Carhart model. Across the 36 high-minus-low deciles, the average magnitude of the alphas is 0.20% per month in the q-factor model, which is lower than 0.36% in the five-factor model, 0.33% in the Carhart model, and 0.51% in the FF three-factor model. In addition, seven out of 36 high-minus-low deciles have alphas that are significant at the 5% level in the q-factor model, in contrast to 19 in the five-factor model, 21 in the Carhart model, and 28 in the three-factor model.

The q-factor model has the lowest mean absolute alpha across the 36 sets of deciles, 0.11% per month, in contrast to 0.12% in the five-factor model, 0.12% in the Carhart model, and 0.15% in the three-factor model. The GRS test rejects at the 5% level the q-factor model, the five-factor model, and the Carhart model in 25 out of 36 sets of deciles, but the three-factor model in 32 sets.

The q-factor model outperforms the Carhart model, which in turn outperforms both FF models in the momentum categories. Across the eight significant high-minus-low momentum deciles, the average magnitude of the alphas is 0.20% per month in the q-factor model, which is lower than 0.29% in the Carhart model, 0.76% in the five-factor model, and 0.89% in the three-factor model. Two out of eight high-minus-low alphas are significant in the q-factor model, in contrast to four in the Carhart model and all eight in both FF models. Across the eight sets of deciles, the mean absolute alpha is 0.11% in the q-factor model, which is close to 0.10% in the Carhart model. Both are lower than 0.17% in the three-factor and five-factor models. The GRS test rejects the q-factor model in six and the Carhart model in five but the two FF models in all eight sets of deciles.

The four models are largely comparable in the value-versus-growth category, with the five-factor model having a slight edge. None of the high-minus-low alphas are significant in the five-factor model. Except for net payout yield (NO/P), the high-minus-low alphas are also insignificant in the other models. The GRS test rejects the five-factor model in two sets of deciles, and the three-factor model and the q-factor model in three sets, but the Carhart model in only one set of deciles.

In the investment category, three out of 12 high-minus-low alphas are significant in the q-factor model, in contrast to six five-factor alphas, eight Carhart alphas, and 11 three-factor alphas. The average magnitude of the high-minus-low alphas is 0.21% per month in the q-factor model, which is lower than 0.25% in the five-factor model, 0.31% in the Carhart model, and 0.39% in the three-factor model. The mean absolute alphas across the deciles are comparable: 0.11% in the q-factor model, 0.10% in the five-factor model, 0.12% in the Carhart model, and 0.13% in the three-factor model. However, all four models are rejected by the GRS test in most sets of deciles.

The q-factor model dominates the other models in the profitability category. None of the five high-minus-low alphas are significant in the q-factor model. In contrast, all but one (gross profits-to-assets) high-minus-low alphas are significant in the five-factor model, and all five are significant in the three-factor and Carhart models. The average magnitude of the high-minus-low alphas is 0.13% per month in the q-factor model, which is substantially lower than 0.44% in the five-factor model, 0.57% in the Carhart model, and 0.78% in the three-factor model. However, the GRS test still rejects the q-factor model (and the five-factor model) in three out of five sets of deciles, and rejects the Carhart model in four, and the three-factor model in all five sets of deciles.

We comment on three results in the remaining columns in the lower panel of Table 6. First, the organizational capital (OC/A) effect is captured by the q-factor model but not by the five-factor model. The high-minus-low decile has a q-model alpha of 0.13% per month ($t = 1.03$) but a five-factor alpha of 0.33% ($t = 2.61$). Second, the q-factor model fails to fit the R&D-to-market anomaly, with a large high-minus-low alpha of 0.60% ($t = 2.46$). In contrast, the five-factor alpha is 0.38% ($t = 1.57$), and the three-factor and Carhart alphas are even smaller (and insignificant). Finally, both the q-factor model and the five-factor model capture the systematic volatility (Svol) effect, with high-minus-low alphas around -0.34%, which are within 1.5 standard errors from zero.

Overall, except for the R&D-to-market anomaly, the q-factor model performs well relative to the FF five-factor model. The q-factor model outperforms the five-factor model in the momentum, investment, and profitability categories. The two models are largely comparable, but the five-factor model has a slight edge in the value-versus-growth category.

4.2.2 Factor Loadings

To shed light on the sources behind the relative performance of the q-factor model and the FF five-factor model, Table 7 examines their factor loadings.

The first eight columns (from "SUE-1‘" to "I-Mom") in the upper panel show why the q-factor model outperforms the five-factor model in capturing price and earnings momentum. Across the eight high-minus-low deciles, the ROE factor loadings vary from 0.18 to 1.46, all of which are more than 2.5 standard errors from zero. In contrast, the RMW factor loadings are substantially smaller and mostly insignificant. In fact, the RMW loadings for two anomalies (Abr-1 and Abr-6) are even negative, albeit insignificant. Only the high-minus-low deciles on revisions in analysts' earnings forecasts (RE-1 and RE-6) have significant RMW loadings, and the rest are insignificant. Intuitively, formed monthly on the latest announced quarterly earnings, our ROE factor is more powerful in capturing the profitability differences between winners and losers. In contrast, formed annually on earnings from the last fiscal year end, RMW seems less effective.

The next six columns (from "B/M" to "Dur") show that HML is the main source of the five-factor model's power in fitting the value-versus-growth anomalies. All the high-minus-low deciles have HML loadings that are at least 3.5 standard errors from zero. CMA also helps, but its loadings can be insignificant, and their signs can occasionally be opposite to those of the HML loadings. In the q-factor model, the investment factor is the main source of its power in fitting these anomalies. Ranging from -1.17 to 1.40, the loadings are all at least six standard errors from zero.

The last four columns in the upper panel and the first eight columns in the lower panel show that the investment factor is the main source of the q-factor model's power in fitting the investment, equity issues, inventory, and accrual anomalies. Leaving aside abnormal corporate investment (ACI), net operating assets (NOA), and operating accruals (OA), the loadings on the investment factor vary from -0.68 to -1.37, all of which are at least six standard errors from zero. Similarly, CMA is the main source of the five-factor model's power in fitting these anomalies. Leaving aside ACI, NOA, and OA, the CMA loadings vary from -0.57 to -1.14, all of which are significant.

The high-minus-low ACI decile has an investment factor loading of 0.13 ($t = 1.01$) and an ROE factor loading of -0.19 ($t = -2.10$). However, its RMW and CMA loadings are both close to zero. Accordingly, the q-model alpha is -0.17% per month ($t = -0.96$, Table 6), and the five-factor alpha is -0.30% ($t = -1.91$). Although commonly viewed as an investment variable, ACI is the ratio of capital expenditure divided by sales (scaled by the prior three-year moving average of the ratio). The denominator seems to make ACI closer to profitability than to investment.

Consistent with HXZ (2014), the q-factor model has trouble in fitting the NOA and OA anomalies. The five-factor model also struggles with these two. The high-minus-low NOA decile has a q-model alpha of -0.39% per month ($t = -2.10$) and a five-factor alpha of -0.44% ($t = -2.62$) (Table 6). Table 7 shows that the investment factor loading for the high-minus-low decile is only -0.07. Although commonly viewed as an accrual variable, NOA is a stock variable, as opposed to a flow variable such as accruals.[11] The problem for the five-factor model arises from a different source. Although both large and significant, the HML and CMA loadings have different signs that work to offset each other, leaving a large alpha unaccounted for.

The high-minus-low OA decile has a q-model alpha of -0.54% ($t = -3.81$) and a five-factor alpha of -0.52% ($t = -4.10$) (Table 6), although both models capture the two percent accrual anomalies, POA and PTA. The high-minus-low OA decile has a tiny investment factor loading, -0.05, in the q-factor model but a significant ROE loading of 0.27 that goes in the wrong direction in capturing the average returns (Table 7). The same trouble also plagues the five-factor model, with a CMA loading of 0.01 and a large RMW loading of 0.40 ($t = 6.18$).

The next five columns (from "ROE" to "NEI") in the lower panel of Table 7 show that the profitability anomalies are largely captured by the ROE factor in the q-factor model. The ROE

[11] In untabulated results, we show that the change in NOA (a flow variable) forecasts returns, and the q-factor model captures this effect. The high-minus-low decile earns on average -0.53% per month ($t = -3.84$). The CAPM, FF three-factor, and Carhart alphas are $-0.62\%, -0.40\%$, and -0.34% ($t = -4.51, -3.06$, and -2.40), respectively. The q-model alpha is only -0.09 ($t = -0.60$). The investment factor loading is -1.06 ($t = -9.35$), and all the other factor loadings are insignificant. The five-factor alpha is -0.22% ($t = -1.41$).

loadings for the high-minus-low deciles range from 0.54 to 1.50, all of which are more than seven standard errors from zero. RMW is the main source of power for the five-factor model. However, the RMW loadings are smaller than the ROE factor loadings. In fact, other than gross profits-to-assets, the five-factor alphas for the other profitability variables vary from 0.46% per month to 0.53%, all of which are at least three standard errors from zero (Table 6). Intuitively, all the other anomaly deciles are formed monthly, meaning that the annually formed RMW is less powerful than the monthly formed ROE factor in capturing these anomalies.

Finally, the "RD/M" column in the lower panel of Table 7 shows why the q-factor model underperforms the five-factor model in capturing the R&D-to-market anomaly. Despite earning an average return of 0.64% per month ($t = 2.40$), the high-minus-low decile has an ROE factor loading of -0.58 ($t = -4.08$). HXZ (2014) conjecture that because R&D is expensed rather than capitalized per standard accounting rules, high R&D expenses give rise to artificially low ROE. Although this problem also appears in the five-factor model, as evidenced in the RMW loading of -0.52 ($t = -2.86$), it causes more trouble for the q-factor model.

In all, our ROE factor is more powerful than RMW, and allows the q-factor model to outperform the FF five-factor model in capturing the momentum and profitability anomalies. Our investment factor is also somewhat more powerful than CMA, likely resulting from jointly sorting with ROE, and allows the q-factor model to outperform the five-factor model in capturing the investment anomalies. The five-factor model has a slight edge over the q-factor model in fitting the value-versus-growth anomalies, likely because both HML and CMA are at work, whereas only the investment factor is at work in the q-factor model.

4.3 All-but-micro Breakpoints and Equal-weighted Returns

We next compare the performance of the various factor models in capturing the 50 significant anomalies with all-but-micro breakpoints and equal-weighted returns.

4.3.1 Pricing Errors and Tests of Overall Performance

Table 8 reports the high-minus-low alphas and their t-statistics as well as the mean absolute alphas across a given set of deciles and the corresponding p-values for the GRS test. The q-factor model continues to perform well. Across the 50 high-minus-low deciles, the average magnitude of the alphas is 0.24% per month in the q-factor model, which is lower than 0.41% in the five-factor model, 0.40% in the Carhart model, and 0.59% in the three-factor model. Also, 16 out of 50 high-minus-low deciles have alphas that are significant at the 5% level in the q-factor model, in contrast to 34 in the five-factor model, 37 in the Carhart model, and 44 in the three-factor model. The mean absolute alpha is 0.13% in the q-factor model, which is slightly higher than 0.11% in the five-factor model, but lower than 0.16% in the Carhart model and 0.14% in the three-factor model. Finally, the GRS test rejects the q-factor model at the 5% level in 37 out of 50 sets of deciles, and rejects the five-factor model in 35, the Carhart model in 39, and the three-factor model in 41 sets of deciles.

Across the ten significant momentum anomalies, the average magnitude of the high-minus-low alphas is 0.27% per month in the q-factor model, which is lower than 0.31% in the Carhart model, and substantially lower than 0.79% in the five-factor model and 0.92% in the three-factor model. Three high-minus-low alphas are significant in the q-factor model, in contrast to five in the Carhart model, and ten out of ten in both the five-factor and three-factor models. The average magnitude of the alphas across the ten sets of deciles is 0.13% in the q-factor model, which is identical to 0.13% in the Carhart model, but lower than 0.18% in the five-factor model and 0.19% in the three-factor model. However, all four models are rejected by the GRS test in most sets of deciles.

Across the seven anomalies in the value-versus-growth category, the q-factor model is largely comparable with the five-factor model. (The slight edge for the five-factor model with NYSE breakpoints and value-weighted returns has vanished.) Both models perform somewhat better than the Carhart model and the three-factor model. None of the high-minus-low alphas are significant in the q-factor model or the five-factor model, whereas two Carhart alphas and five three-factor alphas are significant. The GRS test rejects the q-factor model as well as the five-factor model in one set of deciles, but rejects the Carhart and three-factor models in two sets of deciles.

The q-factor model is also largely comparable with the five-factor model across the 14 investment anomalies. The average magnitude of the high-minus-low alphas is 0.32% per month in the q-factor model, which is lower than 0.39% in the five-factor model, 0.42% in the Carhart model, and 0.51% in the three-factor model. Ten out of 14 high-minus-low alphas are significant in the q-factor model, in contrast to 13 in the five-factor model and all 14 in the Carhart and three-factor models. However, the five-factor model has the lowest mean absolute alpha across all 14 sets of deciles, 0.09%, in contrast to 0.14% in the q-factor model, 0.19% in the Carhart model, and 0.13% in the three-factor model. All four models are rejected by the GRS test in most sets of deciles.

The q-factor model dominates all the other models in the profitability category. The average magnitude of the nine high-minus-low alphas is 0.14% per month in the q-factor model, in contrast to 0.37% in the five-factor model, 0.53% in the Carhart model, and 0.70% in the three-factor model. One out of nine high-minus-low alphas is significant in the q-factor model, in contrast to seven in the five-factor model and eight in the Carhart and three-factor models. The mean absolute alpha is 0.12% in the q-factor model, 0.11% in the five-factor model, and 0.17% in the Carhart and three-factor models. However, all four models are still rejected by the GRS test in most sets of deciles.

The last eight columns in Table 8 show that the q-factor model performs well relative to the five-factor model in the intangibles and trading frictions categories. The underperformance of the q-factor model in fitting the R&D-to-market anomaly relative to the five-factor model has attenuated. The high-minus-low q-model alpha is 0.78% per month ($t = 2.66$), which is not far from the five-factor alpha of 0.69% ($t = 2.70$). The high-minus-low deciles on maximum daily returns and dispersion in analysts' earnings forecasts have q-model alphas of -0.16% and -0.04%, respectively. Both are within one standard error from zero. In contrast, their five-factor alphas of -0.28% and -0.33%, respectively, are both significant. Finally, except for organizational capital, both models reduce the high-minus-low alphas for the other anomaly variables to insignificance.

4.3.2 Factor Loadings

Table 9 reports the factor loadings for the q-factor model and the FF five-factor model for high-minus-low deciles with all-but-micro breakpoints and equal-weighted returns.

The first ten columns show that the ROE factor loadings for the high-minus-low momentum deciles vary from 0.22 to 1.36, all of which are significant. In contrast, the RMW loadings for these deciles are substantially smaller, varying from -0.07 to 0.32, and six out of ten loadings are insignificant. The next seven columns (from "B/M" to "Rev") show that the investment factor is mostly responsible for the q-factor model's power in fitting the value-versus-growth anomalies. The loadings vary from -1.18 to 1.97, all of which are more than seven standard errors from zero. Naturally, HML is the most powerful factor in the five-factor model in capturing these anomalies.

The next 14 columns (from "ACI" to "PTA") in Table 9 show that the investment factor is the main force of the q-factor model to fit the investment anomalies. Again leaving aside ACI, NOA, and OA, the investment factor loadings vary from -0.55 to -1.25, all of which are more than six standard errors from zero. Similarly, the CMA loadings in the five-factor model vary from -0.35 to -0.97, all of which are more than three standard errors from zero. As noted, ACI in effect combines investment and profitability. The high-minus-low decile has a significant loading of -0.15 on both the investment and ROE factors, which together produce a q-model alpha of -0.13% per month ($t = -1.32$). Although the CMA loading is significantly negative, the HML and RMW loadings are insignificant, producing a five-factor alpha of -0.26% ($t = -2.85$).

For the high-minus-low NOA decile, its investment factor loading is virtually zero, giving rise to a large q-model alpha of -0.71% per month ($t = -3.26$) (Table 8).[12] Although the CMA loading

[12] In untabulated results, we again verify that the q-factor model does better in capturing the average returns across deciles formed on the NOA change. The high-minus-low decile with all-but-micro breakpoints and equal-weighted returns earns on average -0.76% per month ($t = -5.93$). The CAPM, FF three-factor, and Carhart alphas are $-0.87\%, -0.72\%$, and -0.60% ($t = -7.17, -5.99$, and -5.05), respectively. The high-minus-low decile has a large investment factor loading of -0.83 ($t = -9.83$), but its q-model alpha is still -0.46% ($t = -3.69$). For comparison, the five-factor alpha is -0.57% ($t = -5.16$), despite a CMA loading of -0.82 ($t = -8.88$).

is -0.65 ($t = -5.41$), the HML loading, 0.61 ($t = 5.91$), goes in the wrong direction as the average return, giving rise to a large five-factor alpha of -0.79 ($t = -4.89$). The high-minus-low OA decile has a q-model alpha of -0.53% ($t = -4.05$) and a five-factor alpha of -0.51% ($t = -4.79$) (Table 8). As noted, the problem with the q-factor model is that the high-minus-low decile has an insignificant investment factor loading of -0.19, but a significant ROE loading of 0.43, which goes in the wrong direction in capturing the average returns. The same problem also plagues the five-factor model, with a small CMA loading, -0.13, but a large RMW loading, 0.62.

Across the nine high-minus-low profitability deciles, the ROE factor loadings vary from -0.54 to 1.50, all of which are more than 5.5 standard errors from zero. The RMW loadings vary from -0.60 to 1.59, and all except for tax expense surprise are at least 4.5 standard errors from zero. Because the factor loadings are of similar magnitude, the difference in performance between the q-factor model and the five-factor model likely results from the difference between the average ROE factor return, 0.57% per month, and the average RMW return, 0.27%.

We comment on three results in the remaining columns in Table 9. First, the high-minus-low hiring rate decile has a large investment factor loading of -1.14, which is more than 15 standard errors from zero. Intuitively, firms that hire more workers also invest more, and vice versa. As a result, despite a high average return of -0.50% ($t = 3.62$), the q-model alpha is tiny, -0.05% ($t = -0.44$). The five-factor model also has a small alpha of -0.11% ($t = -1.19$). Second, the q-factor model reduces the maximum daily return (MDR) anomaly to insignificance. The investment and ROE factor loadings, -1.19 and -0.78, respectively, are both more than four standard errors from zero. Finally, the q-factor model captures the average high-minus-low return on the dispersion in analysts' earnings forecasts (Disp) mainly through the ROE factor, with a loading of -1.04 ($t = -14.58$). The five-factor alphas are significant for both MDR and Disp anomalies.

4.4 Alternative Factor Constructions

The relative performance of the q-factor model is robust with alternative factor constructions.

4.4.1 Alternative Factors

In addition to the benchmark 2×3 sorts, FF (2014a) also consider 2×2 sorts and a quadruple $2 \times 2 \times 2 \times 2$ sort on size, book-to-market, Inv, and OP to construct their new factors. Analogously, in addition to the benchmark $2 \times 3 \times 3$ sort, we also consider a triple $2 \times 2 \times 2$ sort on size, I/A, and ROE and double (2×3 and 2×2) sorts on size and I/A as well as on size and ROE in constructing the q-factors. The triple $2 \times 2 \times 2$ sort on size, I/A, and ROE is similar to the benchmark $2 \times 3 \times 3$ sort, except that we use NYSE medians to break stocks into two I/A groups and two ROE groups.

In the 2×3 sorts for the q-factors, at the end of June of year t, we use the NYSE median to split stocks into two size groups, small and big. Independently, at the end of June of year t, we split stocks into three I/A groups with the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the rank values of I/A for the fiscal year ending in calendar year $t-1$. Also, independently, at the beginning of each month, we split all stocks into three ROE groups with the NYSE breakpoints for the low 30%, middle 40%, and high 30% of the rank values of ROE calculated with the most recent announced quarterly earnings. Taking the intersection of the two size and three I/A groups, we form six portfolios. Monthly value-weighted returns are calculated from July of year t to June of year $t+1$, and the portfolios are rebalanced in June. Taking the intersection of the two size and three ROE groups, we form six different portfolios. Monthly value-weighted returns are calculated for the current month, and the portfolios are rebalanced at the beginning of next month.

The investment factor is the simple average of the returns on the two low I/A portfolios minus the simple average of the returns on the two high I/A portfolios. The ROE factor is the simple average of the returns on the two high ROE portfolios minus the simple average of the returns on the two low ROE portfolios. Also, the two double sorts generate six small portfolios and six big portfolios. As such, the size factor is the simple average of the returns on the six small portfolios minus the simple average of the returns on the six big portfolios. Finally, the 2×2 sorts are similar to the 2×3 sorts, except that we use NYSE medians to split stocks into two I/A and two ROE groups.

4.4.2 Empirical Properties

From Panel A of Table 10, the investment and ROE factors from the $2 \times 2 \times 2$ sort earn on average 0.26% per month ($t = 3.90$) and 0.40% ($t = 5.00$), respectively. By focusing less on the extreme I/A and ROE stocks, these premiums are somewhat lower than those of the benchmark q-factors. Still, the premiums cannot be captured by the Carhart model or the FF five-factor model. The Carhart alphas of the investment and ROE factors are 0.18% ($t = 3.63$) and 0.36% ($t = 4.99$), and the five-factor alphas are 0.07% ($t = 2.20$) and 0.29% ($t = 4.80$), respectively.

The investment and ROE factors from the 2×3 sorts earn on average 0.29% per month ($t = 3.07$) and 0.57% ($t = 4.44$). As such, the joint sort on I/A and ROE in the benchmark construction does not affect the ROE factor, but reduces the average return of the investment factor by 0.15%. In fact, this alternative construction of the investment factor is virtually identical to the benchmark construction of CMA. As such, the benchmark five-factor model largely captures the investment factor return, but still leaves a large alpha of 0.37% ($t = 4.02$) for the ROE factor. The investment and ROE factors from the 2×2 sorts earn on average 0.19% ($t = 2.68$) and 0.40% ($t = 4.36$). A comparison with the $2 \times 2 \times 2$ sort shows that the joint sort again leaves the ROE factor largely untouched, but reduces somewhat the investment factor premium. The benchmark five-factor model again captures the investment factor return, but leaves an alpha of 0.23% ($t = 3.59$) for the ROE factor.

Panel B reports the results from the alternative sorts for the new FF factors. RMW and CMA from the $2 \times 2 \times 2 \times 2$ sort earn on average 0.27% per month ($t = 3.78$) and 0.16% ($t = 2.84$), respectively. Both RMW and CMA survive the Carhart model, but their average returns are captured by the benchmark q-factor model, with alphas of 0.13% ($t = 1.68$) and −0.00% ($t = -0.01$), respectively. Finally, the alternative 2×2 sorts produce largely similar results. RMW and CMA from these sorts earn average returns of 0.19% ($t = 2.56$) and 0.24% ($t = 3.33$), but tiny q-model alphas of 0.03% ($t = 0.50$) and 0.03% ($t = 0.93$), respectively.

4.4.3 Regressions with Alternative Factors

The q-factor model outperforms the FF five-factor model under alternative factor constructions. Panel A of Table 11 reports factor regressions for testing deciles with NYSE breakpoints and value-weighted returns. Across the 36 high-minus-low deciles, the average magnitude of the alphas is 0.26% per month in the $2 \times 2 \times 2$, 0.26% in the 2×3, and 0.29% in the 2×2 version of the q-factor model (0.20% in the benchmark). These estimates are all lower than 0.40% in the $2 \times 2 \times 2 \times 2$ and 0.37% in the 2×2 version of the five-factor model (0.36% in the benchmark). Also, ten out of 36 high-minus-low deciles have significant alphas at the 5% level in the $2 \times 2 \times 2$, 11 in the 2×3, and 11 in the 2×2 version of the q-factor model (seven in the benchmark), which are again all lower than 19 in the $2 \times 2 \times 2 \times 2$ and 20 in the 2×2 version of the five-factor model (19 in the benchmark).

The mean absolute alpha across the 36 deciles is 0.11% per month in all three alternative versions of the q-factor model (as well as the benchmark). The estimate is 0.12% in the two alternative versions of the five-factor model (as well as the benchmark). Also, the GRS test rejects the $2 \times 2 \times 2$ q-model in 20 out of 36 sets of deciles, the 2×2 q-model in 23, and the 2×3 q-model (as well as the benchmark) in 25 sets of deciles. For comparison, the GRS test rejects the $2 \times 2 \times 2 \times 2$ five-factor model in 23 and the 2×2 five-factor model (as well as the benchmark) in 25 sets of deciles.

Panel B furnishes the results for the testing deciles with all-but-micro breakpoints and equal-weighted returns. Across the 50 high-minus-low deciles, the average magnitude of the alphas is 0.29% per month in the $2 \times 2 \times 2$, 0.29% in the 2×3, and 0.31% in the 2×2 version of the q-factor model (0.24% in the benchmark). These estimates are all lower than 0.46% in the $2 \times 2 \times 2 \times 2$ and 0.43% in the 2×2 five-factor model (0.41% in the benchmark). Also, 20 out of 50 high-minus-low deciles have significant alphas at the 5% level in the $2 \times 2 \times 2$, 21 in the 2×3, and 22 in the 2×2 q-model (16 in the benchmark). In contrast, 36 have significant five-factor alphas in the $2 \times 2 \times 2 \times 2$ and 35 in the 2×2 five-factor model (34 in the benchmark).

The mean absolute alpha across the 50 deciles is 0.15% per month in the $2 \times 2 \times 2$, and 0.13%

in the 2×3 and 2×2 q-models (0.13% in the benchmark). These estimates are slightly higher than 0.12% in the $2 \times 2 \times 2 \times 2$ and 0.11% in the 2×2 five-factor model (0.11% in the benchmark). Also, the GRS test rejects the $2 \times 2 \times 2$ q-model in 37 sets of deciles and the 2×3 and 2×2 q-models in 36 sets (37 for the benchmark). For comparison, the GRS test rejects the $2 \times 2 \times 2 \times 2$ in 34 and the 2×2 five-factor model (as well as the benchmark) in 35 sets of deciles. Finally, without going through the details, we can report that the q-factor model outperforms the FF five-factor model by a big margin in the momentum and profitability categories with the alternative factors.[13]

5 Conclusion

Our comparison between the q-factor model and the FF five-factor model yields two major findings. Conceptually, four concerns cast doubt on the motivation of the five-factor model from valuation theory: (i) The internal rate of return often correlates negatively with the one-period-ahead expected return; (ii) the value factor is separate in theory but redundant in the data; (iii) the expected investment tends to be positively correlated with the one-period-ahead expected return; and (iv) past investment does not forecast future investment. The last two concerns, in particular, suggest that the investment factor can only be derived from the q-theory link between value and investment.

Empirically, the q-factor model outperforms the five-factor model, especially in capturing price and earnings momentum and profitability anomalies. The relative performance of the q-factor model is robust to several perturbations of our test design, including breakpoints and return-weighting schemes in forming testing portfolios, as well as alternative factor constructions. In all, we conclude that the FF five-factor model is in essence a noisy version of the q-factor model.

[13]In constructing q-factors, we scale earnings by lagged book equity, as opposed to lagged book assets. FF (2014a) also use book equity to scale the operating profitability when constructing RMW. Replacing the ROE factor with a factor formed on ROA (earnings scaled by one-quarter-lagged book assets) has little impact on the performance of the q-factor model. If anything, the ROA factor improves slightly the q-model's performance (the Internet Appendix).

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Table 1 : Empirical Properties of the New Factors, January 1967 to December 2013

r_{ME}, $r_{\mathrm{I/A}}$, and r_{ROE} are the size, investment, ROE factors in the q-factor model, respectively. We calculate MKT as the value-weighted market return minus the one-month Treasury bill rate from CRSP. SMB, HML, RMW, and CMA are the size, value, profitability, and investment factors from the FF five-factor model (from 2×3 sorts), respectively. The data for SMB and HML in the three-factor model, SMB, HML, RMW, and CMA in the five-factor model, as well as UMD are from Kenneth French's Web site. m is the average return, α is either the FF three-factor alpha or the Carhart alpha, α_q the q-model alpha, a is the five-factor alpha, and b, s, h, r, and c are five-factor loadings. The numbers in parentheses in Panels A to C are heteroscedasticity-and-autocorrelation-adjusted t-statistics, which test that a given point estimate is zero. In Panel D, the numbers in parentheses are p-values testing that a given correlation is zero.

Panel A: The q-factors

	m	α	β_{MKT}	β_{SMB}	β_{HML}	β_{UMD}	R^2
r_{ME}	0.34	0.03	0.01	0.98	0.17		0.93
	(2.51)	(0.95)	(0.83)	(60.34)	(7.05)		
		0.00	0.01	0.98	0.18	0.03	0.93
		(0.06)	(1.50)	(65.19)	(7.27)	(2.02)	
$r_{\mathrm{I/A}}$	0.44	0.34	−0.07	−0.04	0.40		0.51
	(5.12)	(5.57)	(−4.70)	(−1.66)	(13.14)		
		0.29	−0.06	−0.04	0.41	0.05	0.52
		(4.54)	(−4.40)	(−1.76)	(13.07)	(1.89)	
r_{ROE}	0.57	0.77	−0.09	−0.31	−0.22		0.20
	(5.21)	(7.82)	(−2.32)	(−5.64)	(−2.70)		
		0.52	−0.03	−0.30	−0.13	0.27	0.40
		(5.52)	(−1.31)	(−4.17)	(−1.82)	(6.13)	
	a	b	s	h	r	c	R^2
r_{ME}	0.04	0.01	0.98	0.03	−0.01	0.04	0.95
	(1.22)	(0.76)	(65.86)	(1.14)	(−0.17)	(1.17)	
$r_{\mathrm{I/A}}$	0.12	0.01	−0.04	0.04	0.08	0.82	0.84
	(3.24)	(0.85)	(−2.67)	(1.53)	(2.79)	(25.71)	
r_{ROE}	0.45	−0.04	−0.11	−0.25	0.76	0.14	0.52
	(5.44)	(−1.29)	(−2.65)	(−3.59)	(13.21)	(1.39)	

Panel B: The FF five factors

	m	α	β_{MKT}	β_{SMB}	β_{HML}	β_{UMD}	R^2
SMB	0.28	−0.02	0.01	1.00	0.13	0.00	0.99
	(2.02)	(−1.26)	(0.99)	(88.07)	(8.12)	(0.11)	
HML	0.37	0.00	−0.00	0.00	1.00	0.00	1.00
	(2.63)	(1.49)	(−0.68)	(0.37)	(1752.68)	(0.97)	
RMW	0.27	0.34	−0.04	−0.27	−0.00	0.04	0.19
	(2.58)	(3.36)	(−1.38)	(−3.08)	(−0.07)	(0.83)	
CMA	0.36	0.19	−0.09	0.04	0.46	0.04	0.55
	(3.68)	(2.82)	(−4.42)	(0.90)	(13.43)	(1.52)	
		α_q	β_{MKT}	β_{ME}	$\beta_{\mathrm{I/A}}$	β_{ROE}	R^2
SMB		0.05	−0.00	0.94	−0.09	−0.10	0.96
		(1.58)	(−0.48)	(58.83)	(−4.72)	(−5.61)	
HML		0.04	−0.05	0.00	1.03	−0.17	0.50
		(0.36)	(−1.37)	(0.01)	(11.67)	(−2.19)	
RMW		0.04	−0.03	−0.12	−0.03	0.52	0.49
		(0.49)	(−1.07)	(−1.70)	(−0.37)	(8.54)	
CMA		0.02	−0.05	0.04	0.93	−0.11	0.85
		(0.45)	(−3.65)	(1.58)	(33.68)	(−3.90)	

Panel C: The Carhart momentum factor, UMD

	m	α_q	β_{MKT}	β_{ME}	$\beta_{\mathrm{I/A}}$	β_{ROE}	R^2
UMD	0.68	0.09	−0.07	0.24	0.04	0.92	0.28
	(3.65)	(0.38)	(−1.10)	(1.71)	(0.22)	(5.63)	
	a	b	s	h	r	c	R^2
UMD	0.70	−0.13	0.03	−0.55	0.26	0.49	0.09
	(3.02)	(−1.76)	(0.24)	(−2.97)	(1.26)	(1.91)	

Panel D: Correlation matrix

	$r_{\mathrm{I/A}}$	r_{ROE}	MKT	SMB	HML	UMD	RMW	CMA
r_{ME}	−0.15	−0.31	0.28	0.97	−0.08	−0.02	−0.37	−0.06
	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)	(0.70)	(0.00)	(0.16)
$r_{\mathrm{I/A}}$		0.03	−0.39	−0.20	0.69	0.04	0.04	0.90
		(0.45)	(0.00)	(0.00)	(0.00)	(0.36)	(0.29)	(0.00)
r_{ROE}			−0.20	−0.37	−0.11	0.50	0.68	−0.11
			(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
MKT				0.29	−0.31	−0.14	−0.22	−0.40
				(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SMB					−0.12	−0.05	−0.37	−0.10
					(0.00)	(0.23)	(0.00)	(0.02)
HML						−0.15	0.10	0.71
						(0.00)	(0.02)	(0.00)
UMD							0.10	0.01
							(0.02)	(0.84)
RMW								−0.09
								(0.04)

Table 2 : Estimates of the Internal Rates of Return for the FF Factors

AR, IRR, and Diff (all in monthly percent) are the average return, the internal rate of return, and AR minus IRR, respectively. SMB, HML, RMW, and CMA are the factors (other than the market factor) in the FF five-factor model. Results from the benchmark 2×3 construction and those from the two alternative constructions based on 2×2 and $2 \times 2 \times 2 \times 2$ are presented. Appendix A describes in details all the IRR estimation methods.

	2×3			2×2			$2 \times 2 \times 2 \times 2$			2×3			2×2			$2 \times 2 \times 2 \times 2$		
	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff
	Panel A: Estimates with the Institutional Brokers' Estimate System (IBES) earnings forecasts (1/1979–12/2013)																	
	The Gebhardt, Lee, and Swaminathan (2001) model									The Easton (2004) MPEG model								
SMB	0.26	0.06	0.20	0.27	0.07	0.20	0.25	0.05	0.20	0.26	0.18	0.08	0.27	0.18	0.09	0.27	0.15	0.11
[t]	1.89	9.61	1.45	1.89	10.18	1.43	1.94	9.98	1.56	1.86	29.04	0.59	1.86	28.97	0.60	2.01	33.10	0.85
HML	0.23	0.27	−0.04	0.17	0.19	−0.02	0.17	0.19	−0.02	0.25	0.25	0.00	0.19	0.17	0.02	0.18	0.12	0.06
[t]	1.38	40.30	−0.23	1.42	35.93	−0.14	1.37	40.11	−0.12	1.43	15.46	−0.01	1.50	15.38	0.17	1.40	12.26	0.46
RMW	0.32	−0.08	0.40	0.21	−0.06	0.27	0.23	0.01	0.22	0.34	−0.24	0.57	0.22	−0.16	0.37	0.23	−0.10	0.33
[t]	2.65	−15.74	3.34	2.63	−13.25	3.38	2.78	4.18	2.64	2.54	−21.17	4.34	2.45	−19.57	4.24	2.56	−14.28	3.72
CMA	0.28	0.05	0.23	0.20	0.03	0.17	0.17	−0.01	0.18	0.29	0.19	0.11	0.20	0.12	0.09	0.16	0.08	0.09
[t]	2.75	9.22	2.27	2.67	8.83	2.25	2.68	−3.46	2.84	2.86	17.02	1.07	2.68	16.37	1.15	2.54	12.53	1.38
	The Claus and Thomas (2001) model									The Gordon and Gordon (1997) model								
SMB	0.27	0.08	0.19	0.27	0.08	0.20	0.26	0.07	0.19	0.27	0.00	0.27	0.27	0.00	0.27	0.26	−0.01	0.27
[t]	1.95	14.78	1.40	1.95	14.64	1.41	1.99	14.39	1.45	2.00	−0.61	2.06	1.99	−0.27	2.03	2.03	−2.27	2.15
HML	0.23	0.00	0.23	0.17	0.01	0.17	0.17	0.02	0.15	0.19	0.25	−0.06	0.15	0.18	−0.03	0.15	0.22	−0.07
[t]	1.36	0.01	1.36	1.42	1.02	1.36	1.38	2.63	1.20	1.16	20.81	−0.39	1.28	19.82	−0.26	1.26	23.49	−0.56
RMW	0.31	0.04	0.28	0.20	0.03	0.17	0.23	0.05	0.18	0.31	0.08	0.23	0.20	0.05	0.16	0.23	0.13	0.10
[t]	2.78	5.71	2.47	2.76	8.08	2.37	2.90	11.74	2.32	3.17	12.68	2.37	3.08	9.83	2.38	3.20	33.25	1.35
CMA	0.27	0.01	0.26	0.19	−0.01	0.20	0.16	−0.01	0.17	0.23	0.03	0.20	0.16	0.02	0.14	0.15	−0.02	0.17
[t]	2.67	0.97	2.62	2.59	−1.39	2.68	2.61	−1.60	2.69	2.28	6.03	1.97	2.23	5.67	1.94	2.35	−7.08	2.75
	The Ohlson and Juettner-Nauroth (2005) model									Averages across the five models								
SMB	0.27	0.05	0.22	0.27	0.05	0.22	0.25	0.04	0.21	0.25	0.09	0.16	0.25	0.09	0.16	0.24	0.08	0.17
[t]	1.98	9.39	1.64	1.98	9.41	1.63	1.99	7.81	1.71	1.77	13.05	1.14	1.76	13.13	1.13	1.84	13.37	1.27
HML	0.17	0.05	0.12	0.14	0.03	0.11	0.15	0.04	0.11	0.25	0.17	0.07	0.19	0.12	0.07	0.18	0.12	0.06
[t]	1.04	7.13	0.75	1.18	6.92	0.90	1.17	8.77	0.85	1.45	20.96	0.43	1.52	19.82	0.53	1.45	19.72	0.49
RMW	0.30	0.00	0.30	0.19	−0.00	0.19	0.21	0.02	0.19	0.35	−0.07	0.42	0.23	−0.05	0.28	0.25	0.00	0.25
[t]	3.05	0.19	3.05	2.80	−0.05	2.80	2.80	4.15	2.55	2.68	−16.56	3.25	2.69	−14.90	3.23	2.91	1.36	2.86
CMA	0.25	0.00	0.25	0.17	−0.00	0.17	0.15	−0.01	0.17	0.28	0.08	0.20	0.20	0.05	0.15	0.16	0.02	0.15
[t]	2.46	0.59	2.43	2.24	−1.23	2.32	2.39	−4.21	2.61	2.75	14.96	1.99	2.66	12.90	2.06	2.61	5.21	2.34

	2×3			2×2			$2 \times 2 \times 2 \times 2$			2×3			2×2			$2 \times 2 \times 2 \times 2$		
	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff
	Panel B: Estimates with the Hou, van Dijk, and Zhang (2012) cross-sectional earnings forecasts (1/1967–12/2013)																	
	The Gebhardt, Lee, and Swaminathan (2001) model									The Easton (2004) MPEG model								
SMB	0.30	0.12	0.18	0.31	0.12	0.18	0.31	0.09	0.21	0.28	0.38	−0.09	0.29	0.38	−0.09	0.31	0.35	−0.04
[t]	2.11	9.81	1.29	2.13	9.97	1.28	2.30	9.51	1.61	2.07	16.60	−0.68	2.10	16.53	−0.65	2.37	15.66	−0.35
HML	0.31	0.43	−0.12	0.21	0.31	−0.10	0.24	0.31	−0.07	0.27	0.54	−0.27	0.19	0.38	−0.19	0.20	0.34	−0.13
[t]	2.18	66.94	−0.86	1.97	60.16	−0.93	2.30	66.34	−0.65	1.88	31.43	−1.85	1.77	32.51	−1.77	1.91	32.47	−1.26
RMW	0.27	−0.11	0.38	0.19	−0.09	0.28	0.25	0.04	0.21	0.33	−0.28	0.61	0.23	−0.21	0.44	0.26	−0.07	0.33
[t]	2.68	−16.18	3.85	2.76	−16.34	4.12	3.77	9.18	3.23	2.86	−24.33	5.29	3.00	−25.15	5.67	3.35	−11.14	4.29
CMA	0.30	0.13	0.18	0.20	0.09	0.11	0.14	0.01	0.13	0.35	0.31	0.04	0.24	0.22	0.03	0.19	0.13	0.06
[t]	3.30	20.23	1.96	2.95	22.51	1.61	2.69	4.12	2.47	4.14	23.43	0.43	3.80	24.67	0.41	3.62	13.44	1.11
	The Claus and Thomas (2001) model									The Gordon and Gordon (1997) model								
SMB	0.30	0.20	0.09	0.31	0.20	0.11	0.30	0.19	0.11	0.32	0.11	0.20	0.33	0.12	0.21	0.33	0.09	0.23
[t]	2.15	10.35	0.69	2.19	10.25	0.76	2.31	10.50	0.84	2.35	7.22	1.54	2.39	7.27	1.57	2.54	7.46	1.84
HML	0.29	0.27	0.01	0.19	0.20	−0.01	0.23	0.22	0.01	0.25	0.47	−0.21	0.17	0.33	−0.17	0.21	0.38	−0.17
[t]	2.04	33.10	0.10	1.80	34.34	−0.06	2.20	38.17	0.08	1.88	33.35	−1.59	1.62	32.11	−1.63	2.07	35.50	−1.75
RMW	0.25	0.00	0.25	0.17	−0.00	0.18	0.23	0.09	0.14	0.22	0.00	0.22	0.15	−0.01	0.16	0.21	0.16	0.05
[t]	2.96	0.60	2.92	2.96	−0.83	3.03	4.07	17.48	2.49	2.92	0.43	2.88	2.75	−2.19	2.98	4.17	32.64	1.07
CMA	0.27	0.12	0.15	0.18	0.08	0.09	0.13	0.03	0.10	0.26	0.15	0.10	0.17	0.11	0.06	0.13	0.02	0.11
[t]	2.93	22.24	1.64	2.62	22.44	1.36	2.42	9.75	1.77	2.66	23.03	1.08	2.44	25.60	0.90	2.27	5.27	1.90
	The Ohlson and Juettner-Nauroth (2005) model									Averages across the five models								
SMB	0.37	0.24	0.13	0.39	0.25	0.14	0.37	0.23	0.14	0.28	0.23	0.06	0.29	0.23	0.06	0.29	0.21	0.09
[t]	2.84	12.82	0.99	2.91	12.76	1.08	3.02	12.57	1.13	2.00	13.49	0.41	2.00	13.38	0.43	2.17	13.87	0.64
HML	0.26	0.36	−0.09	0.18	0.26	−0.07	0.21	0.25	−0.03	0.33	0.42	−0.10	0.22	0.30	−0.08	0.25	0.30	−0.05
[t]	1.93	43.64	−0.69	1.78	42.81	−0.69	2.10	46.43	−0.32	2.26	51.22	−0.67	2.06	52.28	−0.72	2.33	50.53	−0.45
RMW	0.24	−0.12	0.35	0.17	−0.09	0.26	0.24	0.02	0.22	0.28	−0.13	0.41	0.20	−0.10	0.29	0.25	0.03	0.22
[t]	3.06	−13.21	4.55	3.04	−14.51	4.59	4.25	2.98	3.90	2.62	−21.32	3.81	2.68	−22.16	4.02	3.62	8.08	3.18
CMA	0.31	0.16	0.15	0.20	0.12	0.08	0.17	0.05	0.12	0.31	0.21	0.10	0.21	0.15	0.06	0.15	0.07	0.08
[t]	3.30	24.06	1.57	2.85	23.58	1.17	3.03	11.59	2.10	3.48	35.32	1.15	3.15	37.92	0.97	2.86	14.05	1.51

	2 × 3			2 × 2			2 × 2 × 2 × 2			2 × 3			2 × 2			2 × 2 × 2 × 2		
	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff	AR	IRR	Diff
	Panel C: Estimates with the Tang, Wu, and Zhang (2014) cross-sectional ROE forecasts (1/1967–12/2013)																	
	The Gebhardt, Lee, and Swaminathan (2001) model									The Easton (2004) MPEG model								
SMB	0.32	0.01	0.31	0.33	0.02	0.31	0.30	−0.02	0.32	0.31	0.09	0.22	0.33	0.10	0.22	0.30	0.01	0.28
[t]	2.39	1.38	2.32	2.42	2.28	2.29	2.41	−3.16	2.57	2.28	10.47	1.62	2.34	11.58	1.61	2.28	1.37	2.17
HML	0.31	0.40	−0.09	0.22	0.28	−0.06	0.26	0.28	−0.02	0.33	0.58	−0.25	0.23	0.40	−0.17	0.27	0.29	−0.02
[t]	2.24	77.38	−0.68	2.18	69.67	−0.59	2.44	72.39	−0.23	2.26	35.58	−1.75	2.12	36.47	−1.56	2.47	31.62	−0.20
RMW	0.23	−0.11	0.34	0.15	−0.08	0.24	0.24	0.03	0.22	0.24	−0.49	0.74	0.17	−0.35	0.52	0.26	−0.23	0.49
[t]	2.33	−19.02	3.45	2.25	−18.55	3.48	3.43	7.82	3.07	2.49	−45.27	7.43	2.46	−43.88	7.57	3.58	−31.09	6.62
CMA	0.29	0.09	0.20	0.19	0.07	0.13	0.13	−0.00	0.13	0.27	0.36	−0.09	0.19	0.26	−0.07	0.10	0.18	−0.08
[t]	3.23	12.54	2.26	2.97	14.07	1.98	2.56	−0.11	2.56	2.87	24.92	−0.94	2.90	28.70	−1.16	2.00	24.16	−1.51
	The Claus and Thomas (2001) model									The Gordon and Gordon (1997) model								
SMB	0.34	−0.08	0.41	0.34	−0.08	0.42	0.32	−0.10	0.42	0.34	0.00	0.34	0.34	0.00	0.34	0.32	−0.04	0.35
[t]	2.62	−7.69	3.25	2.65	−7.32	3.24	2.66	−10.50	3.51	2.67	−0.31	2.72	2.70	0.37	2.70	2.71	−4.41	3.03
HML	0.26	0.20	0.07	0.20	0.14	0.06	0.23	0.16	0.07	0.26	0.37	−0.11	0.19	0.26	−0.07	0.23	0.30	−0.07
[t]	2.04	12.14	0.52	2.04	12.87	0.57	2.34	14.93	0.74	1.99	35.25	−0.82	1.96	34.83	−0.72	2.25	38.63	−0.71
RMW	0.19	−0.00	0.20	0.13	−0.01	0.13	0.22	0.06	0.15	0.20	−0.02	0.22	0.13	−0.02	0.15	0.22	0.10	0.11
[t]	2.44	−0.53	2.47	2.31	−1.24	2.41	3.75	26.14	2.65	2.73	−2.87	2.96	2.51	−5.85	2.88	4.02	31.05	2.09
CMA	0.24	0.05	0.19	0.16	0.04	0.12	0.11	0.02	0.09	0.23	0.06	0.17	0.15	0.05	0.11	0.10	−0.01	0.12
[t]	2.68	9.01	2.11	2.47	9.29	1.86	2.03	4.87	1.72	2.42	11.83	1.76	2.27	13.33	1.58	1.86	−4.43	2.10
	The Ohlson and Juettner-Nauroth (2005) model									Averages across the five models								
SMB	0.34	−0.10	0.44	0.36	−0.09	0.45	0.33	−0.13	0.46	0.32	0.00	0.32	0.33	0.01	0.32	0.30	−0.04	0.34
[t]	2.64	−7.88	3.36	2.73	−7.45	3.39	2.68	−10.40	3.68	2.39	0.10	2.39	2.41	0.82	2.37	2.41	−4.57	2.69
HML	0.29	0.33	−0.04	0.22	0.23	−0.01	0.24	0.22	0.02	0.31	0.40	−0.09	0.23	0.28	−0.05	0.26	0.26	0.00
[t]	2.14	20.58	−0.29	2.19	20.70	−0.12	2.39	22.46	0.21	2.25	39.43	−0.63	2.20	39.39	−0.51	2.45	40.15	−0.01
RMW	0.16	−0.16	0.32	0.11	−0.11	0.21	0.17	−0.03	0.20	0.23	−0.17	0.40	0.15	−0.12	0.27	0.24	−0.02	0.26
[t]	2.03	−20.08	4.03	1.88	−17.23	3.74	3.03	−5.19	3.47	2.32	−33.97	4.06	2.23	−36.15	4.03	3.42	−6.49	3.69
CMA	0.25	0.06	0.19	0.17	0.05	0.12	0.10	−0.01	0.11	0.28	0.15	0.13	0.19	0.11	0.08	0.14	0.05	0.09
[t]	2.69	8.03	2.01	2.45	9.63	1.71	1.79	−1.03	1.84	3.21	30.53	1.50	2.97	27.79	1.31	2.56	14.83	1.62

Table 3 : Annual Cross-sectional Regressions of Future Book Equity Growth Rates and Operating Profitability

The sample contains all common stocks traded on NYSE, Amex, and Nasdaq. We do not exclude financial firms, because these stocks are included in the construction of the FF (2014a) five factors. All the regressions are annual cross-sectional regressions. TA_{it} is total assets for firm i at year t, $\triangle\text{TA}_{it} \equiv \text{TA}_{it} - \text{TA}_{it-1}$, BE_{it} is book equity for firm i at year t, $\triangle\text{BE}_{it} \equiv \text{BE}_{it} - \text{BE}_{it-1}$, and OP_{it} is operating profitability for firm i at year t. Book equity is measured as in Davis, Fama, and French (2000), and operating profitability is measured as in FF (2014a). Variables dated t are measured at the end of the fiscal year ending in calendar year t. To avoid the excess influence of small firms, we exclude those with total assets below \$5 million or book equity below \$2.5 million in year t in Panel A. The cutoffs are \$25 million and \$12.5 million in Panel B. We also winsorize all regression variables at the 1st and 99th percentiles of their cross-sectional distributions each year.

		$\frac{\triangle\text{BE}_{it+\tau}}{\text{BE}_{it+\tau-1}} = \gamma_0 + \gamma_1 \frac{\triangle\text{TA}_{it}}{\text{TA}_{it-1}} + \epsilon_{t+\tau}$					$\frac{\triangle\text{BE}_{it+\tau}}{\text{BE}_{it+\tau-1}} = \gamma_0 + \gamma_1 \frac{\triangle\text{BE}_{it}}{\text{BE}_{it-1}} + \epsilon_{t+\tau}$					$\text{OP}_{it+\tau} = \gamma_0 + \gamma_1 \text{OP}_{it} + \epsilon_{t+\tau}$				
τ	#firms	γ_0	t_{γ_0}	γ_1	t_{γ_1}	R^2	γ_0	t_{γ_0}	γ_1	t_{γ_1}	R^2	γ_0	t_{γ_0}	γ_1	t_{γ_1}	R^2
Panel A: Firms with assets $\geq$ \$5 million and book equity $\geq$ \$2.5 million																
1	3,112	0.09	14.47	0.22	14.23	0.05	0.09	12.95	0.21	8.66	0.06	0.03	5.24	0.80	51.05	0.55
2	2,847	0.10	14.54	0.10	7.38	0.01	0.10	14.65	0.10	5.17	0.02	0.06	6.80	0.67	30.48	0.36
3	2,622	0.10	15.06	0.07	6.23	0.01	0.10	15.00	0.06	4.05	0.01	0.07	8.25	0.59	25.49	0.28
4	2,425	0.10	16.23	0.05	5.76	0.00	0.10	16.27	0.06	3.77	0.00	0.09	9.75	0.53	23.42	0.22
5	2,247	0.10	14.87	0.05	3.93	0.00	0.10	15.94	0.03	2.18	0.00	0.10	11.48	0.49	23.50	0.19
6	2,086	0.10	15.18	0.05	4.56	0.00	0.10	14.94	0.03	2.36	0.00	0.10	13.20	0.46	23.28	0.16
7	1,939	0.10	15.38	0.05	4.50	0.00	0.10	15.54	0.03	2.78	0.00	0.11	14.75	0.43	22.12	0.14
8	1,803	0.10	15.35	0.03	3.97	0.00	0.10	15.63	0.01	1.58	0.00	0.12	16.23	0.40	20.24	0.12
9	1,679	0.10	15.23	0.03	3.55	0.00	0.10	15.48	0.01	1.26	0.00	0.12	16.06	0.38	19.93	0.12
10	1,565	0.09	14.76	0.04	4.28	0.00	0.10	15.06	0.02	2.00	0.00	0.13	15.51	0.37	20.15	0.11
Panel B: Firms with assets $\geq$ \$25 million and book equity $\geq$ \$12.5 million																
1	2,473	0.08	15.84	0.23	17.57	0.05	0.08	13.96	0.25	10.49	0.07	0.03	7.27	0.82	58.03	0.61
2	2,264	0.09	15.86	0.13	9.93	0.02	0.09	16.23	0.13	7.00	0.02	0.06	9.30	0.69	35.98	0.42
3	2,086	0.09	16.82	0.09	7.48	0.01	0.09	16.62	0.09	5.76	0.01	0.08	11.18	0.61	31.81	0.32
4	1,930	0.09	17.19	0.07	7.09	0.01	0.09	17.13	0.07	4.54	0.01	0.09	13.38	0.56	29.86	0.26
5	1,792	0.09	16.65	0.06	4.09	0.00	0.09	17.31	0.05	3.15	0.01	0.10	15.82	0.52	30.37	0.22
6	1,665	0.09	16.77	0.05	5.53	0.00	0.09	16.57	0.04	3.48	0.00	0.11	17.16	0.49	29.68	0.19
7	1,551	0.09	16.99	0.05	4.91	0.00	0.09	17.07	0.04	3.24	0.00	0.12	19.16	0.45	29.69	0.16
8	1,446	0.09	16.17	0.03	3.93	0.00	0.09	16.24	0.02	2.62	0.00	0.13	20.69	0.42	28.89	0.14
9	1,349	0.09	16.00	0.04	3.99	0.00	0.09	16.32	0.02	2.14	0.00	0.13	20.31	0.41	25.44	0.13
10	1,260	0.09	14.91	0.05	5.16	0.00	0.09	15.30	0.03	2.83	0.00	0.14	18.77	0.40	24.99	0.12

Table 4 : List of Anomalies

This table lists all the anomalies that we study. The anomalies are grouped into six categories: (i) momentum; (ii) value-versus-growth; (iii) investment; (iv) profitability; (v) intangibles; and (vi) trading frictions. For each anomaly variable, we list its symbol, brief description, and source in the academic literature. Appendix C details variable definition and portfolio construction.

	Panel A: Momentum		
SUE-1	Earnings surprise (1-month holding period), Foster, Olsen, and Shevlin (1984)	SUE-6	Earnings surprise (6-month holding period), Foster, Olsen, and Shevlin (1984)
Abr-1	Cumulative abnormal stock returns around earnings announcements (1-month holding period), Chan, Jegadeesh, and Lakonishok (1996)	Abr-6	Cumulative abnormal stock returns around earnings announcements (6-month holding period), Chan, Jegadeesh, and Lakonishok (1996)
RE-1	Revisions in analysts' earnings forecasts (1-month holding period), Chan, Jegadeesh, and Lakonishok (1996)	RE-6	Revisions in analysts' earnings forecasts (6-month holding period), Chan, Jegadeesh, and Lakonishok (1996)
R6-1	Price momentum (6-month prior returns, 1-month holding period), Jegadeesh and Titman (1993)	R6-6	Price momentum (6-month prior returns, 6-month holding period), Jegadeesh and Titman (1993)
R11-1	Price momentum, (11-month prior returns, 1-month holding period), Fama and French (1996)	I-Mom	Industry momentum, Moskowitz and Grinblatt (1999)
	Panel B: Value-versus-growth		
B/M	Book-to-market equity, Rosenberg, Reid, and Lanstein (1985)	A/ME	Market leverage, Bhandari (1988)
Rev	Reversal, De Bondt and Thaler (1985)	E/P	Earnings-to-price, Basu (1983)
EF/P	Analysts' earnings forecasts-to-price, Elgers, Lo, and Pfeiffer (2001)	CF/P	Cash flow-to-price, Lakonishok, Shleifer, and Vishny (1994)
D/P	Dividend yield, Litzenberger and Ramaswamy (1979)	O/P	Payout yield, Boudoukh, Michaely, Richardson, and Roberts (2007)
NO/P	Net payout yield, Boudoukh, Michaely, Richardson, and Roberts (2007)	SG	Sales growth, Lakonishok, Shleifer, and Vishny (1994)
LTG	Long-term growth forecasts of analysts, La Porta (1996)	Dur	Equity duration, Dechow, Sloan, and Soliman (2004)
	Panel C: Investment		
ACI	Abnormal corporate investment, Titman, Wei, and Xie (2004)	I/A	Investment-to-assets, Cooper, Gulen, and Schill (2008)
NOA	Net operating assets, Hirshleifer, Hou, Teoh, and Zhang (2004)	△PI/A	Changes in property, plant, and equipment plus changes in inventory scaled by assets, Lyandres, Sun, and Zhang (2008)
IG	Investment growth, Xing (2008)	NSI	Net stock issues, Pontiff and Woodgate (2008)
CEI	Composite issuance, Daniel and Titman (2006)	NXF	Net external financing, Bradshaw, Richardson, and Sloan (2006)
IvG	Inventory growth, Belo and Lin (2011)	IvC	Inventory changes, Thomas and Zhang (2002)
OA	Operating accruals, Sloan (1996)	TA	Total accruals, Richardson, Sloan, Soliman, and Tuna (2005)
POA	Percent operating accruals, Hafzalla, Lundholm, and Van Winkle (2011)	PTA	Percent total accruals, Hafzalla, Lundholm, and Van Winkle (2011)

Panel D: Profitability			
ROE	Return on equity, Haugen and Baker (1996)	ROA	Return on assets, Balakrishnan, Bartov, and Faurel (2010)
RNA	Return on net operating assets, Soliman (2008)	PM	Profit margin, Soliman (2008)
ATO	Asset turnover, Soliman (2008)	CTO	Capital turnover, Haugen and Baker (1996)
GP/A	Gross profits-to-assets, Novy-Marx (2013)	F	F-score, Piotroski (2000)
TES	Tax expense surprise, Thomas and Zhang (2011)	TI/BI	Taxable income-to-book income, Green, Hand, and Zhang (2013)
RS	Revenue surprise, Jegadeesh and Livnat (2006)	NEI	Number of consecutive quarters with earnings increases, Barth, Elliott, and Finn (1999)
FP	Failure probability, Campbell, Hilscher, and Szilagyi (2008)	O	O-score, Dichev (1998)
Panel E: Intangibles			
OC/A	Organizational capital-to-assets, Eisfeldt and Papanikolaou (2013)	BC/A	Brand capital-to-assets, Belo, Lin, and Vitorino (2014)
Ad/M	Advertisement expense-to-market, Chan, Lakonishok, and Sougiannis (2001)	RD/S	R&D-to-sales, Chan, Lakonishok, and Sougiannis (2001)
RD/M	R&D-to-market, Chan, Lakonishok, and Sougiannis (2001)	RC/A	R&D capital-to-assets, Li (2011)
H/N	Hiring rate, Belo, Lin, and Bazdresch (2014)	OL	Operating leverage, Novy-Marx (2011)
G	Corporate governance, Gompers, Ishii, and Metrick (2003)	AccQ	Accrual quality, Francis, Lafond, Olsson, and Schipper (2005)
Panel F: Trading frictions			
ME	The market equity, Banz (1981)	Ivol	Idiosyncratic volatility, Ang, Hodrick, Xing, and Zhang (2006)
Tvol	Total volatility, Ang, Hodrick, Xing, and Zhang (2006)	Svol	Systematic volatility, Ang, Hodrick, Xing, and Zhang (2006)
MDR	Maximum daily return, Bali, Cakici, and Whitelaw (2011)	β	Market beta, Frazzini and Pedersen (2014)
D-β	Dimson's beta, Dimson (1979)	S-Rev	Short-term reversal, Jegadeesh (1990)
Disp	Dispersion of analysts' earnings forecasts, Diether, Malloy, and Scherbina (2002)	Turn	Share turnover, Datar, Naik, and Radcliffe (1998)
1/P	1/share price, Miller and Scholes (1982)	Dvol	Dollar trading volume, Brennan, Chordia, and Subrahmanyam (1998)
Illiq	Illiquidity as absolute return-to-volume, Amihud (2002)		

Table 5 : Insignificant Anomalies in the Broad Cross Section

We report the average returns (m) of the high-minus-low deciles and their t-statistic (t_m) adjusted for heteroscedasticity and autocorrelations. Table 4 provides a brief description of the symbols. The deciles in Panel A are formed with NYSE breakpoints and value-weighted returns, and those in Panel B with all-but-micro breakpoints and equal-weighted returns. Appendix C details variable definition and portfolio construction.

Panel A: NYSE breakpoints, value-weighted decile returns

	SUE-6	R6-1	A/ME	EF/P	D/P	O/P	SG	LTG	NXF	TA	RNA	PM	ATO
m	0.17	0.57	0.41	0.45	0.19	0.33	−0.24	0.07	−0.27	−0.21	0.11	−0.02	0.30
t_m	1.68	1.88	1.89	1.82	0.75	1.49	−1.29	0.18	−1.42	−1.57	0.57	−0.08	1.67

	CTO	F	TES	TI/BI	FP	O	BC/A	RD/S	RC/A	H/N	G	AccQ	ME
m	0.27	0.34	0.30	0.18	−0.55	−0.09	0.21	0.04	0.34	−0.28	0.03	−0.04	−0.33
t_m	1.58	1.21	1.85	1.31	−1.72	−0.46	0.85	0.15	1.40	−1.82	0.09	−0.19	−1.32

	Ivol	Tvol	MDR	β	D-β	S-Rev	Disp	Turn	1/P	Dvol	Illiq
m	−0.49	−0.36	−0.32	−0.16	0.07	−0.30	−0.27	−0.15	0.09	−0.32	0.34
t_m	−1.55	−1.01	−1.04	−0.47	0.31	−1.50	−1.05	−0.57	0.29	−1.71	1.54

Panel B: All-but-micro breakpoints, equal-weighted decile returns

	EF/P	D/P	O/P	SG	LTG	RNA	PM	ATO	TI/BI	FP	BC/A	RD/S	RC/A
m	0.47	0.18	0.39	−0.27	−0.47	0.19	0.21	0.16	0.19	−0.49	0.32	−0.04	0.37
t_m	1.47	0.87	1.94	−1.70	−1.01	1.18	0.88	0.98	1.82	−1.76	1.45	−0.12	1.11

	G	AccQ	ME	Ivol	Tvol	β	D-β	Turn	1/P	Illiq
m	−0.02	−0.06	−0.22	−0.61	−0.65	−0.25	−0.09	−0.44	−0.05	0.29
t_m	−0.08	−0.30	−1.25	−1.87	−1.80	−0.70	−0.41	−1.65	−0.21	1.92

Table 6 : Significant Anomalies with NYSE Breakpoints and Value-weighted Returns

For each anomaly variable, m, α_{FF}, α_C, α_q, and a are the average return, the FF three-factor alpha, the Carhart alpha, the q-model alpha, and the FF five-factor alpha for the high-minus-low decile, and t_m, t_{FF}, t_C, t_q, and t_a are their t-statistics adjusted for heteroscedasticity and autocorrelations, respectively. $\overline{|\alpha_{FF}|}$, $\overline{|\alpha_C|}$, $\overline{|\alpha_q|}$, and $\overline{|a|}$ are the average magnitude of the alphas, and p_{FF}, p_C, p_q, and p_a are the p-values of the GRS test that all the alphas are jointly zero across a given set of deciles. Table 4 provides a brief description of the symbols.

	SUE-1	Abr-1	Abr-6	RE-1	RE-6	R6-6	R11-1	I-Mom	B/M	Rev	E/P	CF/P	NO/P	Dur	ACI	I/A	NOA	△PI/A
m	0.41	0.73	0.30	0.78	0.52	0.83	1.20	0.58	0.64	−0.46	0.55	0.46	0.65	−0.46	−0.31	−0.46	−0.39	−0.50
α_{FF}	0.53	0.84	0.37	1.13	0.87	1.10	1.54	0.74	−0.05	0.06	0.02	−0.04	0.53	0.03	−0.31	−0.21	−0.53	−0.39
α_C	0.35	0.62	0.18	0.49	0.31	0.07	0.18	−0.11	−0.05	−0.07	−0.02	−0.10	0.51	0.01	−0.19	−0.17	−0.43	−0.34
α_q	0.15	0.64	0.26	0.06	−0.02	0.22	0.26	0.03	0.16	−0.16	0.11	0.15	0.36	−0.18	−0.17	0.09	−0.39	−0.23
a	0.44	0.85	0.44	0.86	0.66	0.97	1.25	0.61	−0.02	0.08	0.05	0.01	0.22	−0.05	−0.30	0.04	−0.44	−0.31
t_m	3.65	5.58	3.10	3.05	2.35	3.44	4.00	2.91	2.88	−2.02	2.67	2.30	3.27	−2.39	−2.12	−2.86	−2.82	−3.67
t_{FF}	4.79	6.01	3.91	4.75	4.41	4.91	5.72	3.84	−0.39	0.32	0.15	−0.33	3.63	0.27	−2.03	−1.63	−3.68	−3.01
t_C	2.95	4.40	2.04	2.38	1.83	0.70	1.41	−0.72	−0.42	−0.39	−0.13	−0.76	3.45	0.09	−1.23	−1.20	−3.08	−2.55
t_q	1.12	4.21	2.25	0.22	−0.07	0.68	0.65	0.11	0.96	−0.93	0.53	0.77	2.45	−0.92	−0.96	0.72	−2.10	−1.81
t_a	3.74	5.87	4.23	3.23	2.86	3.38	3.45	2.45	−0.17	0.45	0.37	0.09	1.57	−0.34	−1.91	0.34	−2.62	−2.61
$\overline{\lvert\alpha_{FF}\rvert}$	0.16	0.16	0.11	0.25	0.22	0.18	0.25	0.16	0.07	0.10	0.09	0.08	0.17	0.09	0.12	0.12	0.16	0.12
$\overline{\lvert\alpha_C\rvert}$	0.10	0.12	0.08	0.10	0.09	0.09	0.13	0.05	0.07	0.10	0.08	0.07	0.15	0.06	0.11	0.10	0.14	0.11
$\overline{\lvert\alpha_q\rvert}$	0.06	0.13	0.07	0.11	0.12	0.09	0.15	0.12	0.09	0.08	0.12	0.15	0.12	0.08	0.13	0.10	0.10	0.13
$\overline{\lvert a\rvert}$	0.11	0.16	0.08	0.20	0.17	0.17	0.23	0.21	0.06	0.05	0.09	0.13	0.11	0.05	0.15	0.11	0.10	0.11
p_{FF}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.046	0.08	0.045	0.10	0.00	0.20	0.00	0.00	0.00	0.00
p_C	0.00	0.00	0.00	0.05	0.06	0.00	0.00	0.41	0.08	0.26	0.15	0.11	0.00	0.43	0.00	0.01	0.00	0.01
p_q	0.39	0.00	0.01	0.16	0.02	0.00	0.00	0.03	0.13	0.25	0.04	0.00	0.00	0.36	0.00	0.00	0.00	0.00
p_a	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.44	0.42	0.13	0.03	0.00	0.72	0.00	0.00	0.02	0.01

	IG	NSI	CEI	IvG	IvC	OA	POA	PTA	ROE	ROA	GP/A	RS	NEI	OC/A	Ad/M	RD/M	OL	Svol
m	−0.42	−0.72	−0.57	−0.38	−0.46	−0.28	−0.43	−0.42	0.68	0.58	0.40	0.31	0.38	0.58	0.78	0.64	0.46	−0.55
α_{FF}	−0.27	−0.70	−0.54	−0.27	−0.40	−0.37	−0.31	−0.33	1.09	0.97	0.58	0.63	0.60	0.62	0.15	0.21	0.42	−0.63
α_C	−0.21	−0.61	−0.45	−0.19	−0.31	−0.33	−0.24	−0.31	0.79	0.64	0.51	0.49	0.42	0.41	0.31	0.31	0.39	−0.59
α_q	0.02	−0.31	−0.25	−0.01	−0.28	−0.54	−0.09	−0.15	−0.03	0.06	0.20	0.21	0.18	0.13	0.11	0.60	0.02	−0.34
a	−0.08	−0.32	−0.25	−0.12	−0.38	−0.52	−0.12	−0.11	0.51	0.50	0.21	0.53	0.46	0.33	−0.06	0.38	0.09	−0.34
t_m	−3.33	−4.56	−3.18	−2.72	−3.30	−2.24	−3.08	−3.03	2.95	2.54	2.75	2.15	3.34	4.59	2.99	2.40	2.65	−2.46
t_{FF}	−2.33	−5.04	−4.52	−2.08	−2.95	−3.02	−2.56	−2.57	5.60	5.27	3.98	4.72	6.17	5.00	0.79	0.93	2.43	−2.82
t_C	−1.84	−4.35	−3.71	−1.37	−2.23	−2.46	−2.01	−2.29	4.15	3.46	3.51	3.41	3.92	3.34	1.38	1.43	2.28	−2.51
t_q	0.18	−2.22	−1.85	−0.09	−1.95	−3.81	−0.68	−1.03	−0.24	0.49	1.39	1.41	1.72	1.03	0.40	2.46	0.14	−1.37
t_a	−0.75	−2.43	−2.33	−0.99	−2.92	−4.10	−1.03	−0.87	3.57	3.43	1.58	3.73	4.57	2.61	−0.32	1.57	0.56	−1.36
$\overline{\lvert\alpha_{FF}\rvert}$	0.12	0.17	0.15	0.11	0.11	0.13	0.12	0.11	0.24	0.22	0.15	0.16	0.20	0.16	0.13	0.18	0.12	0.19
$\overline{\lvert\alpha_C\rvert}$	0.10	0.15	0.14	0.09	0.10	0.11	0.12	0.11	0.15	0.13	0.15	0.12	0.13	0.12	0.19	0.21	0.12	0.16
$\overline{\lvert\alpha_q\rvert}$	0.09	0.11	0.12	0.10	0.07	0.14	0.12	0.08	0.10	0.07	0.12	0.08	0.09	0.11	0.11	0.27	0.11	0.11
$\overline{\lvert a\rvert}$	0.06	0.10	0.10	0.10	0.08	0.12	0.12	0.08	0.11	0.15	0.10	0.15	0.15	0.11	0.12	0.21	0.09	0.11
p_{FF}	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.01	0.01	0.00
p_C	0.00	0.00	0.00	0.07	0.03	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.08	0.00	0.02	0.03
p_q	0.02	0.01	0.01	0.08	0.45	0.00	0.00	0.01	0.01	0.79	0.19	0.04	0.03	0.01	0.09	0.00	0.03	0.13
p_a	0.28	0.01	0.01	0.04	0.20	0.00	0.00	0.02	0.01	0.06	0.08	0.00	0.00	0.00	0.28	0.00	0.06	0.25

Table 7 : Factor Loadings for the q-factor Model and the FF Five-factor Model, Significant Anomalies with NYSE Breakpoints and Value-weighted Returns

For the high-minus-low decile formed on each anomaly variable, $\beta_{\mathrm{MKT}}, \beta_{\mathrm{ME}}, \beta_{\mathrm{I/A}}$, and β_{ROE} are the loadings on the market, size, investment, and ROE factors in the q-factor model, and $t_{\beta_{\mathrm{MKT}}}, t_{\beta_{\mathrm{ME}}}, t_{\beta_{\mathrm{I/A}}}$, and $t_{\beta_{\mathrm{ROE}}}$ are their t-statistics, respectively. b, s, h, r, and c are the loadings on MKT, SMB, HML, RMW, and CMA in the FF five-factor model, and t_b, t_s, t_h, t_r, and t_c are their t-statistics, respectively. All t-statistics are adjusted for heteroscedasticity and autocorrelations. Table 4 provides a brief description of the symbols.

	SUE-1	Abr-1	Abr-6	RE-1	RE-6	R6-6	R11-1	I-Mom	B/M	Rev	E/P	CF/P	NO/P	Dur	ACI	I/A	NOA	△PI/A
β_{MKT}	−0.09	−0.06	−0.03	−0.06	−0.06	−0.08	−0.12	−0.08	−0.01	0.05	−0.08	−0.12	−0.17	0.07	0.01	0.03	−0.01	0.04
β_{ME}	0.10	0.07	0.08	−0.19	−0.18	0.22	0.33	0.25	0.48	−0.64	0.29	0.20	−0.32	−0.26	−0.29	−0.14	0.10	−0.08
$\beta_{\mathrm{I/A}}$	0.03	−0.14	−0.17	0.09	−0.07	0.01	0.12	0.09	1.40	−1.17	1.01	1.00	1.03	−0.86	0.13	−1.37	−0.07	−0.79
β_{ROE}	0.46	0.28	0.18	1.31	1.10	1.01	1.46	0.82	−0.53	0.72	−0.11	−0.26	0.02	0.27	−0.19	0.17	0.01	0.16
$t_{\beta_{\mathrm{MKT}}}$	−2.18	−1.37	−1.30	−0.98	−1.15	−1.04	−1.28	−1.19	−0.18	1.08	−1.47	−1.90	−3.78	1.12	0.24	0.92	−0.21	1.13
$t_{\beta_{\mathrm{ME}}}$	1.88	0.70	1.81	−2.11	−1.98	1.25	1.53	1.55	5.86	−7.83	2.34	1.91	−4.31	−1.93	−4.99	−2.35	1.01	−1.63
$t_{\beta_{\mathrm{I/A}}}$	0.32	−1.31	−2.27	0.52	−0.45	0.06	0.39	0.39	13.01	−10.49	6.27	7.31	10.33	−6.36	1.01	−16.71	−0.48	−7.70
$t_{\beta_{\mathrm{ROE}}}$	5.76	3.18	2.86	9.82	9.36	5.40	5.80	4.95	−6.24	7.47	−0.78	−2.03	0.21	2.22	−2.10	2.58	0.08	2.02
b	−0.11	−0.08	−0.07	−0.16	−0.15	−0.16	−0.22	−0.13	0.07	−0.02	−0.02	−0.05	−0.10	0.01	0.03	−0.01	0.00	0.03
s	−0.03	−0.05	0.01	−0.42	−0.40	−0.08	−0.05	0.01	0.52	−0.67	0.32	0.25	−0.25	−0.32	−0.26	−0.10	0.16	−0.03
h	−0.17	−0.20	−0.12	−0.16	−0.27	−0.54	−0.71	−0.37	1.16	−0.47	1.38	1.29	0.46	−1.18	0.16	−0.18	0.46	0.01
r	0.14	−0.11	−0.12	0.55	0.41	0.11	0.35	0.12	−0.27	0.39	0.16	0.00	0.51	0.02	−0.03	0.03	0.08	0.25
c	0.18	0.13	−0.07	−0.02	0.02	0.39	0.67	0.39	0.33	−0.77	−0.38	−0.24	0.54	0.29	−0.02	−1.14	−0.52	−0.75
t_b	−2.45	−1.94	−2.51	−1.97	−2.22	−1.77	−1.86	−1.66	2.29	−0.37	−0.58	−1.12	−2.75	0.32	0.70	−0.47	−0.08	0.94
t_s	−0.45	−0.63	0.16	−3.79	−4.23	−0.56	−0.27	0.06	10.93	−6.65	5.96	4.92	−3.96	−5.04	−4.15	−1.52	2.25	−0.58
t_h	−1.67	−1.80	−1.74	−0.94	−1.76	−2.44	−2.47	−1.79	15.84	−3.70	14.16	14.05	5.57	−11.93	1.58	−2.56	5.11	0.16
t_r	1.75	−1.15	−1.73	3.28	2.80	0.44	1.13	0.51	−3.80	4.44	2.14	0.01	6.83	0.25	−0.33	0.34	0.64	3.62
t_c	1.25	0.84	−0.60	−0.05	0.07	1.25	1.62	1.24	3.06	−4.57	−3.00	−1.93	4.33	2.28	−0.10	−10.88	−3.58	−6.88
	IG	NSI	CEI	IvG	IvC	OA	POA	PTA	ROE	ROA	GP/A	RS	NEI	OC/A	Ad/M	RD/M	OL	Svol
β_{MKT}	−0.03	0.03	0.23	−0.02	0.04	0.05	−0.02	0.05	−0.09	−0.14	0.03	−0.04	0.01	−0.10	0.04	0.15	−0.04	0.04
β_{ME}	−0.15	0.17	0.25	0.08	−0.01	0.29	0.14	0.15	−0.39	−0.38	0.04	−0.13	−0.09	0.24	0.51	0.66	0.30	0.31
$\beta_{\mathrm{I/A}}$	−0.76	−0.72	−1.04	−0.94	−0.68	−0.05	−0.94	−0.86	0.08	−0.09	−0.31	−0.40	−0.32	0.29	1.40	0.20	0.11	−0.21
β_{ROE}	−0.07	−0.30	−0.11	0.05	0.18	0.27	0.06	0.05	1.50	1.32	0.54	0.61	0.65	0.51	−0.26	−0.58	0.54	−0.42
$t_{\beta_{\mathrm{MKT}}}$	−0.86	0.91	6.43	−0.73	1.31	1.56	−0.62	1.47	−2.50	−4.41	0.92	−0.95	0.37	−2.86	0.48	2.44	−0.82	0.53
$t_{\beta_{\mathrm{ME}}}$	−2.60	2.41	3.92	1.80	−0.13	4.85	3.32	2.44	−6.44	−6.50	0.76	−2.41	−2.32	5.66	2.92	6.84	3.10	2.32
$t_{\beta_{\mathrm{I/A}}}$	−10.41	−6.96	−14.03	−12.40	−6.09	−0.51	−10.91	−8.76	0.88	−1.12	−3.21	−4.56	−4.36	2.98	6.01	1.13	0.95	−1.32
$t_{\beta_{\mathrm{ROE}}}$	−1.18	−3.85	−1.44	0.60	1.98	4.16	1.21	0.62	21.14	17.12	7.58	7.99	11.41	6.92	−1.34	−4.08	4.88	−3.53
b	−0.03	−0.01	0.18	−0.03	0.05	0.07	−0.05	0.02	−0.12	−0.16	0.04	−0.09	−0.04	−0.09	0.13	0.21	−0.02	0.03
s	−0.13	0.12	0.24	0.11	0.07	0.31	0.18	0.11	−0.48	−0.48	0.11	−0.25	−0.17	0.21	0.65	0.60	0.37	0.25
h	−0.08	−0.12	−0.41	−0.08	0.03	0.01	−0.16	−0.23	−0.27	−0.25	−0.45	−0.47	−0.35	−0.13	1.03	0.05	0.04	−0.06
r	−0.14	−0.66	−0.41	0.07	0.35	0.40	−0.04	−0.23	1.43	1.25	0.89	0.28	0.45	0.55	0.47	−0.52	0.89	−0.56
c	−0.60	−0.57	−0.60	−0.74	−0.64	0.01	−0.75	−0.57	0.20	0.03	0.19	−0.02	−0.08	0.40	0.14	0.41	0.06	−0.12
t_b	−1.16	−0.17	6.01	−0.74	1.37	2.08	−1.71	0.56	−2.42	−3.73	1.09	−1.83	−1.39	−2.38	2.09	3.40	−0.55	0.49
t_s	−2.53	2.58	4.82	2.12	1.29	5.90	4.41	1.76	−6.22	−6.13	2.25	−4.12	−3.67	4.49	6.93	6.96	5.75	2.35
t_h	−1.23	−1.89	−6.50	−0.91	0.39	0.14	−2.94	−2.36	−2.57	−2.95	−4.46	−5.53	−5.45	−1.70	7.17	0.33	0.44	−0.39
t_r	−1.90	−9.56	−5.71	0.72	3.77	6.18	−0.63	−2.76	12.18	10.52	9.56	3.33	6.49	5.13	4.41	−2.86	10.50	−4.02
t_c	−5.45	−5.36	−6.39	−7.32	−4.66	0.10	−8.47	−4.67	1.27	0.18	1.46	−0.17	−0.77	2.92	0.68	1.99	0.45	−0.57

Table 8 : Significant Anomalies with All-but-micro Breakpoints and Equal-weighted Returns

For each variable, m, α_{FF}, α_C, α_q, and a are the average return, the three-factor alpha, the Carhart alpha, the q-model alpha, and the five-factor alpha for the high-minus-low decile, and t_m, t_{FF}, t_C, t_q, and t_a are their t-statistics adjusted for heteroscedasticity and autocorrelations, respectively. $\overline{|\alpha_{FF}|}$, $\overline{|\alpha_C|}$, $\overline{|\alpha_q|}$, and $\overline{|a|}$ are the average magnitude of the alphas, and p_{FF}, p_C, p_q, and p_a are the p-values of the GRS test that all the alphas are jointly zero across a given set of deciles. Table 4 provides a brief description of the symbols.

	SUE-1	SUE-6	Abr-1	Abr-6	RE-1	RE-6	R6-1	R6-6	R11-1	I-Mom	B/M	E/P	CF/P
m	0.72	0.30	0.97	0.46	0.79	0.44	1.08	0.92	1.24	0.68	0.77	0.65	0.73
α_{FF}	0.85	0.43	1.05	0.52	0.95	0.61	1.34	1.12	1.56	0.77	0.25	0.33	0.33
α_C	0.58	0.21	0.87	0.31	0.47	0.20	0.16	0.03	0.23	−0.01	0.17	0.29	0.25
α_q	0.31	−0.04	0.85	0.31	0.26	−0.06	0.34	0.04	0.37	0.13	0.06	0.25	0.20
a	0.70	0.31	1.02	0.52	0.86	0.48	1.12	0.90	1.35	0.62	−0.01	0.18	0.13
t_m	6.39	3.36	8.74	5.61	4.08	2.65	3.86	3.82	4.27	3.47	3.29	3.20	3.46
t_{FF}	8.51	5.26	9.08	6.16	5.33	4.08	5.24	4.78	5.67	4.01	2.58	2.89	2.88
t_C	5.40	2.60	8.54	3.47	2.78	1.41	0.84	0.19	1.77	−0.08	1.35	2.48	1.87
t_q	3.06	−0.53	5.55	2.14	1.53	−0.37	0.84	0.11	0.88	0.48	0.27	1.33	0.96
t_a	6.50	3.41	7.94	4.68	4.62	2.87	3.10	2.68	3.62	2.44	−0.12	1.46	0.95
$\overline{\lvert\alpha_{FF}\rvert}$	0.23	0.11	0.20	0.11	0.24	0.17	0.20	0.21	0.31	0.18	0.06	0.07	0.08
$\overline{\lvert\alpha_C\rvert}$	0.16	0.13	0.19	0.14	0.15	0.12	0.13	0.10	0.09	0.04	0.13	0.15	0.15
$\overline{\lvert\alpha_q\rvert}$	0.11	0.10	0.19	0.17	0.13	0.15	0.16	0.14	0.11	0.10	0.14	0.06	0.06
$\overline{\lvert a\rvert}$	0.19	0.08	0.19	0.11	0.23	0.14	0.18	0.16	0.27	0.21	0.04	0.06	0.05
p_{FF}	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.44	0.12	0.14
p_C	0.00	0.00	0.00	0.00	0.01	0.16	0.00	0.00	0.03	0.30	0.09	0.11	0.10
p_q	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.20	0.21	0.42	0.23
p_a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.49	0.63

	NO/P	Dur	A/ME	Rev	ACI	I/A	NOA	△PI/A	IG	NSI	CEI	NXF	IvG
m	0.64	−0.64	0.67	−0.64	−0.32	−0.72	−0.56	−0.64	−0.41	−0.82	−0.65	−0.67	−0.50
α_{FF}	0.57	−0.33	0.04	−0.26	−0.32	−0.56	−0.75	−0.62	−0.32	−0.79	−0.70	−0.70	−0.47
α_C	0.42	−0.17	0.02	−0.22	−0.19	−0.47	−0.63	−0.50	−0.22	−0.62	−0.54	−0.54	−0.34
α_q	0.20	−0.01	−0.17	−0.30	−0.13	−0.30	−0.71	−0.34	−0.03	−0.26	−0.28	−0.23	−0.29
a	0.24	−0.06	−0.26	−0.20	−0.26	−0.34	−0.79	−0.45	−0.12	−0.34	−0.43	−0.33	−0.38
t_m	3.46	−2.93	2.56	−3.50	−3.74	−4.84	−3.40	−5.07	−4.30	−5.49	−3.90	−3.80	−4.32
t_{FF}	4.72	−2.58	0.28	−1.70	−3.62	−4.72	−4.45	−5.26	−3.66	−6.32	−6.75	−5.47	−4.26
t_C	3.41	−1.15	0.10	−1.31	−2.10	−3.84	−3.94	−4.28	−2.43	−4.73	−4.69	−4.34	−3.24
t_q	1.46	−0.04	−0.69	−1.89	−1.32	−2.52	−3.26	−2.72	−0.34	−2.02	−2.12	−1.70	−2.35
t_a	1.94	−0.49	−1.85	−1.30	−2.85	−3.21	−4.89	−4.27	−1.45	−3.04	−3.99	−2.55	−3.55
$\overline{\lvert\alpha_{FF}\rvert}$	0.13	0.09	0.05	0.09	0.09	0.15	0.17	0.15	0.09	0.16	0.16	0.17	0.12
$\overline{\lvert\alpha_C\rvert}$	0.19	0.14	0.13	0.13	0.17	0.19	0.21	0.21	0.15	0.20	0.20	0.22	0.18
$\overline{\lvert\alpha_q\rvert}$	0.11	0.11	0.14	0.08	0.10	0.14	0.17	0.17	0.12	0.14	0.12	0.13	0.10
$\overline{\lvert a\rvert}$	0.06	0.04	0.08	0.04	0.07	0.08	0.15	0.12	0.04	0.10	0.07	0.09	0.08
p_{FF}	0.00	0.09	0.55	0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
p_C	0.00	0.08	0.18	0.047	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p_q	0.048	0.06	0.10	0.12	0.15	0.01	0.00	0.00	0.41	0.00	0.00	0.00	0.00
p_a	0.03	0.48	0.25	0.39	0.09	0.01	0.00	0.00	0.89	0.00	0.00	0.00	0.00

	IvC	OA	POA	TA	PTA	ROE	ROA	GP/A	RS	NEI	CTO	F	TES
m	−0.50	−0.30	−0.43	−0.46	−0.51	1.00	0.90	0.65	0.57	0.47	0.36	0.58	0.32
α_{FF}	−0.49	−0.31	−0.35	−0.35	−0.46	1.20	1.09	0.63	0.83	0.62	0.24	0.73	0.39
α_C	−0.43	−0.33	−0.24	−0.38	−0.43	0.91	0.82	0.53	0.67	0.44	0.23	0.49	0.27
α_q	−0.42	−0.53	−0.14	−0.45	−0.35	0.10	0.12	−0.06	0.26	0.05	−0.15	0.25	0.03
a	−0.50	−0.51	−0.23	−0.38	−0.33	0.56	0.51	0.00	0.59	0.36	−0.18	0.48	0.32
t_m	−4.30	−2.50	−3.88	−3.99	−5.06	4.60	4.03	3.67	4.49	4.28	1.98	2.57	2.52
t_{FF}	−4.44	−2.55	−3.99	−3.24	−5.33	6.01	5.34	3.65	7.49	6.03	1.40	4.33	3.23
t_C	−3.80	−2.35	−2.63	−2.89	−4.82	4.42	3.87	3.15	5.61	4.25	1.29	2.72	2.25
t_q	−3.37	−4.05	−1.51	−4.13	−3.88	0.71	0.89	−0.41	2.39	0.70	−0.79	1.28	0.28
t_a	−5.12	−4.79	−2.74	−3.68	−3.62	4.14	3.52	0.01	5.07	4.02	−1.32	2.67	2.65
$\overline{\lvert\alpha_{FF}\rvert}$	0.11	0.13	0.12	0.09	0.09	0.24	0.24	0.14	0.18	0.23	0.09	0.19	0.13
$\overline{\lvert\alpha_C\rvert}$	0.17	0.18	0.18	0.17	0.19	0.19	0.18	0.16	0.16	0.21	0.15	0.18	0.14
$\overline{\lvert\alpha_q\rvert}$	0.11	0.16	0.16	0.13	0.14	0.12	0.14	0.14	0.09	0.11	0.12	0.12	0.10
$\overline{\lvert a\rvert}$	0.10	0.12	0.13	0.07	0.09	0.12	0.14	0.08	0.12	0.19	0.09	0.13	0.09
p_{FF}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
p_C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
p_q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.08	0.54
p_a	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.02	0.01	0.19

	O	OC/A	Ad/M	RD/M	H/N	OL	Svol	MDR	S-Rev	Disp	Dvol
m	−0.28	0.35	0.64	0.94	−0.50	0.41	−0.45	−0.66	−0.57	−0.44	−0.37
α_{FF}	−0.55	0.45	0.22	0.66	−0.37	0.39	−0.52	−0.87	−0.36	−0.83	−0.11
α_C	−0.42	0.38	0.20	0.65	−0.28	0.38	−0.47	−0.73	−0.67	−0.63	−0.15
α_q	−0.23	0.39	−0.25	0.78	−0.05	−0.04	−0.15	−0.16	−0.62	−0.04	0.03
a	−0.31	0.45	−0.32	0.69	−0.11	−0.01	−0.18	−0.28	−0.43	−0.33	0.08
t_m	−1.98	3.72	2.15	3.69	−3.62	2.18	−2.18	−2.14	−2.61	−1.98	−2.64
t_{FF}	−4.27	4.89	0.97	2.86	−3.64	2.06	−2.63	−4.76	−1.51	−4.62	−1.08
t_C	−3.23	3.67	0.84	2.70	−2.68	2.14	−2.23	−3.62	−2.94	−3.47	−1.32
t_q	−1.51	3.12	−0.84	2.66	−0.44	−0.22	−0.76	−0.76	−1.74	−0.25	0.20
t_a	−2.21	4.38	−1.45	2.70	−1.19	−0.08	−0.92	−2.02	−1.45	−2.32	0.73
$\overline{\lvert\alpha_{FF}\rvert}$	0.11	0.13	0.07	0.16	0.10	0.06	0.15	0.20	0.14	0.17	0.05
$\overline{\lvert\alpha_C\rvert}$	0.17	0.15	0.23	0.27	0.16	0.15	0.17	0.19	0.20	0.16	0.08
$\overline{\lvert\alpha_q\rvert}$	0.13	0.17	0.23	0.36	0.12	0.13	0.16	0.12	0.19	0.10	0.12
$\overline{\lvert a\rvert}$	0.08	0.10	0.14	0.22	0.08	0.07	0.08	0.09	0.15	0.07	0.06
p_{FF}	0.01	0.00	0.68	0.07	0.00	0.19	0.048	0.00	0.03	0.00	0.13
p_C	0.00	0.00	0.10	0.01	0.00	0.05	0.06	0.00	0.02	0.01	0.02
p_q	0.02	0.00	0.047	0.00	0.00	0.11	0.04	0.03	0.00	0.29	0.00
p_a	0.08	0.00	0.23	0.04	0.01	0.18	0.31	0.04	0.03	0.07	0.15

Table 9 : Factor Loadings for the q-factor Model and the FF Five-factor Model, Significant Anomalies with All-but-micro Breakpoints and Equal-weighted Returns

For the high-minus-low decile formed on each anomaly variable, $\beta_{\text{MKT}}, \beta_{\text{ME}}, \beta_{\text{I/A}}$, and β_{ROE} are the loadings on the market, size, investment, and ROE factors in the q-factor model, and $t_{\beta_{\text{MKT}}}, t_{\beta_{\text{ME}}}, t_{\beta_{\text{I/A}}}$, and $t_{\beta_{\text{ROE}}}$ are their t-statistics, respectively. b, s, h, r, and c are the loadings on MKT, SMB, HML, RMW, and CMA in the FF five-factor model, and t_b, t_s, t_h, t_r, and t_c are their t-statistics, respectively. All t-statistics are adjusted for heteroscedasticity and autocorrelations. Table 4 provides a brief description of the symbols.

	SUE-1	SUE-6	Abr-1	Abr-6	RE-1	RE-6	R6-1	R6-6	R11-1	I-Mom	B/M	E/P	CF/P
β_{MKT}	−0.02	0.00	−0.07	−0.01	0.01	0.02	−0.21	−0.04	−0.09	−0.06	−0.15	−0.20	−0.17
β_{ME}	0.01	−0.03	0.10	0.13	0.04	−0.01	0.53	0.47	0.52	0.33	0.11	0.00	0.01
$\beta_{\text{I/A}}$	0.13	0.07	0.00	−0.05	−0.15	−0.09	0.02	0.12	−0.06	0.16	1.82	1.15	1.33
β_{ROE}	0.62	0.56	0.22	0.25	0.94	0.87	1.16	1.21	1.36	0.70	−0.10	−0.01	0.04
$t_{\beta_{\text{MKT}}}$	−0.72	−0.04	−1.95	−0.46	0.19	0.57	−2.09	−0.49	−0.92	−0.93	−2.80	−3.57	−2.66
$t_{\beta_{\text{ME}}}$	0.26	−0.91	1.35	2.07	0.72	−0.21	1.85	2.30	2.13	1.88	0.99	0.00	0.04
$t_{\beta_{\text{I/A}}}$	2.17	1.35	0.01	−0.48	−1.35	−1.03	0.04	0.41	−0.17	0.69	8.32	7.92	7.82
$t_{\beta_{\text{ROE}}}$	8.42	12.45	2.80	3.12	8.78	11.16	4.07	5.10	5.14	4.02	−0.59	−0.11	0.26
b	−0.05	−0.04	−0.08	−0.04	−0.07	−0.05	−0.28	−0.12	−0.19	−0.10	−0.05	−0.13	−0.09
s	−0.13	−0.15	0.01	0.03	−0.12	−0.16	0.20	0.11	0.14	0.11	0.15	0.03	0.06
h	−0.21	−0.19	−0.19	−0.14	−0.08	−0.13	−0.67	−0.60	−0.87	−0.35	1.29	1.12	1.26
r	0.25	0.23	−0.07	−0.02	0.30	0.32	0.22	0.26	0.19	0.10	0.39	0.38	0.53
c	0.26	0.15	0.23	0.04	−0.23	−0.13	0.65	0.57	0.65	0.49	0.51	−0.01	0.04
t_b	−1.40	−1.23	−2.43	−1.47	−1.11	−0.90	−2.38	−1.20	−1.71	−1.26	−1.99	−4.17	−2.86
t_s	−2.58	−3.43	0.19	0.66	−1.38	−2.34	0.91	0.74	0.76	0.74	3.66	0.72	1.21
t_h	−2.32	−2.66	−2.20	−1.93	−0.56	−1.10	−1.95	−2.23	−2.83	−1.60	23.11	16.35	18.64
t_r	4.00	4.25	−0.72	−0.19	2.89	3.58	0.47	0.76	0.50	0.36	3.93	4.75	6.28
t_c	2.46	1.62	1.88	0.26	−1.07	−0.70	1.30	1.38	1.47	1.55	4.32	−0.06	0.40

	NO/P	Dur	A/ME	Rev	ACI	I/A	NOA	△PI/A	IG	NSI	CEI	NXF	IvG
β_{MKT}	−0.22	0.22	−0.02	0.06	0.01	0.07	0.12	0.10	0.00	0.11	0.24	0.20	0.07
β_{ME}	−0.25	−0.07	0.07	−0.36	−0.14	0.02	−0.03	0.01	0.01	0.07	0.29	0.23	0.08
$\beta_{\text{I/A}}$	1.08	−1.18	1.97	−1.13	−0.15	−1.25	0.00	−0.82	−0.77	−0.90	−0.94	−0.89	−0.68
β_{ROE}	0.27	−0.34	−0.08	0.44	−0.15	0.15	0.18	0.02	−0.08	−0.43	−0.31	−0.38	0.05
$t_{\beta_{\text{MKT}}}$	−6.79	3.15	−0.27	1.46	0.29	3.19	2.03	3.16	0.06	4.16	7.25	7.50	3.14
$t_{\beta_{\text{ME}}}$	−5.48	−0.61	0.48	−5.74	−3.78	0.46	−0.19	0.11	0.29	1.19	6.47	5.09	1.94
$t_{\beta_{\text{I/A}}}$	10.01	−7.43	8.40	−9.19	−2.09	−15.01	−0.01	−8.50	−12.00	−8.86	−10.62	−8.09	−7.46
$t_{\beta_{\text{ROE}}}$	2.66	−1.88	−0.40	4.13	−2.19	2.09	1.47	0.25	−1.30	−5.10	−3.64	−4.26	0.79
b	−0.16	0.15	0.08	0.01	0.02	0.03	0.14	0.08	−0.02	0.07	0.22	0.16	0.06
s	−0.25	−0.09	0.13	−0.36	−0.10	0.08	0.11	0.08	0.05	0.04	0.33	0.27	0.13
h	0.44	−1.11	1.49	−0.45	0.11	−0.20	0.61	0.06	−0.09	−0.21	−0.41	−0.14	−0.03
r	0.57	−0.71	0.52	0.21	−0.03	0.02	0.51	0.06	−0.13	−0.80	−0.45	−0.59	0.10
c	0.54	−0.05	0.42	−0.65	−0.24	−0.97	−0.65	−0.82	−0.63	−0.65	−0.40	−0.68	−0.58
t_b	−5.46	3.96	2.45	0.28	0.64	1.31	3.65	2.79	−0.84	2.68	7.84	5.69	2.80
t_s	−4.66	−1.55	2.78	−4.44	−2.67	1.75	1.68	1.83	1.29	0.92	5.62	5.17	3.03
t_h	6.55	−12.35	20.90	−4.02	1.76	−2.97	5.91	0.81	−1.96	−3.98	−5.75	−2.02	−0.49
t_r	6.51	−6.44	5.35	1.64	−0.41	0.19	4.32	0.89	−2.01	−9.90	−5.67	−5.96	1.49
t_c	4.98	−0.30	3.45	−3.74	−2.60	−8.90	−5.41	−8.64	−6.75	−7.02	−4.28	−6.19	−6.31

	IvC	OA	POA	TA	PTA	ROE	ROA	GP/A	RS	NEI	CTO	F	TES
β_{MKT}	0.06	0.00	0.00	0.06	0.09	−0.02	−0.05	0.11	−0.03	0.02	0.15	−0.30	0.13
β_{ME}	0.10	0.22	0.18	0.05	0.09	−0.12	−0.12	0.25	−0.11	−0.03	0.44	−0.23	0.10
$\beta_{\mathrm{I/A}}$	−0.55	−0.19	−0.77	−0.65	−0.58	0.24	0.12	0.23	−0.17	−0.08	−0.18	0.38	−0.32
β_{ROE}	0.17	0.43	−0.01	0.42	0.04	1.50	1.40	0.84	0.76	0.80	0.64	0.68	0.51
$t_{\beta_{\mathrm{MKT}}}$	2.78	−0.01	−0.21	1.71	3.78	−0.52	−1.31	2.66	−1.10	1.23	2.89	−5.68	4.65
$t_{\beta_{\mathrm{ME}}}$	2.38	4.07	5.60	1.16	2.14	−1.11	−1.28	2.98	−2.61	−1.13	4.19	−3.03	2.01
$t_{\beta_{\mathrm{I/A}}}$	−6.07	−1.69	−12.18	−7.89	−9.28	2.24	1.08	1.75	−2.69	−2.20	−1.47	2.46	−2.93
$t_{\beta_{\mathrm{ROE}}}$	2.85	4.84	−0.22	4.90	0.72	20.45	18.27	8.00	13.52	26.12	6.84	5.60	6.97
b	0.07	0.02	−0.02	0.05	0.07	−0.02	−0.03	0.14	−0.06	−0.01	0.18	−0.29	0.08
s	0.17	0.25	0.23	0.05	0.06	−0.15	−0.17	0.35	−0.20	−0.12	0.59	−0.28	0.02
h	0.00	0.01	−0.21	−0.12	−0.18	−0.03	−0.07	−0.19	−0.35	−0.25	−0.08	0.27	−0.27
r	0.32	0.62	−0.02	0.38	−0.14	1.59	1.48	1.44	0.56	0.65	1.16	0.68	0.22
c	−0.47	−0.13	−0.47	−0.48	−0.35	0.20	0.14	0.45	0.11	0.10	0.01	0.00	−0.13
t_b	2.66	0.61	−0.68	1.22	2.63	−0.45	−0.72	5.27	−1.78	−0.21	5.57	−4.99	2.60
t_s	5.27	6.22	6.71	0.93	1.50	−1.98	−2.25	7.73	−4.24	−2.72	13.27	−2.93	0.34
t_h	0.07	0.15	−4.71	−1.32	−2.99	−0.22	−0.69	−2.80	−4.90	−4.00	−1.31	2.22	−3.67
t_r	5.21	8.35	−0.33	4.71	−2.46	16.11	14.48	18.02	6.98	10.97	16.02	5.20	2.32
t_c	−5.68	−1.08	−6.42	−3.26	−3.53	1.32	0.90	3.84	1.09	1.01	0.06	0.01	−1.01

	O	OC/A	Ad/M	RD/M	H/N	OL	Svol	MDR	S-Rev	Disp	Dvol
β_{MKT}	0.15	−0.16	−0.10	0.10	0.07	−0.07	0.00	0.50	−0.29	0.29	0.26
β_{ME}	0.16	0.00	0.14	0.63	0.09	0.26	0.18	0.67	0.05	0.28	−0.64
$\beta_{\mathrm{I/A}}$	0.29	0.04	1.67	0.28	−1.14	0.29	−0.16	−1.19	0.16	−0.14	−0.74
β_{ROE}	−0.54	0.03	0.27	−0.37	−0.02	0.47	−0.52	−0.78	0.19	−1.04	0.02
$t_{\beta_{\mathrm{MKT}}}$	4.34	−6.24	−1.24	1.56	2.50	−1.47	0.00	7.60	−2.89	7.59	6.87
$t_{\beta_{\mathrm{ME}}}$	2.89	0.07	1.02	4.61	2.39	3.82	1.19	4.65	0.20	4.61	−6.85
$t_{\beta_{\mathrm{I/A}}}$	2.37	0.34	8.52	1.05	−15.65	2.29	−0.87	−6.23	0.58	−2.08	−8.45
$t_{\beta_{\mathrm{ROE}}}$	−5.74	0.35	1.38	−2.02	−0.32	4.51	−4.00	−4.44	0.98	−14.58	0.20
b	0.14	−0.16	0.02	0.15	0.03	−0.03	0.00	0.42	−0.30	0.29	0.22
s	0.17	−0.02	0.25	0.50	0.13	0.30	0.15	0.65	−0.06	0.28	−0.69
h	0.27	−0.07	0.98	−0.28	−0.25	−0.07	0.09	−0.64	−0.31	0.02	−0.43
r	−0.60	−0.02	1.01	−0.39	−0.20	0.86	−0.60	−1.24	−0.13	−1.06	−0.33
c	−0.07	0.07	0.55	0.76	−0.82	0.41	−0.23	−0.53	0.50	−0.02	−0.32
t_b	3.94	−6.14	0.36	2.52	1.07	−0.81	0.01	7.66	−3.47	7.21	7.95
t_s	3.45	−0.56	3.16	5.07	2.89	5.45	1.23	10.53	−0.37	5.32	−12.70
t_h	3.17	−1.06	10.27	−2.08	−4.82	−0.88	0.62	−4.86	−1.31	0.25	−6.24
t_r	−4.95	−0.26	9.44	−1.67	−2.63	8.81	−3.78	−12.43	−0.42	−16.58	−5.39
t_c	−0.60	0.59	3.95	2.73	−7.73	2.98	−1.23	−3.54	1.86	−0.17	−3.68

Table 10 : Empirical Properties of the New Factors, Alternative Factor Constructions, January 1967 to December 2013

r_{ME}, $r_{\mathrm{I/A}}$, and r_{ROE} are the size, investment, ROE factors from the q-factor model, respectively. 2×3 denotes the q-factors from double sorts (two-by-three) on size and I/A as well as on size and ROE, 2×2 from double sorts (two-by-two) on size and I/A as well as on size and ROE, and $2\times2\times2$ from a triple sort (two-by-three-by-three) on size, I/A, and ROE. SMB, HML, RMW, and CMA are the size, value, profitability, and investment factors from the FF five-factor model, respectively. 2×2 denotes the factors from double sorts (two-by-two) by interacting size, separately, with book-to-market, Inv, and OP, and $2\times2\times2\times2$ from a quadruple sort (two-by-two-by-two-by-two) on size, book-to-market, Inv, and OP. MKT is the value-weighted market return minus the one-month Treasury bill rate from CRSP. We obtain the data for UMD as well as the benchmark and alternative versions of SMB, HML, RMW, and CMA from Kenneth French's Web site. m is the average return. In Panel A, α is the Carhart alpha, and a is the five-factor alpha, b, s, h, r, and c are factor loadings, and the five-factor regressions use the benchmark FF five factors from two-by-three sorts. In Panel B, α is the Carhart alpha, α_q the q-model alpha, and the q-factor regressions use the benchmark factors from a triple two-by-three-by-three sort.

Panel A: The q-factors							
$2\times2\times2$	m	α	β_{MKT}	β_{SMB}	β_{HML}	β_{UMD}	R^2
r_{ME}	0.33	−0.03	0.05	1.03	0.19	0.02	0.94
	(2.27)	(−0.79)	(4.82)	(74.66)	(6.66)	(1.24)	
$r_{\mathrm{I/A}}$	0.26	0.18	−0.07	−0.02	0.28	0.03	0.48
	(3.90)	(3.63)	(−5.38)	(−0.56)	(10.14)	(1.31)	
r_{ROE}	0.40	0.36	−0.01	−0.20	−0.08	0.18	0.33
	(5.00)	(4.99)	(−0.63)	(−3.53)	(−1.52)	(5.50)	
	a	b	s	h	r	c	R^2
r_{ME}	−0.01	0.05	1.03	0.02	0.01	0.08	0.96
	(−0.39)	(5.32)	(76.52)	(0.88)	(0.24)	(2.19)	
$r_{\mathrm{I/A}}$	0.07	−0.02	−0.04	0.01	0.00	0.59	0.78
	(2.20)	(−2.47)	(−2.94)	(0.61)	(0.21)	(22.79)	
r_{ROE}	0.29	−0.01	−0.05	−0.17	0.59	0.10	0.52
	(4.80)	(−0.51)	(−1.67)	(−3.23)	(12.90)	(1.26)	
2×3	m	α	β_{MKT}	β_{SMB}	β_{HML}	β_{UMD}	R^2
r_{ME}	0.30	−0.05	0.04	1.03	0.19	0.01	0.95
	(2.07)	(−1.49)	(4.54)	(87.41)	(6.85)	(0.53)	
$r_{\mathrm{I/A}}$	0.29	0.13	−0.08	0.01	0.48	0.02	0.55
	(3.07)	(1.88)	(−4.57)	(0.45)	(15.75)	(0.76)	
r_{ROE}	0.57	0.52	−0.03	−0.31	−0.10	0.27	0.32
	(4.44)	(4.40)	(−0.89)	(−3.51)	(−1.06)	(5.04)	
	a	b	s	h	r	c	R^2
r_{ME}	−0.02	0.04	1.02	0.05	−0.03	0.02	0.97
	(−0.79)	(5.29)	(100.22)	(3.31)	(−1.22)	(0.78)	
$r_{\mathrm{I/A}}$	−0.04	0.00	−0.03	0.07	−0.04	0.90	0.92
	(−1.34)	(0.52)	(−1.89)	(3.07)	(−2.03)	(31.81)	
r_{ROE}	0.37	−0.02	−0.06	−0.24	0.97	0.16	0.57
	(4.02)	(−0.63)	(−1.22)	(−3.09)	(12.90)	(1.41)	

2×2	m	α	β_{MKT}	β_{SMB}	β_{HML}	β_{UMD}	R^2
r_{ME}	0.29	−0.07	0.06	1.05	0.19	0.00	0.95
	(1.96)	(−1.91)	(6.34)	(88.91)	(6.57)	(0.15)	
$r_{\mathrm{I/A}}$	0.19	0.10	−0.08	0.01	0.32	0.01	0.51
	(2.68)	(1.99)	(−5.47)	(0.32)	(13.36)	(0.30)	
r_{ROE}	0.40	0.35	0.00	−0.21	−0.07	0.19	0.27
	(4.36)	(4.04)	(0.17)	(−3.07)	(−1.06)	(4.61)	

	a	b	s	h	r	c	R^2
r_{ME}	−0.04	0.05	1.05	0.04	−0.03	0.03	0.98
	(−1.61)	(8.20)	(103.46)	(2.83)	(−1.36)	(1.20)	
$r_{\mathrm{I/A}}$	0.00	−0.03	−0.03	0.05	−0.08	0.59	0.84
	(0.05)	(−3.09)	(−2.95)	(3.00)	(−4.48)	(24.00)	
r_{ROE}	0.23	0.01	−0.02	−0.16	0.72	0.09	0.57
	(3.59)	(0.55)	(−0.64)	(−2.97)	(12.82)	(1.04)	

Panel B: The FF five factors

$2 \times 2 \times 2 \times 2$	m	α	β_{MKT}	β_{SMB}	β_{HML}	β_{UMD}	R^2
SMB	0.29	0.03	−0.02	0.94	0.08	0.00	0.97
	(2.23)	(1.26)	(−3.18)	(66.68)	(5.26)	(0.52)	
HML	0.29	0.06	−0.02	−0.06	0.69	0.00	0.90
	(2.74)	(1.66)	(−1.82)	(−3.73)	(47.39)	(0.10)	
RMW	0.27	0.25	−0.02	−0.16	0.20	0.00	0.34
	(3.78)	(3.97)	(−1.24)	(−3.35)	(6.09)	(0.00)	
CMA	0.16	0.14	−0.08	−0.03	0.15	0.02	0.33
	(2.84)	(2.88)	(−5.51)	(−1.55)	(6.23)	(0.97)	

	α_q	β_{MKT}	β_{ME}	$\beta_{\mathrm{I/A}}$	β_{ROE}	R^2
SMB	0.07	−0.03	0.89	−0.11	−0.05	0.92
	(1.88)	(−1.89)	(48.08)	(−3.89)	(−2.38)	
HML	0.09	−0.06	−0.05	0.65	−0.07	0.39
	(0.89)	(−1.90)	(−0.81)	(8.97)	(−1.05)	
RMW	0.13	−0.03	−0.10	0.16	0.21	0.30
	(1.68)	(−1.19)	(−1.82)	(2.84)	(4.33)	
CMA	−0.00	−0.04	−0.02	0.44	−0.02	0.63
	(−0.01)	(−3.79)	(−1.09)	(19.61)	(−0.68)	

2×2	m	α	β_{MKT}	β_{SMB}	β_{HML}	β_{UMD}	R^2
SMB	0.28	−0.03	0.02	1.01	0.14	0.00	0.98
	(2.03)	(−1.45)	(3.20)	(92.98)	(8.18)	(0.05)	
HML	0.27	0.03	−0.02	−0.03	0.71	0.00	0.96
	(2.58)	(1.17)	(−3.37)	(−3.99)	(68.49)	(0.22)	
RMW	0.19	0.23	−0.01	−0.19	−0.02	0.01	0.15
	(2.56)	(3.27)	(−0.37)	(−2.94)	(−0.32)	(0.44)	
CMA	0.24	0.14	−0.08	0.02	0.32	0.02	0.55
	(3.33)	(2.90)	(−5.38)	(0.69)	(12.31)	(1.08)	

	α_q	β_{MKT}	β_{ME}	$\beta_{\mathrm{I/A}}$	β_{ROE}	R^2
SMB	0.05	0.01	0.95	−0.08	−0.10	0.95
	(1.40)	(0.71)	(59.89)	(−4.16)	(−5.71)	
HML	0.04	−0.06	−0.03	0.76	−0.12	0.52
	(0.51)	(−2.09)	(−0.58)	(11.78)	(−2.12)	
RMW	0.03	0.00	−0.09	−0.05	0.36	0.45
	(0.50)	(0.06)	(−1.78)	(−0.89)	(7.87)	
CMA	0.03	−0.06	0.03	0.63	−0.09	0.79
	(0.93)	(−5.34)	(1.28)	(30.82)	(−3.76)	

Table 11 : Significant Anomalies with NYSE Breakpoints and Value-weighted Decile Returns, Alternative Factor Constructions

$\alpha^q_{2\times2\times2}, \alpha^q_{2\times3}$, and $\alpha^q_{2\times2}$ are the high-minus-low q-model alphas from the alternative $2\times2\times2$, 2×3, and 2×2 constructions of the q-factors, respectively. $a_{2\times2\times2\times2}$ and $a_{2\times2}$ are the high-minus-low five-factor alphas from the alternative $2\times2\times2\times2$ and 2×2 constructions of the FF five factors, respectively. $t^q_{2\times2\times2}$, $t^q_{2\times3}$, $t^q_{2\times2}$, $t^a_{2\times2\times2\times2}$, and $t^a_{2\times2}$ are their corresponding t-statistics adjusted for heteroscedasticity and autocorrelations. $\overline{|\alpha^q_{2\times2\times2}|}$, $\overline{|\alpha^q_{2\times3}|}$, $\overline{|\alpha^q_{2\times2}|}$, $\overline{|a_{2\times2\times2\times2}|}$, and $\overline{|a_{2\times2}|}$ are the average magnitude of the alphas across a given set of deciles, and $p^q_{2\times2\times2}$, $p^q_{2\times3}$, $p^q_{2\times2}$, $p^a_{2\times2\times2\times2}$, and $p^a_{2\times2}$ are the corresponding p-values of the GRS test. Table 4 provides a brief description of the symbols.

	SUE-1	Abr-1	Abr-6	RE-1	RE-6	R6-6	R11-1	I-Mom	B/M	Rev	E/P	CF/P	NO/P	Dur	ACI	I/A	NOA	△PI/A
$\alpha^q_{2\times2\times2}$	0.14	0.61	0.24	0.23	0.12	0.31	0.39	0.07	0.31	−0.22	0.31	0.33	0.42	−0.34	−0.19	−0.04	−0.37	−0.30
$\alpha^q_{2\times3}$	0.21	0.66	0.30	0.24	0.13	0.43	0.51	0.19	0.18	−0.18	0.13	0.16	0.39	−0.17	−0.23	0.01	−0.45	−0.32
$\alpha^q_{2\times2}$	0.20	0.67	0.29	0.33	0.21	0.49	0.60	0.21	0.23	−0.15	0.23	0.25	0.40	−0.25	−0.24	−0.04	−0.43	−0.34
$a_{2\times2\times2\times2}$	0.48	0.88	0.43	0.95	0.75	1.11	1.45	0.74	0.02	0.05	0.00	−0.03	0.26	−0.02	−0.26	−0.07	−0.46	−0.36
$a_{2\times2}$	0.45	0.86	0.45	0.95	0.75	1.05	1.36	0.64	−0.02	0.10	0.02	0.00	0.22	−0.04	−0.31	0.02	−0.42	−0.32
$t^q_{2\times2\times2}$	1.12	4.34	2.21	0.86	0.53	1.07	1.08	0.29	1.70	−1.21	1.43	1.59	2.71	−1.71	−1.09	−0.31	−2.21	−2.42
$t^q_{2\times3}$	1.62	4.27	2.54	0.91	0.56	1.33	1.25	0.72	1.08	−1.05	0.62	0.83	2.64	−0.94	−1.35	0.05	−2.47	−2.57
$t^q_{2\times2}$	1.66	4.56	2.67	1.28	0.96	1.66	1.62	0.84	1.34	−0.89	1.08	1.25	2.68	−1.28	−1.42	−0.33	−2.50	−2.78
$t^a_{2\times2\times2\times2}$	4.21	6.22	4.48	3.82	3.52	4.15	4.35	3.22	0.15	0.29	0.00	−0.23	1.90	−0.11	−1.77	−0.63	−2.87	−3.03
$t^a_{2\times2}$	3.80	6.18	4.45	3.73	3.41	3.90	3.98	2.69	−0.19	0.61	0.18	0.03	1.61	−0.32	−1.96	0.18	−2.67	−2.66
$\overline{\lvert\alpha^q_{2\times2\times2}\rvert}$	0.06	0.13	0.07	0.10	0.11	0.08	0.12	0.10	0.10	0.10	0.13	0.13	0.11	0.11	0.12	0.08	0.10	0.13
$\overline{\lvert\alpha^q_{2\times3}\rvert}$	0.05	0.13	0.07	0.09	0.10	0.09	0.13	0.14	0.09	0.09	0.11	0.15	0.12	0.07	0.14	0.08	0.11	0.13
$\overline{\lvert\alpha^q_{2\times2}\rvert}$	0.06	0.13	0.07	0.08	0.10	0.09	0.12	0.14	0.09	0.08	0.12	0.13	0.11	0.09	0.13	0.08	0.10	0.13
$\overline{\lvert a_{2\times2\times2\times2}\rvert}$	0.13	0.16	0.09	0.20	0.18	0.19	0.27	0.23	0.06	0.05	0.07	0.09	0.10	0.05	0.12	0.08	0.10	0.10
$\overline{\lvert a_{2\times2}\rvert}$	0.12	0.16	0.09	0.21	0.18	0.18	0.26	0.22	0.05	0.05	0.08	0.12	0.11	0.05	0.14	0.10	0.09	0.11
$p^q_{2\times2\times2}$	0.24	0.00	0.01	0.14	0.03	0.00	0.00	0.09	0.11	0.23	0.03	0.00	0.00	0.36	0.01	0.01	0.01	0.00
$p^q_{2\times3}$	0.29	0.00	0.00	0.17	0.04	0.00	0.00	0.02	0.11	0.17	0.04	0.00	0.00	0.41	0.00	0.00	0.00	0.00
$p^q_{2\times2}$	0.22	0.00	0.01	0.11	0.04	0.00	0.00	0.04	0.15	0.24	0.04	0.00	0.00	0.47	0.00	0.00	0.00	0.00
$p^a_{2\times2\times2\times2}$	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.41	0.70	0.30	0.22	0.00	0.76	0.02	0.07	0.00	0.01
$p^a_{2\times2}$	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.43	0.16	0.05	0.00	0.84	0.00	0.00	0.01	0.00

	IG	NSI	CEI	IvG	IvC	OA	POA	PTA	ROE	ROA	GP/A	RS	NEI	OC/A	Ad/M	RD/M	OL	Svol
$\alpha^q_{2\times2\times2}$	−0.03	−0.41	−0.39	−0.14	−0.36	−0.53	−0.16	−0.23	0.05	0.10	0.15	0.17	0.14	0.18	0.28	0.57	0.09	−0.34
$\alpha^q_{2\times3}$	−0.06	−0.37	−0.31	−0.10	−0.36	−0.58	−0.15	−0.20	0.06	0.14	0.22	0.25	0.24	0.18	0.16	0.56	0.05	−0.30
$\alpha^q_{2\times2}$	−0.05	−0.42	−0.39	−0.14	−0.37	−0.57	−0.18	−0.21	0.13	0.18	0.20	0.24	0.22	0.22	0.22	0.55	0.10	−0.31
$a_{2\times2\times2\times2}$	−0.14	−0.36	−0.32	−0.18	−0.38	−0.49	−0.22	−0.13	0.61	0.58	0.20	0.56	0.47	0.40	−0.07	0.43	0.14	−0.35
$a_{2\times2}$	−0.07	−0.34	−0.31	−0.14	−0.35	−0.52	−0.13	−0.09	0.55	0.55	0.18	0.56	0.46	0.34	−0.09	0.34	0.10	−0.36
$t^q_{2\times2\times2}$	−0.25	−2.81	−2.71	−1.06	−2.52	−3.78	−1.22	−1.61	0.39	0.88	1.05	1.24	1.45	1.43	1.02	2.39	0.51	−1.42
$t^q_{2\times3}$	−0.50	−2.66	−2.38	−0.84	−2.63	−4.36	−1.16	−1.39	0.53	1.33	1.56	1.68	2.33	1.49	0.58	2.34	0.32	−1.20
$t^q_{2\times2}$	−0.46	−2.85	−2.71	−1.13	−2.67	−4.20	−1.42	−1.56	1.09	1.70	1.43	1.74	2.26	1.77	0.82	2.30	0.61	−1.25
$t^a_{2\times2\times2\times2}$	−1.22	−3.06	−2.73	−1.46	−2.94	−3.91	−1.85	−1.04	3.91	3.66	1.44	3.97	4.62	3.27	−0.34	1.71	0.91	−1.48
$t^a_{2\times2}$	−0.65	−2.74	−2.68	−1.06	−2.70	−4.17	−1.12	−0.70	3.75	3.63	1.39	4.05	4.50	2.73	−0.45	1.37	0.65	−1.48
$\overline{\lvert\alpha^q_{2\times2\times2}\rvert}$	0.07	0.10	0.12	0.09	0.08	0.14	0.12	0.09	0.10	0.05	0.10	0.07	0.08	0.10	0.12	0.26	0.10	0.11
$\overline{\lvert\alpha^q_{2\times3}\rvert}$	0.08	0.11	0.12	0.09	0.08	0.14	0.13	0.09	0.08	0.06	0.12	0.08	0.09	0.11	0.11	0.26	0.11	0.10
$\overline{\lvert\alpha^q_{2\times2}\rvert}$	0.07	0.11	0.12	0.09	0.08	0.14	0.12	0.09	0.09	0.06	0.12	0.07	0.09	0.11	0.11	0.26	0.10	0.11
$\overline{\lvert a_{2\times2\times2\times2}\rvert}$	0.06	0.09	0.10	0.10	0.09	0.12	0.12	0.08	0.14	0.16	0.09	0.15	0.17	0.11	0.10	0.21	0.07	0.11
$\overline{\lvert a_{2\times2}\rvert}$	0.06	0.11	0.10	0.10	0.08	0.12	0.12	0.07	0.12	0.15	0.10	0.15	0.16	0.12	0.11	0.20	0.09	0.11
$p^q_{2\times2\times2}$	0.06	0.00	0.00	0.11	0.16	0.00	0.00	0.01	0.00	0.86	0.24	0.11	0.09	0.01	0.09	0.00	0.06	0.17
$p^q_{2\times3}$	0.04	0.00	0.00	0.15	0.24	0.00	0.00	0.01	0.0498	0.68	0.12	0.048	0.02	0.00	0.07	0.00	0.01	0.20
$p^q_{2\times2}$	0.06	0.00	0.00	0.13	0.15	0.00	0.00	0.01	0.03	0.73	0.13	0.11	0.03	0.00	0.12	0.00	0.02	0.18
$p^a_{2\times2\times2\times2}$	0.25	0.02	0.01	0.04	0.14	0.00	0.00	0.03	0.02	0.07	0.12	0.00	0.00	0.00	0.56	0.01	0.19	0.18
$p^a_{2\times2}$	0.20	0.01	0.01	0.07	0.26	0.00	0.00	0.04	0.00	0.04	0.06	0.00	0.00	0.00	0.39	0.00	0.03	0.26

Table 12 : Significant Anomalies with All-but-micro Breakpoints and Equal-weighted Decile Returns, Alternative Factor Constructions

$\alpha^q_{2\times2\times2}$, $\alpha^q_{2\times3}$, and $\alpha^q_{2\times2}$ are the high-minus-low q-model alphas from the alternative $2\times2\times2$, 2×3, and 2×2 constructions of the q-factors, respectively. $a_{2\times2\times2\times2}$ and $a_{2\times2}$ are the high-minus-low five-factor alphas from the alternative $2\times2\times2\times2$ and 2×2 constructions of the FF five factors, respectively. $t^q_{2\times2\times2}$, $t^q_{2\times3}$, $t^q_{2\times2}$, $t^a_{2\times2\times2\times2}$, and $t^a_{2\times2}$ are their corresponding t-statistics adjusted for heteroscedasticity and autocorrelations. $\overline{|\alpha^q_{2\times2\times2}|}$, $\overline{|\alpha^q_{2\times3}|}$, $\overline{|\alpha^q_{2\times2}|}$, $\overline{|a_{2\times2\times2\times2}|}$, and $\overline{|a_{2\times2}|}$ are the average magnitude of the alphas across a given set of deciles, and $p^q_{2\times2\times2}$, $p^q_{2\times3}$, $p^q_{2\times2}$, $p^a_{2\times2\times2\times2}$, and $p^a_{2\times2}$ are the corresponding p-values of the GRS test. Table 4 provides a brief description of the symbols.

	SUE-1	SUE-6	Abr-1	Abr-6	RE-1	RE-6	R6-1	R6-6	R11-1	I-Mom	B/M	E/P	CF/P
$\alpha^q_{2\times2\times2}$	0.37	−0.01	0.87	0.32	0.37	0.04	0.43	0.16	0.49	0.17	0.21	0.37	0.35
$\alpha^q_{2\times3}$	0.40	0.03	0.87	0.37	0.39	0.05	0.54	0.26	0.62	0.26	0.11	0.28	0.25
$\alpha^q_{2\times2}$	0.43	0.04	0.89	0.38	0.46	0.10	0.61	0.32	0.68	0.29	0.16	0.32	0.29
$a_{2\times2\times2\times2}$	0.78	0.36	1.07	0.55	0.90	0.54	1.38	1.13	1.55	0.79	0.08	0.19	0.12
$a_{2\times2}$	0.74	0.33	1.03	0.53	0.92	0.54	1.19	0.98	1.44	0.65	−0.03	0.15	0.09
$t^q_{2\times2\times2}$	3.75	−0.16	6.14	2.53	2.07	0.22	1.21	0.47	1.31	0.68	0.93	1.88	1.57
$t^q_{2\times3}$	3.82	0.33	5.82	2.63	2.18	0.28	1.32	0.66	1.44	0.97	0.58	1.55	1.22
$t^q_{2\times2}$	4.49	0.45	6.34	2.94	2.60	0.64	1.66	0.92	1.75	1.13	0.79	1.74	1.40
$t^a_{2\times2\times2\times2}$	7.78	4.14	8.25	5.83	5.27	3.62	4.10	3.82	4.51	3.30	0.71	1.60	0.98
$t^a_{2\times2}$	7.30	3.78	8.13	5.18	5.16	3.38	3.55	3.14	4.11	2.67	−0.24	1.25	0.69
$\overline{\|\alpha^q_{2\times2\times2}\|}$	0.12	0.12	0.20	0.17	0.14	0.16	0.15	0.14	0.11	0.08	0.15	0.09	0.09
$\overline{\|\alpha^q_{2\times3}\|}$	0.11	0.09	0.19	0.16	0.13	0.13	0.15	0.12	0.12	0.12	0.12	0.06	0.05
$\overline{\|\alpha^q_{2\times2}\|}$	0.12	0.09	0.20	0.16	0.14	0.13	0.15	0.12	0.13	0.12	0.12	0.07	0.07
$\overline{\|a_{2\times2\times2\times2}\|}$	0.21	0.10	0.21	0.11	0.23	0.15	0.22	0.21	0.32	0.24	0.03	0.05	0.05
$\overline{\|a_{2\times2}\|}$	0.20	0.09	0.20	0.11	0.24	0.16	0.19	0.18	0.29	0.22	0.03	0.05	0.04
$p^q_{2\times2\times2}$	0.00	0.01	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.23	0.12	0.28	0.08
$p^q_{2\times3}$	0.00	0.06	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.18	0.32	0.44	0.20
$p^q_{2\times2}$	0.00	0.05	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.17	0.32	0.45	0.18
$p^a_{2\times2\times2\times2}$	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.72	0.67	0.70
$p^a_{2\times2}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.69	0.77

	NO/P	Dur	A/ME	Rev	ACI	I/A	NOA	△PI/A	IG	NSI	CEI	NXF	IvG
$\alpha^q_{2\times2\times2}$	0.27	−0.15	−0.03	−0.34	−0.15	−0.37	−0.70	−0.41	−0.08	−0.35	−0.37	−0.27	−0.36
$\alpha^q_{2\times3}$	0.27	−0.07	−0.12	−0.36	−0.19	−0.39	−0.76	−0.45	−0.10	−0.35	−0.38	−0.29	−0.38
$\alpha^q_{2\times2}$	0.28	−0.13	−0.10	−0.32	−0.19	−0.38	−0.75	−0.45	−0.09	−0.37	−0.42	−0.30	−0.39
$a_{2\times2\times2\times2}$	0.28	−0.07	−0.19	−0.20	−0.28	−0.43	−0.85	−0.51	−0.18	−0.37	−0.46	−0.42	−0.42
$a_{2\times2}$	0.23	−0.05	−0.30	−0.16	−0.27	−0.33	−0.80	−0.46	−0.12	−0.34	−0.43	−0.34	−0.39
$t^q_{2\times2\times2}$	1.89	−0.70	−0.13	−2.08	−1.55	−3.13	−3.52	−3.30	−0.78	−2.64	−2.75	−2.00	−2.94
$t^q_{2\times3}$	2.01	−0.39	−0.51	−2.31	−1.89	−3.53	−3.66	−3.65	−1.06	−2.90	−2.99	−2.30	−3.26
$t^q_{2\times2}$	2.13	−0.64	−0.43	−2.10	−1.95	−3.49	−3.73	−3.71	−1.00	−3.01	−3.19	−2.41	−3.29
$t^a_{2\times2\times2\times2}$	2.38	−0.54	−1.31	−1.38	−3.14	−3.86	−4.80	−4.79	−2.11	−3.42	−4.21	−3.23	−3.84
$t^a_{2\times2}$	1.92	−0.40	−2.23	−1.07	−2.99	−3.06	−5.10	−4.16	−1.34	−3.22	−3.93	−2.56	−3.42
$\overline{\|\alpha^q_{2\times2\times2}\|}$	0.13	0.12	0.15	0.11	0.13	0.17	0.19	0.19	0.14	0.16	0.14	0.16	0.13
$\overline{\|\alpha^q_{2\times3}\|}$	0.10	0.09	0.12	0.08	0.09	0.14	0.18	0.17	0.10	0.14	0.12	0.13	0.11
$\overline{\|\alpha^q_{2\times2}\|}$	0.11	0.09	0.12	0.09	0.10	0.14	0.18	0.17	0.10	0.14	0.12	0.14	0.11
$\overline{\|a_{2\times2\times2\times2}\|}$	0.07	0.04	0.06	0.05	0.07	0.09	0.15	0.12	0.05	0.10	0.08	0.10	0.09
$\overline{\|a_{2\times2}\|}$	0.06	0.04	0.08	0.04	0.07	0.08	0.15	0.12	0.04	0.10	0.07	0.09	0.08
$p^q_{2\times2\times2}$	0.01	0.08	0.11	0.05	0.08	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00
$p^q_{2\times3}$	0.02	0.14	0.17	0.08	0.08	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00
$p^q_{2\times2}$	0.01	0.19	0.22	0.10	0.10	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00
$p^a_{2\times2\times2\times2}$	0.01	0.40	0.54	0.36	0.10	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00
$p^a_{2\times2}$	0.03	0.42	0.18	0.43	0.10	0.01	0.00	0.00	0.85	0.00	0.00	0.00	0.00

	IvC	OA	POA	TA	PTA	ROE	ROA	GP/A	RS	NEI	CTO	F	TES
$\alpha^q_{2\times2\times2}$	−0.45	−0.54	−0.20	−0.50	−0.39	0.21	0.19	−0.01	0.30	0.07	−0.12	0.33	0.05
$\alpha^q_{2\times3}$	−0.50	−0.58	−0.22	−0.50	−0.39	0.15	0.16	−0.01	0.31	0.10	−0.13	0.31	0.08
$\alpha^q_{2\times2}$	−0.48	−0.57	−0.22	−0.50	−0.39	0.22	0.19	0.02	0.34	0.12	−0.11	0.37	0.08
$a_{2\times2\times2\times2}$	−0.51	−0.49	−0.27	−0.39	−0.33	0.64	0.58	0.04	0.65	0.40	−0.20	0.56	0.30
$a_{2\times2}$	−0.48	−0.50	−0.23	−0.36	−0.31	0.61	0.57	0.02	0.64	0.39	−0.17	0.54	0.33
$t^q_{2\times2\times2}$	−3.74	−4.20	−2.03	−4.65	−4.40	1.63	1.51	−0.08	2.84	1.08	−0.69	1.69	0.48
$t^q_{2\times3}$	−4.31	−4.91	−2.39	−4.73	−4.23	1.28	1.26	−0.06	2.76	1.55	−0.74	1.69	0.71
$t^q_{2\times2}$	−4.09	−4.72	−2.32	−4.80	−4.44	1.84	1.62	0.12	3.16	1.79	−0.65	1.97	0.71
$t^a_{2\times2\times2\times2}$	−4.73	−4.50	−3.24	−3.92	−3.98	4.07	3.62	0.32	5.69	4.35	−1.44	3.16	2.47
$t^a_{2\times2}$	−4.61	−4.60	−2.69	−3.53	−3.54	4.47	3.87	0.17	5.47	4.27	−1.34	3.00	2.70
$\overline{\lvert\alpha^q_{2\times2\times2}\rvert}$	0.14	0.18	0.17	0.15	0.16	0.12	0.13	0.15	0.10	0.15	0.13	0.13	0.12
$\overline{\lvert\alpha^q_{2\times3}\rvert}$	0.12	0.16	0.16	0.12	0.14	0.12	0.13	0.13	0.08	0.13	0.11	0.11	0.09
$\overline{\lvert\alpha^q_{2\times2}\rvert}$	0.12	0.16	0.16	0.12	0.14	0.11	0.12	0.12	0.09	0.14	0.11	0.12	0.10
$\overline{\lvert a_{2\times2\times2\times2}\rvert}$	0.11	0.11	0.12	0.08	0.09	0.13	0.14	0.08	0.13	0.21	0.10	0.14	0.09
$\overline{\lvert a_{2\times2}\rvert}$	0.10	0.12	0.12	0.07	0.09	0.12	0.14	0.09	0.13	0.20	0.09	0.14	0.10
$p^q_{2\times2\times2}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.03	0.44
$p^q_{2\times3}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.04	0.61
$p^q_{2\times2}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.60
$p^a_{2\times2\times2\times2}$	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.10
$p^a_{2\times2}$	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.04	0.00	0.00	0.02	0.00	0.11

	O	OC/A	Ad/M	RD/M	H/N	OL	Svol	MDR	S-Rev	Disp	Dvol
$\alpha^q_{2\times2\times2}$	−0.24	0.40	−0.15	0.78	−0.13	0.02	−0.18	−0.25	−0.62	−0.10	−0.04
$\alpha^q_{2\times3}$	−0.23	0.45	−0.19	0.75	−0.11	0.01	−0.13	−0.17	−0.62	−0.09	−0.01
$\alpha^q_{2\times2}$	−0.27	0.45	−0.19	0.77	−0.13	0.04	−0.15	−0.22	−0.58	−0.15	−0.03
$a_{2\times2\times2\times2}$	−0.34	0.42	−0.27	0.88	−0.17	0.03	−0.21	−0.39	−0.34	−0.39	0.03
$a_{2\times2}$	−0.34	0.44	−0.38	0.67	−0.10	−0.01	−0.20	−0.31	−0.40	−0.38	0.06
$t^q_{2\times2\times2}$	−1.69	3.47	−0.52	2.80	−1.06	0.09	−0.93	−1.22	−1.96	−0.68	−0.33
$t^q_{2\times3}$	−1.55	3.96	−0.66	2.68	−1.14	0.07	−0.65	−0.89	−1.83	−0.70	−0.05
$t^q_{2\times2}$	−1.88	4.06	−0.68	2.82	−1.19	0.21	−0.77	−1.13	−1.82	−1.09	−0.21
$t^a_{2\times2\times2\times2}$	−2.47	4.26	−1.28	3.55	−1.79	0.15	−1.10	−2.27	−1.11	−2.53	0.31
$t^a_{2\times2}$	−2.46	4.42	−1.80	2.75	−1.00	−0.06	−1.07	−2.07	−1.37	−2.55	0.59
$\overline{\lvert\alpha^q_{2\times2\times2}\rvert}$	0.14	0.17	0.24	0.36	0.13	0.13	0.17	0.14	0.20	0.11	0.13
$\overline{\lvert\alpha^q_{2\times3}\rvert}$	0.11	0.16	0.22	0.33	0.11	0.11	0.16	0.12	0.19	0.09	0.12
$\overline{\lvert\alpha^q_{2\times2}\rvert}$	0.11	0.15	0.21	0.33	0.11	0.10	0.17	0.13	0.19	0.10	0.12
$\overline{\lvert a_{2\times2\times2\times2}\rvert}$	0.08	0.10	0.10	0.22	0.08	0.08	0.09	0.10	0.13	0.08	0.05
$\overline{\lvert a_{2\times2}\rvert}$	0.09	0.10	0.13	0.22	0.08	0.07	0.09	0.10	0.14	0.08	0.06
$p^q_{2\times2\times2}$	0.03	0.00	0.12	0.00	0.00	0.12	0.04	0.01	0.00	0.13	0.00
$p^q_{2\times3}$	0.03	0.00	0.06	0.00	0.00	0.15	0.03	0.01	0.00	0.14	0.00
$p^q_{2\times2}$	0.04	0.00	0.22	0.00	0.00	0.20	0.03	0.01	0.00	0.07	0.00
$p^a_{2\times2\times2\times2}$	0.10	0.00	0.69	0.01	0.01	0.18	0.51	0.07	0.03	0.03	0.26
$p^a_{2\times2}$	0.04	0.00	0.34	0.06	0.01	0.20	0.31	0.03	0.03	0.04	0.15

A Estimating the Internal Rate of Return

A.1 The Gebhardt, Lee, and Swaminathan (2001, GLS) Model

At the end of June in each year t, we estimate the internal rate of returns (IRR) from:

$$P_t = B_t + \sum_{\tau=1}^{11} \frac{(E_t[\mathrm{ROE}_{t+\tau}] - \mathrm{IRR}) \times B_{t+\tau-1}}{(1+\mathrm{IRR})^{\tau}} + \frac{(E_t[\mathrm{ROE}_{t+12}] - \mathrm{IRR}) \times B_{t+11}}{\mathrm{IRR} \times (1+\mathrm{IRR})^{11}}, \qquad \text{(A1)}$$

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

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

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

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

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

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

The Modified Procedure with Regression-based Earnings Forecasts Following Hou, van Dijk, and Zhang (2012), we estimate the IRRs at the firm level (not the per share basis), whenever regression-based earnings forecasts (not analysts' earnings forecasts) are used. We use pooled cross-sectional regressions to forecast future earnings for up to three years ahead:

$$Y_{is+\tau} = a + b_1 A_{is} + b_2 D_{is} + b_3 DD_{is} + b_4 Y_{is} + b_5 Y_{is}^{-} + b_6 AC_{is} + \epsilon_{is+\tau}, \tag{A2}$$

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

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

In equation (A2), regressors with time subscript s are from the fiscal year ending between March of year s and February of $s + 1$. Following Hou, van Dijk, and Zhang (2012), we winsorize all the level variables in equation (A2) at the 1st and 99th percentiles of their cross-sectional distributions each year. In June of each year t, we estimate the regressions using the pooled panel data from the previous ten years. With a minimum four-month lag, the accounting data are from fiscal years ending between March of $t - 10$ and February of t. Differing from the baseline GLS procedure, we forecast the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t - 1$ and February of t.

The Modified Procedure with Regression-based ROE Forecasts Instead of analysts' earnings forecasts, we use annual cross-sectional regressions per Tang, Wu, and Zhang (2014) to forecast the future ROE for up to three years, $\text{ROE}_{is+\tau} \equiv Y_{is+\tau}/B_{is+\tau-1}$:

$$\text{ROE}_{is+\tau} = a + b_1 \log\left(\frac{B_{is}}{P_{is}}\right) + b_2 \log(P_{is}) + b_3 Y_{is}^{-} + b_4 \text{ROE}_{is} + b_5 \frac{A_{is} - A_{is-1}}{A_{is-1}} + \epsilon_{is+\tau}, \tag{A3}$$

for $1 \leq \tau \leq 3$, in which ROE_{is} is return on equity of firm i for fiscal year s, Y_{is} is earnings (Compustat annual item IB), B_{is} is the book equity, P_{is} is the market equity at the fiscal year end from Compustat or CRSP, Y_{is}^{-} is a dummy variable that equals one for negative earnings and zero otherwise, and A_{is} is total assets (item AT). Regression variables with time subscript s are from the fiscal year ending between March of year s and February of $s + 1$.

Extremely small firms tend to have extreme regression variables which can affect the ROE regression estimates significantly. To alleviate this problem, we exclude firm-years with total assets less than \$5 million or book equity less than \$2.5 million. FF (2006, p. 496) require firms to have at least \$25 million total assets and \$12.5 million book equity, but state that their results are robust to using the \$5 million total assets and \$2.5 million book equity cutoff. We choose the less restrictive cutoff to enlarge the sample coverage. We also winsorize each variable (except for Y_{it}^{-}) at the 1st and 99th percentiles of its cross-sectional distribution each year to further alleviate the impact of outliers.

In June of each year t, we run the regression (A3) using the previous ten years of data. With a minimum four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. Differing from the baseline GLS procedure, we directly forecast the expected ROE, $E_t[\text{ROE}_{t+\tau}]$, as the average cross-sectional regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. We implement this modified GLS procedure at the firm level.

A.2 The Claus and Thomas (2001, CT) Model

At the end of June in each year t, we estimate the internal rate of returns (IRR) from:

$$P_t = B_t + \sum_{\tau=1}^{5} \frac{(E_t[\text{ROE}_{t+\tau}] - \text{IRR}) \times B_{t+\tau-1}}{(1+\text{IRR})^{\tau}} + \frac{(E_t[\text{ROE}_{t+5}] - \text{IRR}) \times B_{t+4} \times (1+g)}{(\text{IRR}-g) \times (1+\text{IRR})^5}, \tag{A4}$$

in which P_t is the market equity in year t, $B_{t+\tau}$ is the book equity, $E_t[\text{ROE}_{t+\tau}]$ is the expected ROE for year $t+\tau$ based on information available in year t, and g is the long-term growth rate of abnormal earnings. Abnormal earnings are defined as $(E_t[\text{ROE}_{t+\tau}] - \text{IRR}) \times B_{t+\tau-1}$.

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

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

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

Regression-based Earnings Forecasts Instead of analysts' earnings forecasts, we use pooled cross-sectional regressions in equation (A2) to forecast future earnings for up to five years ahead. In June of each year t, we estimate the regression using the pooled panel data from the previous ten years. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We forecast the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t-1$ and February of t. We implement this modified CT procedure at the firm level.

Regression-based ROE Forecasts Instead of analysts' earnings forecasts, we use annual cross-sectional regressions in equation (A3) to forecast future ROE for up to five years ahead. In June of each year t, we estimate the regression using the previous ten years of data. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We directly forecast the expected ROE, $E_t[\mathrm{ROE}_{t+\tau}]$, as the average cross-sectional regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. We implement the modified CT procedure at the firm level.

A.3 The Ohlson and Juettner-Nauroth (2005, OJ) Model

At the end of June in each year t, we construct the internal rate of returns (IRR) as:

$$\mathrm{IRR} = A + \sqrt{A^2 + \frac{E_t[Y_{t+1}]}{P_t} \times (g - (\gamma - 1))}, \tag{A5}$$

in which

$$A \equiv \frac{1}{2}\left((\gamma - 1) + \frac{E_t[D_{t+1}]}{P_t}\right), \tag{A6}$$

$$g \equiv \frac{1}{2}\left(\frac{E_t[Y_{t+3}] - E_t[Y_{t+2}]}{E_t[Y_{t+2}]} + \frac{E_t[Y_{t+5}] - E_t[Y_{t+4}]}{E_t[Y_{t+4}]}\right). \tag{A7}$$

P_t is the market equity in year t, $E_t[Y_{t+\tau}]$ is the expected earnings for year $t+\tau$ based on information available in t, and $E_t[D_{t+1}]$ is the expected dividends for year $t+1$. Expected earnings are based on analyst forecasts from IBES or forecasts from regression models. Expected dividends are expected earnings times the current dividend payout ratio, which is computed as dividends (Compustat annual item DVC) divided by earnings (item IB) for profitable firms, or dividends divided by 6% of total assets (item AT) for firms with zero or negative earnings. We follow Gode and Mohanram (2003) and use the average of forecasted near-term growth rate and five-year growth rate as an estimate of g. We require $E_t[Y_{t+2}]$ and $E_t[Y_{t+4}]$ to be positive so that g is well defined. $\gamma - 1$ is the perpetual growth rate of abnormal earnings and is assume to be the ten-year Treasury bond rate minus 3%.

The Baseline OJ Procedure with Analysts' Earnings Forecasts from IBES Following Gode and Mohanram (2003), we implement the OJ model on the per share basis with analysts' earnings forecasts. We measure P_t as the June-end share price from CRSP. At the end of June in year t, the expected earnings per share for year $t+\tau$ is the consensus mean forecast from IBES (unadjusted file, item MEANEST) for year $t+\tau$ (fiscal period indicator = τ) reported in June of t. We require the availability of earnings forecast for years $t+1$ and $t+2$. When the forecast after year $t+2$ is not available, we use the long-term growth rate (item LTG) to construct it as: $\text{FEPS}_{t+\tau} = \text{FEPS}_{t+\tau-1} \times (1+\text{LTG})$. If the long-term growth rate is missing, we replace it with the growth rate implied by the forecasts for the previous two years: $\text{FEPS}_{t+\tau} = \text{FEPS}_{t+\tau-1} \times (\text{FEPS}_{t+\tau-1}/\text{FEPS}_{t+\tau-2})$, when $\text{FEPS}_{t+\tau-2}$ and $\text{FEPS}_{t+\tau-1}$ are both positive.

Regression-based Earnings Forecasts Instead of analysts' earnings forecasts, we use pooled cross-sectional regressions in equation (A2) to forecast future earnings for up to five years ahead. In June of each year t, we estimate the regression using the pooled panel data from the previous ten years. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We construct the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t-1$ and February of t. We implement the modified OJ procedure at the firm level.

Regression-based ROE Forecasts We also use annual cross-sectional regressions in equation (A3) to forecast future ROE for up to five years ahead. In June of each year t, we estimate the regression using the previous ten years of data. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We forecast the expected ROE, $E_t[\text{ROE}_{t+\tau}]$, as the average cross-sectional regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. Expected earnings are then constructed as: $E_t[Y_{t+\tau}] = E_t[ROE_{t+\tau}] \times B_{t+\tau-1}$, in which $B_{t+\tau-1}$ is the book equity in year $t+\tau-1$. We measure current book equity B_t based on the latest accounting data from the fiscal year ending in March of $t-1$ to February of t, and impute future book equity by applying clean surplus accounting recursively. We implement the modified OJ procedure at the firm level.

A.4 The MPEG Model from Easton (2004)

At the end of June in each year t, we estimate the internal rate of returns (IRR) from:

$$P_t = \frac{E_t[Y_{t+2}] + \text{IRR} \times E_t[D_{t+1}] - E_t[Y_{t+1}]}{\text{IRR}^2}, \tag{A8}$$

in which P_t is the market equity in year t, $E_t[Y_{t+\tau}]$ is the expected earnings for year $t+\tau$ based on information available in year t, and $E_t[D_{t+1}]$ is the expected dividends for year $t+1$. Expected earnings are based on analyst forecasts from IBES or forecasts from regression models. Expected dividends are expected earnings times the current dividend payout ratio, which is computed as dividends (Compustat annual item DVC) divided by earnings (item IB) for profitable firms, or dividends divided by 6% of total assets (item AT) for firms with zero or negative earnings. When equation (A9) has two positive roots (in very few cases), we use the average as the IRR estimate.

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

Regression-based Earnings Forecasts Instead of analysts' earnings forecasts, we use pooled cross-sectional regressions in equation (A2) to forecast future earnings for up to two years ahead. In June of each year t, we estimate the regression using the pooled panel data from the previous ten years. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We construct the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t-1$ and February of t. We implement the modified MPEG procedure at the firm level.

Regression-based ROE Forecasts Instead of analysts' earnings forecasts, we use annual cross-sectional regressions in equation (A3) to forecast future ROE for up to two years ahead. In June of each year t, we estimate the regression using the previous ten years of data. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We forecast the expected ROE, $E_t[\text{ROE}_{t+\tau}]$, as the average regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. Expected earnings are then constructed as: $E_t[Y_{t+\tau}] = E_t[ROE_{t+\tau}] \times B_{t+\tau-1}$, in which $B_{t+\tau-1}$ is the book equity in year $t+\tau-1$. We measure current book equity B_t based on the latest accounting data from the fiscal year ending in March of $t-1$ to February of t, and impute future book equity by applying clean surplus accounting recursively. We implement the modified MPEG procedure at the firm level.

A.5 The Gordon and Gordon (1997, GG) Model

At the end of June in each year t, we estimate the internal rate of returns (IRR) from:

$$P_t = \frac{E_t[Y_{t+1}]}{\text{IRR}}, \tag{A9}$$

in which P_t is the market equity in year t, and $E_t[Y_{t+1}]$ is the expected earnings for year $t+1$ based on information available in year t. Expected earnings are based on analysts' earnings forecasts from IBES or forecasts from regression models. Following GG (1997), we require the IRRs to be positive and drop firms with zero or negative expected earnings.

The Baseline Procedure with Analysts' Earnings Forecasts from IBES Following GG (1997), we implement the GG model on the per share basis with analysts' earnings forecasts. We measure P_t as the June-end share price from CRSP. At the end of June in year t, the expected earnings per share for year $t+1$ is the consensus mean forecast from IBES (unadjusted file, item MEANEST) for year $t+1$ (fiscal period indicator $=1$) reported in June of t.

Regression-based Earnings Forecasts Instead of analysts' earnings forecasts, we use pooled cross-sectional regressions in equation (A2) to forecast future earnings for one year ahead. In June of each year t, we estimate the regression using the pooled panel data from the previous ten years. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We construct the expected earnings as the estimated regression coefficients times the latest values of the (unwinsorized) predictors from the fiscal year ending between March of $t-1$ and February of t. We implement this modified GG procedure at the firm level.

Regression-based ROE Forecasts Instead of analysts' earnings forecasts, we use annual cross-sectional regressions in equation (A3) to forecast future ROE for one year ahead. In June of each year t, we estimate the regression using the previous ten years of data. With a four-month information lag, the accounting data are from fiscal years ending between March of $t-10$ and February of t. We calculate the expected ROE for year $t+1$ as the average cross-sectional regression coefficients times the latest values of the predictors from fiscal years ending between March of $t-1$ and February of t. Expected earnings are constructed as the current book equity times the expected ROE. We implement this modified GG procedure at the firm level.

B A Dynamic Investment Model

The model is adapted from Liu, Whited, and Zhang (2009). Time is discrete and the horizon infinite. Let $\Pi(A_{it}, X_{it})$ denote the operating profits of firm i at time t, in which A_{it} is productive assets, and X_{it} is a vector of exogenous aggregate and firm-specific shocks. $\Pi(A_{it}, X_{it})$ exhibits constant returns to scale. Assets evolve as $A_{it+1} = I_{it} + A_{it}$, in which the rate of depreciation is assumed to be zero. Firms incur adjustment costs when investing. The adjustment costs function, which is given by $\Phi(I_{it}, A_{it}) = (a/2)(I_{it}/A_{it})^2 A_{it}$ with $a > 0$, is increasing and convex in I_{it}, decreasing in A_{it}, and of constant returns to scale in I_{it} and A_{it}.

Let M_{t+1} be the stochastic discount factor from t to $t+1$ and $D_{it} = \Pi(K_{it}, X_{it}) - (a/2)(I_{it}/A_{it})^2 A_{it} - I_{it}$ be dividends. Taking M_{t+1} as given, firm i maximizes its cum-dividend market value of equity, $V_{it} \equiv \max_{\{I_{it+s}, K_{it+s+1}\}_{s=0}^{\infty}} E_t\left[\sum_{s=0}^{\infty} M_{t+s} D_{it+s}\right]$, subject to a transversality condition: $\lim_{T\to\infty} E_t\left[M_{t+T}\, B_{it+T+1}\right] = 0$, meaning that the firm cannot run a Ponzi game by borrowing forever to pay dividends. Let q_{it} be the Lagrangian multiplier associated with $A_{it+1} = I_{it} + A_{it}$. The first-order conditions with respect to I_{it} and A_{it+1} are, respectively,

$$q_{it} = 1 + a\frac{I_{it}}{A_{it}}; \tag{C1}$$

$$q_{it} = E_t\left[M_{t+1}\left[\frac{\Pi_{it+1}}{A_{it+1}} + \frac{a}{2}\left(\frac{I_{it+1}}{A_{it+1}}\right)^2 + q_{it+1}\right]\right]. \tag{C2}$$

Combining the two equations, we obtain $E_t[M_{t+1} r^I_{it+1}] = 1$, in which r^I_{it+1} is the investment return:

$$r^I_{it+1} \equiv \frac{\Pi_{it+1}/A_{it+1} + (a/2)\left(I_{it+1}/A_{it+1}\right)^2 + \left[1 + a\left(I_{it+1}/A_{it+1}\right)\right]}{1 + a\left(I_{it}/A_{it}\right)}. \tag{C3}$$

Define $P_{it} \equiv V_{it} - D_{it}$ as the ex-dividend market value of equity, and $r^S_{it+1} \equiv (P_{it+1} + D_{it+1})/P_{it}$

as the stock return. We start with $P_{it} + D_{it} = V_{it}$ and expand V_{it} as follows:

$$P_{it} + \Pi(A_{it}, X_{it}) - \frac{a}{2}\left(\frac{I_{it}}{A_{it}}\right)^2 A_{it} - I_{it} = \left[\Pi(A_{it}, X_{it}) - a\frac{I_{it}}{A_{it}} I_{it} + \frac{a}{2}\left(\frac{I_{it}}{A_{it}}\right)^2 A_{it}\right] - I_{it}$$
$$- q_{it}(A_{it+1} - A_{it} - I_{it}) + E_t\left[M_{t+1}\left(\left[\Pi(A_{it+1}, X_{it+1}) - a\frac{I_{it+1}}{A_{it+1}} I_{it+1}\right.\right.\right.$$
$$\left.\left.\left. + \frac{a}{2}\left(\frac{I_{it+1}}{A_{it+1}}\right)^2 A_{it+1}\right] - I_{it+1} - q_{it+1}(A_{it+2} - A_{it+1} - I_{it+1}) + \dots\right)\right]. \tag{C4}$$

Recursively substituting equations (C1) and (C2), and using the linear homogeneity of $\Phi(I_{it}, K_{it})$:

$$P_{it} = \left(1 + a\frac{I_{it}}{A_{it}}\right) I_{it} + q_{it} A_{it} = q_{it} A_{it+1}. \tag{C5}$$

Finally,

$$\begin{aligned} r^S_{it+1} &= \frac{P_{it+1} + \Pi(A_{it+1}, X_{it+1}) - (a/2)\left(I_{it+1}/A_{it+1}\right)^2 A_{it+1} - I_{it+1}}{P_{it}} \\ &= \frac{q_{it+1}(I_{it+1} + A_{it+1}) + \Pi(A_{it+1}, X_{it+1}) - (a/2)\left(I_{it+1}/A_{it+1}\right)^2 A_{it+1} - I_{it+1}}{q_{it} A_{it+1}} \\ &= \frac{q_{it+1} + \Pi(A_{it+1}, X_{it+1})/A_{it+1} + (a/2)\left(I_{it+1}/A_{it+1}\right)^2}{q_{it}} = r^I_{it+1}. \end{aligned} \tag{C6}$$

Taking the conditional expectation on both sides of equation (C3) yields equation (10).

C Variable Definition and Portfolio Construction

As noted, we construct two sets of testing deciles for each anomaly variable: (i) NYSE-breakpoints and value-weighted returns; and (ii) all-but-micro breakpoints and equal-weighted returns.

C.1 Momentum

This category includes ten momentum variables, including SUE-1, SUE-6, Abr-1, Abr-6, RE-1, RE-6, R6-1, R6-6, R11-1, and I-Mom.

SUE-1 and SUE-6 SUE stands for Standardized Unexpected Earnings, and is calculated as the change in quarterly earnings per share (Compustat quarterly item EPSPXQ) from its value four quarters ago divided by the standard deviation of this change in quarterly earnings over the prior eight quarters (six quarters minimum).

At the beginning of each month t, we split all NYSE, Amex, and NASDAQ stocks into deciles based on their most recent past SUE. Before 1972, we use the most recent SUE computed with quarterly earnings from fiscal quarters ending at least four months prior to the portfolio formation. Starting from 1972, we use SUE computed with quarterly earnings from the most recent quarterly earnings announcement dates (Compustat quarterly item RDQ). For a firm to enter our portfolio formation, we require the end of the fiscal quarter that corresponds to its most recent SUE 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 portfolio returns are calculated, separately, for the current month t (SUE-1) and from month t to t+5 (SUE-6). The holding period that is longer than one month as in, for instance, SUE-6, means that for a given SUE-6 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 SUE-6 decile.

R6-1, R6-6, and R11-1 At the beginning of each month t, we split all stocks into deciles based on their prior six-month returns from month $t-7$ to $t-2$. Skipping month $t-1$, we calculate monthly decile returns, separately, for month t (R6-1) and from month t to $t+5$ (R6-6). The deciles are rebalanced at the beginning of month $t+1$. The holding period that is longer than one month as in, for instance, R6-6, means that for a given R6-6 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-deciles returns as the monthly return of the R6-6 decile.

When equal-weighting the returns of price momentum portfolios with all-but-micro breakpoints and equal-weighted returns, we do not impose a separate screen to exclude stocks with prices per share below $5 as in Jegadeesh and Titman (1993). These stocks are mostly microcaps that are absent in the all-but-micro sample. Also, value-weighting returns assigns only small weights to these stocks, which do not need to be excluded with NYSE breakpoints and value-weighted returns.

To construct the R11-1 deciles as in FF (1996), we split all stocks into deciles at the beginning of each month t based on their prior 11-month returns from month $t-12$ to $t-2$. Skipping month $t-1$, we calculate monthly decile returns for month t, and the deciles are rebalanced at the beginning of month $t+1$. Because we exclude financial firms, these decile returns are different from those posted on Kenneth French's Web site.

Abr-1 and Abr-6 Following Chan, Jegadeesh, and Lakonishok (1996), we also measure earnings surprise as cumulative abnormal stock return (Abr) around the latest quarterly earnings announcement date (Compustat quarterly item RDQ):

$$\text{Abr}_i = \sum_{d=-2}^{+1} r_{id} - r_{md}, \tag{D1}$$

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

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 (Abr-1), and, separately, from month t to $t+5$ (Abr-6). The deciles are rebalanced monthly. The six-month holding period for Abr-6 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 Abr-6 decile. Because quarterly earnings announcement dates are largely unavailable before 1972, the sample for Abr-1 and Abr-6 decile returns starts in January 1972.

RE-1 and RE-6 Following Chan, Jegadeesh, and Lakonishok (1996), we also measure earnings surprise as changes in analysts' forecasts of earnings. The earnings forecast data are from the Institutional Brokers' Estimate System (IBES). Because analysts' forecasts are not necessarily revised each month, we construct a six-month moving average of past changes in analysts' forecasts:

$$\mathrm{RE}_{it} = \sum_{j=1}^{6} \frac{f_{it-j} - f_{it-j-1}}{p_{it-j-1}}, \tag{D2}$$

in which f_{it-j} is the consensus mean forecast (IBES unadjusted file, item MEANEST) issued in month $t-j$ for firm i's current fiscal year earnings (fiscal period indicator = 1), and p_{it-j-1} is the prior month's share price (unadjusted file, item PRICE). We adjust for any stock splits and require a minimum of four monthly forecast changes when constructing RE.

At the beginning of each month t, we split all stocks into deciles based on their RE. Monthly decile returns are calculated for the current month t (RE-1), and, separately, from month t to $t+5$ (RE-6). The deciles are rebalanced monthly. The six-month holding period for RE-6 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 RE-6 decile. Due to the availability of analysts' forecasts data, the sample for RE-1 and RE-6 decile returns starts in July 1976.

I-Mom We start with the FF 49-industry classifications. Excluding financial firms from the sample leaves 45 industries. At the beginning of each month t, we sort industries based on their prior six-month value-weighted returns from $t-6$ to $t-1$. Following Moskowitz and Grinblatt (1999), we do not skip month $t-1$ when measuring industry momentum. 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 industry returns within the portfolio. We calculate value-weighted (and equal-weighted) returns for the nine portfolios for six months from t to $t+5$, and rebalance the portfolios at the beginning of $t+1$. For a given I-Mom portfolio in each month there exist six sub-portfolios, each of which is initiated in a different month in the prior six-month period. We take the simple average of the six sub-portfolio returns as the monthly return of the I-Mom portfolio.

C.2 Value-versus-Growth

There are 12 anomaly variables in this category including B/M, A/ME, Rev, E/P, EF/P, CF/P, D/P, O/P, NO/P, SG, LTG, and Dur.

B/M At the end of June of each year t, we split stocks into deciles based on B/M, which is the book equity for the fiscal year ending in calendar year $t-1$ divided by the ME (from Compustat or CRSP) at the end of December of $t-1$. We calculate monthly decile returns from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$. Following Davis, Fama, and French (2000), we measure book equity as stockholders' book equity, plus balance sheet deferred taxes and investment tax credit (Compustat annual item TXDITC) if available, minus the book value of preferred stock. Stockholders' equity is the value reported by Compustat (item SEQ), if it is available. If not, we measure stockholders' equity as the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTK), or the book value of assets (item AT) minus total liabilities (item LT). Depending on availability, we use redemption (item PSTKRV), liquidating (item PSTKL), or par value (item PSTK) for the book value of preferred stock.

A/ME We follow FF (1992) and measure A/ME as the ratio of total book assets to market equity. At the end of June of each year t, we split stocks into deciles based on A/ME. Total assets (Compustat annual item AT) are from the fiscal year ending in calendar year $t-1$ and the market equity (price per share times shares outstanding from Compustat or CRSP) is at the end of December of $t-1$. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

Rev To capture the De Bondt and Thaler (1985) long-term reversal (Rev) effect, at the beginning of each month t, we split stocks into deciles based on the prior returns from month $t-60$ to $t-13$. Monthly decile returns are computed for month t, and the deciles are rebalanced at the beginning of $t+1$. To be included in a portfolio for month t, a stock must have a valid price at the end of $t-61$ and a valid return for $t-13$. In addition, any missing returns from month $t-60$ to $t-14$ must be -99.0, which is the CRSP code for a missing price.

E/P To construct the Basu (1983) earnings-to-price (E/P) deciles, we split stocks into deciles based on E/P at the end of June of each year t. E/P is calculated as income before extraordinary items (Compustat annual item IB) for the fiscal year ending in calendar year $t-1$ divided by the market equity (from Compustat or CRSP) at the end of December of $t-1$. Stocks with negative earnings 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 $t+1$.

EF/P Following Elgers, Lo, and Pfeiffer (2001), we measure analysts' earnings forecasts-to-price (EF/P) as the consensus median forecasts (IBES unadjusted file, item MEDEST) for the current fiscal year (fiscal period indicator = 1) divided by share price (unadjusted file, item PRICE). At the beginning of each month t, we sort stocks into deciles based on EF/P estimated with forecasts in month $t-1$. Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of $t+1$. Because the earnings forecast data start in January 1976, the EF/P decile returns start in February 1976.

CF/P We measure cash flows (CF) as income before extraordinary items (Compustat annual item IB), plus equity's share of depreciation (item DP), plus deferred taxes (if available, item TXDI). The equity's share is defined as market equity divided by total assets (item AT) minus book equity plus market equity. Market equity is share price times shares outstanding from Compustat or CRSP. Book equity is the stockholder's book equity, plus balance sheet deferred taxes and investment tax credit (if available, item TXDITC), minus the book value of preferred stock. Depending on availability, we use redemption (item PSTKRV), liquidating (item PSTKL), or par value (item PSTK) for the book value of preferred stock. Stockholder's equity is the value reported by Compustat (item SEQ), or the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTK), or total assets minus total liabilities (item LT).

At the end of June of each year t, we split stocks into deciles based on CF for the fiscal year ending in calendar year $t-1$ divided by the market equity (from Compustat or CRSP) at the end of December of $t-1$. We exclude firms with negative cash flows. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

D/P At the end of June of each year t, we sort stocks into deciles based on their dividend yields, which are the total dividends paid out from July of year $t-1$ to June of t divided by the market equity (from CRSP) at the end of June of t. We calculate monthly dividends as the begin-of-month market equity times the difference between cum- and ex-dividend returns. Monthly dividends are then accumulated from July of $t-1$ to June of t. We exclude firms that do not pay dividends. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

O/P and NO/P As in Boudoukh, Michaely, Richardson, and Roberts (2007), total payouts are dividends on common stock (Compustat annual item DVC) plus repurchases. Repurchases are the total expenditure on the purchase of common and preferred stocks (item PRSTKC) plus any reduction (negative change over the prior year) in the value of the net number of preferred stocks outstanding (item PSTKRV). Net payouts equal total payouts minus equity issuances, which are the sale of common and preferred stock (item SSTK) minus any increase (positive change over the prior year) in the value of the net number of preferred stocks outstanding (item PSTKRV).

At the end of June of each year t, we sort stocks into deciles based on total payouts (O/P) (or net payouts, NO/P) for the fiscal year ending in calendar year $t-1$ divided by the market equity (from Compustat or CRSP) at the end of December of $t-1$. We exclude firms with non-positive total payouts (zero net payouts). 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 total expenditure and the sale of common and preferred stocks start in 1971, the O/P (NO/P) decile returns start in July 1972.

SG Following Lakonishok, Shleifer, and Vishny (1994), we measure sales growth (SG) in June of year t as the weighted average of the annual sales growth ranks for the prior five years, $\sum_{j=1}^{5}(6-j)\times\text{Rank}(t-j)$. The sales growth for year $t-j$ is the growth rate in sales (COMPUSTAT annual item SALE) from fiscal year ending in $t-j-1$ to fiscal year ending in $t-j$. Only firms with data for all five prior years are used to determine the annual sales growth ranks. For each year from $t-5$ to $t-1$, we rank stocks into deciles based on their annual sales growth, and then assign rank i $(i=1,\ldots,10)$ to a firm if its annual sales growth falls into the i^{th} decile. At the end of June of each year t, we assign stocks into deciles based on SG, and calculate monthly decile returns from July of year t to June of $t+1$.

LTG At the beginning of each month t, we sort stocks into deciles based on analysts' consensus median forecast of the long-term earnings growth rate (IBES item MEDEST, fiscal period indictor $=0$). Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of $t+1$. Because the long-term growth forecast data start in December 1981, the LTG decile returns start in January 1982.

Dur Following Dechow, Sloan, and Soliman (2004), we calculate firm-level equity duration as:

$$\text{Dur} = \frac{\sum_{t=1}^{T} t \times \text{CD}_t/(1+r)^t}{\text{ME}} + \left(T + \frac{1+r}{r}\right) \frac{\text{ME} - \sum_{t=1}^{T} \text{CD}_t/(1+r)^t}{\text{ME}}, \tag{D3}$$

in which CD_t is the net cash distribution in year t, ME is market equity, T is the length of forecasting period, and r is the cost of equity. Market equity is price per share times shares outstanding (Compustat annual item PRCC_F times item CSHO). Net cash distribution, $\text{CD}_t = \text{BE}_{t-1}(\text{ROE}_t - g_t)$, in which BE_{t-1} is the book equity at the end of year $t-1$, ROE_t is return on equity in year t, and g_t is the book equity growth in t. Following Dechow et al., we use autoregressive processes to forecast ROE and book equity growth in future years. We model ROE as a first-order autoregressive process with an autocorrelation coefficient of 0.57 and a long-run mean of 0.12, and the growth in book equity as a first-order autoregressive process with an autocorrelation coefficient of 0.24 and a long-run mean of 0.06. For the starting year ($t = 0$), we measure ROE as income before extraordinary items (item IB) divided by one-year lagged book equity (item CEQ), and the book equity growth rate as the annual change in sales (item SALE). Nissim and Penman (2001) show that past sales growth is a better indicator of future book equity growth than past book equity growth. Finally, we use a forecasting period of $T = 10$ years and a cost of equity of $r = 0.12$.

At the end of June of each year t, we split stocks into deciles based on Dur 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 $t+1$.

C.3 Investment

There are 14 anomaly variables in this category, including ACI, I/A, NOA, △PI/A, IG, NSI, CEI, NXF, IvG, IvC, OA, TA, POA, and PTA.

ACI Following Titman, Wei, and Xie (2004), we measure ACI at the end of June of year t as $\text{CE}_{t-1}/[(\text{CE}_{t-2} + \text{CE}_{t-3} + \text{CE}_{t-4})/3] - 1$, in which CE_{t-j} is capital expenditure (Compustat annual item CAPX) scaled by sales (item SALE) for the fiscal year ending in calendar year $t - j$. The last three-year average capital expenditure is designed to project the benchmark investment at the portfolio formation year. We exclude firms with sales less than ten million dollars. At the end of June of each year t, we sort stocks into deciles based on their ACI. Monthly decile returns are computed from July of year t to June of $t+1$.

I/A Following Cooper, Gulen, and Schill (2008), we measure investment-to-assets, I/A, for the portfolio formation year t as total assets (Compustat annual item AT) for the fiscal year ending in calendar year $t-1$ divided by total assets for the fiscal year ending in $t-2$ minus one. At the end of June of each year t, we split stocks into deciles based on I/A, and calculate monthly decile returns from July of year t to June of $t+1$.

NOA and △NOA Following Hirshleifer, Hou, Teoh, and Zhang (2004), we define net operating assets (NOA) 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). At the end of June of each year t, we assign stocks into deciles based on NOA for the fiscal year ending in calendar year $t-1$ scaled by total assets for the fiscal year ending in $t-2$, and calculate monthly decile returns from July of year t to June of $t+1$. Relatedly, we define $\triangle$NOA for the portfolio formation year t as the change in NOA from the fiscal year ending in calendar year $t-2$ to the fiscal year ending in $t-1$, scaled by total assets for fiscal year ending in $t-2$. At the end of June of each year t, we split stocks into deciles based on $\triangle$NOA. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

$\triangle$PI/A Following Lyandres, Sun, and Zhang (2008), we measure $\triangle$PI/A as changes in gross property, plant, and equipment (Compustat annual item PPEGT) plus changes in inventory (item INVT) scaled by lagged total assets (item AT). At the end of June of each year t, we assign stocks into deciles based on $\triangle$PI/A for the fiscal year ending in calendar year $t-1$, and calculate monthly decile returns from July of year t to June of $t+1$.

IG Following Xing (2008), we measure investment growth, IG, for the portfolio formation year t as the growth rate in capital expenditure (Compustat annual item CAPX) from the fiscal year ending in calendar year $t-2$ to the fiscal year ending in $t-1$. At the end of June of each year t, we split stocks into deciles based on IG, and calculate monthly decile returns from July of year t to June of $t+1$.

NSI Following FF (2008), at the end of June of year t, we measure net stock issues (NSI) as the natural log of the ratio of the split-adjusted shares outstanding at the fiscal year ending in calendar year $t-1$ to the split-adjusted shares outstanding at the fiscal year ending in $t-2$. The split-adjusted shares outstanding is shares outstanding (Compustat annual item CSHO) times the adjustment factor (item AJEX). At the end of June of each year t, we assign all stocks into deciles based on NSI. We exclude firms with zero NSI. 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 Following Daniel and Titman (2006), we measure CEI as the growth rate in the market equity not attributable to the stock return, $\log\left(\mathrm{ME_t}/\mathrm{ME_{t-5}}\right)-r(t-5,t)$. For the portfolio formation at the end of June of year t, $r(t-5,t)$ is the cumulative log return on the stock 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 on the last trading day of June in year t from CRSP. Equity issuance such as seasoned equity issues, employee stock option plans, and share-based acquisitions increase the composite issuance, whereas repurchase activities such as share repurchases and cash dividends reduce the composite issuance. At the end of June of each year t, we sort stocks into deciles on CEI, and calculate monthly decile returns from July of year t to June of year $t+1$.

NXF Following Bradshaw, Richardson, and Sloan (2006), we measure net external financing (NXF) as the sum of net equity financing and net debt financing. Net equity financing is the proceeds from the sale of common and preferred stocks (Compustat annual item SSTK) less cash payments for the repurchases of common and preferred stocks (item PRSTKC) less cash payments for dividends (item DV). Net debt financing is the cash proceeds from the issuance of long-term debt (item DLTIS) less cash payments for long-term debt reductions (item DLTR) plus the net changes in current debt (item DLCCH, zero if missing). At the end of June of each year t, we sort stocks into deciles based on NXF for the fiscal year ending in calendar year $t-1$ scaled by the average of total assets for fiscal years ending in $t-2$ and $t-1$. We exclude firms with zero NXF. 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 coverage of the financing data starts in 1971, the NXF decile returns start in July 1972.

IvG Following Belo and Lin (2011), we define inventory growth (IvG) for the portfolio formation year t as the growth rate in inventory (Compustat annual item INVT) from the fiscal year ending in calendar year $t-2$ to the fiscal year ending in $t-1$. At the end of June of each year t, we split stocks into deciles based on IvG. Monthly decile returns are calculated from July of year t to June of $t+1$, and the decile returns are rebalanced in June of $t+1$.

IvC Following Thomas and Zhang (2002), we define inventory changes (IvC) for the portfolio formation year t as the change in inventory (Compustat annual item INVT) from the fiscal year ending in calendar year $t-2$ to the fiscal year ending in $t-1$, scaled by the average of total assets for fiscal years ending in $t-2$ and $t-1$. At the end of June of each year t, we split stocks into deciles based on IvC. We exclude firms with zero IvC (most of these firms carry no inventory). 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 Prior to 1988, we use the balance sheet approach of Sloan (1996) to measure operating accruals (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 $(\triangle CA - \triangle CASH) - (\triangle CL - \triangle STD - \triangle TP) -$ DP, in which $\triangle CA$ is the change in current assets (Compustat annual item ACT), $\triangle CASH$ is the change in cash or cash equivalents (item CHE), $\triangle CL$ is the change in current liabilities (item LCT), $\triangle STD$ is the change in debt included in current liabilities (item DLC, zero if missing), $\triangle TP$ is the change in income taxes payable (item TXP, zero if missing), and DP is depreciation and amortization (item DP, zero if missing). Starting from 1988, we follow Hribar and Collins (2002) to measure 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. To construct the OA deciles, at the end of June of each year t, we sort stocks into deciles based on OA for the fiscal year ending in calendar year $t-1$ scaled by total assets (item AT) for the fiscal year ending in $t-2$. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

TA Prior to 1988, we use the balance sheet approach in Richardson, Sloan, Soliman, and Tuna (2005) to measure total accruals (TA) as $\triangle WC + \triangle NCO + \triangle FIN$. $\triangle WC$ is the change 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, zero if missing). $\triangle NCO$ is the change in net non-current operating assets. Net non-current operating assets is non-current operating assets ($NCOA$) minus non-current operating liabilities ($NCOL$), with $NCOA =$ total assets (item AT) $-$ current assets (item ACT) $-$ investments and advances (item IVAO, zero if missing), and $NCOL =$ total liabilities (item LT) $-$ current liabilities (item LCT) $-$ long-term debt (item DLTT, zero if missing). $\triangle FIN$ is the change in net financial assets. Net financial assets is financial assets ($FINA$) minus financial liabilities ($FINL$), with $FINA =$ short term investments (item IVST, zero if missing) + long term investments (item

IVAO, zero if missing), and $FINL$ = long term debt (item DLTT, zero if missing) + debt in current liabilities (item DLC, zero if missing) + preferred stock (item PSTK, zero if missing).

Starting from 1988, we use the cash flow approach to measure TA as net income (Compustat annual item NI) minus total operating, investing, and financing cash flows (items OANCF, IVNCF, and FINCF) plus sales of stocks (item SSTK, zero if missing) minus stock repurchases and dividends (items PRSTKC and DV, zero if missing). Data from the statement of cash flows are only available since 1988. To construct the TA deciles, we sort stocks at the end of June of each year t into deciles based on TA for the fiscal year ending in calendar year $t-1$ scaled by total assets (Compustat annual item AT) for the fiscal year ending in $t-2$. We calculate monthly decile returns from July of year t to June of $t+1$, and rebalance the deciles in June of $t+1$.

POA Accruals are traditionally scaled by total assets. Hafzalla, Lundholm, and Van Winkle (2011) show that scaling accruals by the absolute value of earnings (percent accruals) is more effective in selecting firms for which the differences between sophisticated and naive forecasts of earnings are the most extreme. To construct the percent operating accruals (POA) deciles, at the end of June of each year t, we sort stocks into deciles based on OA scaled by the absolute value of net income (Compustat annual item NI) 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 $t+1$.

PTA We sort stocks at the end of June of each year t into deciles based on total accurals (TA) scaled by the absolute value of net income (Compustat annual item NI) for the fiscal year ending in calendar year $t-1$. We calculate decile returns from July of year t to June of $t+1$, and rebalance the deciles in June of $t+1$.

C.4 Profitability

There are 14 anomaly variables in this category, including ROE, ROA, RNA, PM, ATO, CTO, GP/A, F, TES, TI/BI, RS, NEI, FP, and O.

ROE We measure ROE as income before extraordinary items (Compustat quarterly item IBQ) divided by one-quarter-lagged book equity. 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. Depending on availability, we use stockholders' equity (item SEQQ), or common equity (item CEQQ) plus the carrying value of preferred stock (item PSTKQ), or total assets (item ATQ) minus total liabilities (item LTQ) in that order as shareholders' equity. We use redemption value (item PSTKRQ) if available, or carrying value for the book value of preferred stock.

Before 1972, the sample coverage is limited for quarterly book equity in Compustat quarterly files. We expand the coverage by using book equity from Compustat annual files as well as by imputing quarterly book equity with clean surplus accounting. Specifically, whenever available we first use quarterly book equity from Compustat quarterly files. We then supplement the coverage for fiscal quarter four with annual book equity from Compustat annual files. Following Davis, Fama, and French (2000), we measure annual book equity as stockholders' book equity, plus balance sheet deferred taxes and investment tax credit (Compustat annual item TXDITC) if available, minus the book value of preferred stock. Stockholders' equity is the value reported by Compustat (item SEQ), if available. If not, stockholders' equity is the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTK), or the book value of assets (item AT) minus total liabilities (item LT). Depending on availability, we use redemption (item PSTKRV), liquidating (item PSTKL), or par value (item PSTK) for the book value of preferred stock.

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

At the beginning of each month t, we sort all stocks into deciles based on their most recent past ROE. Before 1972, we use the most recent ROE computed with quarterly earnings from fiscal quarters ending at least four months prior to the portfolio formation. Starting from 1972, we use ROE 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 ROE 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.

ROA We measure ROA as income before extraordinary items (Compustat quarterly item IBQ) divided by one-quarter-lagged total assets (item ATQ). At the beginning of each month t, we sort all stocks into deciles based on their ROA computed with quarterly earnings from the most recent 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 ROA 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 month t, and the deciles are rebalanced at the beginning of $t+1$. Because of insufficient coverage for quarterly total assets before 1972, the sample for ROA decile returns starts in January 1972.

RNA, PM, and ATO Following Soliman (2008), we use DuPont analysis to decompose ROE as RNA + FLEV $\times$ SPREAD, in which ROE is return on equity, RNA is return on net operating assets, FLEV is financial leverage, and SPREAD is the difference between return on net operating assets and borrowing costs. We further decompose RNA = PM $\times$ ATO, in which PM is profit margin (operating income/sales) and ATO is asset turnover (sales/net operating assets).

Following Soliman (2008), we use annual sorts to form RNA, PM, and ATO deciles. At the end of June of year t, we measure RNA as operating income after depreciation (Compustat annual item OIADP) for the fiscal year ending in calendar year $t-1$ divided by net operating assets (NOA) for the fiscal year ending in $t-2$. NOA is operating assets minus operating liabilities. Operating assets are total assets (item AT) less cash and short-term investments (item CHE) less other investment and advances (item IVAO, zero if missing). Operating liabilities are total assets (item AT), less the long- and short-term portions of debt (items DLTT and DLC, zero if missing), less minority interest (item MIB, zero if missing), less book value of preferred equity (items PSTK, zero if missing), less book value of common equity (items CEQ). PM is operating income after depreciation (item OIADP) divided by sales (item SALE) for the fiscal year ending in calendar year $t-1$. ATO is sales (item SALE) for the fiscal year ending in calendar year $t-1$ divided by net operating assets (NOA) for the fiscal year ending in $t-2$. At the end of June of each year t, we sort stocks into three sets of deciles based on RNA, PM, and ATO. We exclude firms with non-positive NOA for the fiscal year ending in calendar year $t-2$ when forming the RNA and the ATO deciles. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

CTO To construct the capital turnover (CTO) deciles, at the end of June of each year t, we split stocks into deciles based on sales (Compustat annual item SALE) divided by one-year-lagged total assets (item AT) 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 $t+1$.

GP/A Following Novy-Marx (2013), we measure gross profits-to-assets (GP/A) as total revenue (Compustat annual item REVT) minus cost of goods sold (item COGS) divided by total assets (item AT, the denominator is current, not lagged, total assets). At the end of June of each year t, we sort stocks into deciles based on GP/A 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 $t+1$.

F Piotroski (2000) classifies each firm's fundamental signal as either good or bad depending on the signal's implication for future stock prices and profitability. An indicator variable for a particular signal is one if its realization is good and zero if it is bad. The aggregate signal, denoted F, is the sum of the nine binary signals. F is designed to measure the overall quality, or strength, of the firm's financial position. Nine fundamental signals are chosen to measure three areas of a firm's financial condition, profitability, liquidity, and operating efficiency.

Four variables are selected to measure profitability-related factors:

- ROA is income before extraordinary items (Compustat annual item IB) scaled by one-year-lagged total assets (item AT). If the firm's ROA is positive, the indicator variable F_{ROA} equals one and zero otherwise.

- CFO is cash flow from operation scaled by one-year-lagged total assets (Compustat annual item AT). Cash flow from operation is item OANCF, available after 1988. Prior to that, we use funds from operation (item FOPT) minus the annual change in working capital (item WCAP). If the firm's CFO is positive, the indicator variable F_{CFO} equals one and zero otherwise.

- ΔROA is the current year's ROA less the prior year's ROA. If ΔROA is positive, the indicator variable $F_{\Delta \mathrm{ROA}}$ is one and zero otherwise.
- Sloan (1996) shows that earnings driven by positive accrual adjustments is a bad signal about future earnings. As such, the indicator F_{ACC} equals one if CFO $>$ ROA and zero otherwise.

Three variables are selected to measure changes in capital structure and a firm's ability to meet future debt obligations. Piotroski (2000) assumes that an increase in leverage, a deterioration of liquidity, or the use of external financing is a bad signal about financial risk.

- ΔLEVER is the change in the ratio of total long-term debt (Compustat annual item DLTT) to average total assets over the prior two years. $F_{\Delta \mathrm{LEVER}}$ is one if the firm's leverage ratio falls, i.e., ΔLEVER < 0, in the year preceding portfolio formation, and zero otherwise.
- ΔLIQUID measures the change in a firm's current ratio between the current and prior years, in which the current ratio is the ratio of current assets (Compustat annual item ACT) to current liabilities (item LCT). An improvement in liquidity (ΔLIQUID > 0) is a good signal about the firm's ability to service current debt obligations. The indicator $F_{\Delta \mathrm{LIQUID}}$ equals one if the firm's liquidity improves and zero otherwise.
- The indicator, EQ, equals one if the firm does not issue common equity in the year prior to portfolio formation and zero otherwise. The issuance of common equity is sales of common and preferred stocks (Compustat annual item SSTK) minus any increase in preferred stock (item PSTK). Issuing equity is interpreted as a bad signal (inability to generate sufficient internal funds to service future obligations).

The remaining two signals are designed to measure changes in the efficiency of the firm's operations that reflect two key constructs underlying the decomposition of return on assets.

- ΔMARGIN is the firm's current gross margin ratio, measured as gross margin (Compustat annual item SALE minus item COGS) scaled by sales (item SALE), less the prior year's gross margin ratio. An improvement in margins signifies a potential improvement in factor costs, a reduction in inventory costs, or a rise in the price of the firm's product. The indictor $F_{\Delta \mathrm{MARGIN}}$ equals one if ΔMARGIN > 0 and zero otherwise.
- ΔTURN is the firm's current year asset turnover ratio, measured as total sales (Compustat annual item SALE) scaled by one-year-lagged total assets (item AT), minus the prior year's asset turnover ratio. An improvement in asset turnover ratio signifies greater productivity from the asset base. The indicator, $F_{\Delta \mathrm{TURN}}$, equals one of ΔTURN > 0 and zero otherwise.

Piotroski (2000) forms a composite score, F, as the sum of the individual binary signals:

$$F = F_{\mathrm{ROA}} + F_{\Delta \mathrm{ROA}} + F_{\mathrm{CFO}} + F_{\mathrm{ACC}} + F_{\Delta \mathrm{MARGIN}} + F_{\Delta \mathrm{TURN}} + F_{\Delta \mathrm{LEVER}} + F_{\Delta \mathrm{LIQUID}} + EQ. \quad \text{(D4)}$$

At the end of June of each year t, we sort stocks based on F for the fiscal year ending in calender year $t-1$ to form seven portfolios: low ($F = 0, 1, 2$), 3, 4, 5, 6, 7, and high ($F = 8, 9$). Because extreme F scores are rare, we combine scores 0, 1, and 2 into the low portfolio and scores 8 and 9 into the high portfolio. Monthly portfolio returns are calculated from July of year t to June of $t+1$, and the portfolios are rebalanced in June of $t+1$. Because the data on equity offering start in 1971, the F portfolio returns start in July 1972.

TES Following Thomas and Zhang (2011), we measure tax expense surprise (TES) as changes in tax expense, which is tax expense per share (Compustat quarterly item TXTQ/(item CSHPRQ times item AJEXQ)) in quarter q minus tax expense per share in quarter $q-4$, scaled by assets per share (item ATQ/(item CSHPRQ times item AJEXQ)) in quarter $q-4$. At the beginning of each month t, we sort stocks into deciles based on their TES calculated with Compustat quarterly data items from at least four months ago. We exclude firms with zero TES (most of these firms pay no taxes). We calculate decile returns for the subsequent three months from t to $t+2$, and the portfolios are rebalanced at the beginning of month $t+1$. The three-month holding period means that in each month for any given TES decile there exist three sub-deciles. We take the simple average of the sub-decile returns as the monthly return of the TES decile. For sufficient data coverage, we start the TES deciles in January 1976.

TI/BI Following Green, Hand, and Zhang (2013), we measure taxable income-to-book income (TI/BI) as pretax income (Compustat annual item PI) divided by net income (item NI). At the end of June of each year t, we sort stocks into deciles based on TI/BI for the fiscal year ending in calendar year $t-1$. We exclude firms with negative or zero net income. Monthly decile returns are calculated from July of year t to June of $t+1$.

RS Following Jegadeesh and Livnat (2006), we measure revenue surprise (RS) as the change in revenue per share (Compustat quarterly item SALEQ/(item CSHPRQ times item AJEXQ)) from its value four quarters ago divided by the standard deviation of this change in quarterly revenue per share over the prior eight quarters (six quarters minimum). At the beginning of each month t, we split stocks into deciles based on their most recent past RS. Before 1972, we use the most recent RS computed with quarterly revenue from fiscal quarters ending at least four months prior to the portfolio formation. Starting from 1972, we use RS computed with quarterly revenue from the most recent quarterly earnings announcement dates (Compustat quarterly item RDQ). Jegadeesh and Livnat argue that quarterly revenue data are available when earnings are announced. For a firm to enter the portfolio formation, we require the end of the fiscal quarter that corresponds to its most recent RS to be within six months prior to the portfolio formation. This restriction is imposed to exclude stale revenue information. To avoid potentially erroneous records, we also require the earnings announcement date to be after the corresponding fiscal quarter end. Monthly deciles returns are calculated for the current month t.

NEI We follow Barth, Elliott, and Finn (1999) and Green, Hand, and Zhang (2013) in measuring NEI as the number of consecutive quarters (up to eight quarters) with an increase in earnings (Compustat quarterly item IBQ) over the same quarter in the prior year.At the beginning of each month t, we sort stocks into nine portfolios (with NEI $= 0, 1, 2, \ldots, 7$, and 8, respectively) based on their most recent past NEI. Before 1972, we use NEI computed with quarterly earnings from fiscal quarters ending at least four months prior to the portfolio formation. Starting from 1972, we use NEI computed with 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 NEI 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. We calculate monthly portfolio returns for the current month t and rebalance the portfolios at the beginning of $t+1$. For sufficient data coverage, we start the NEI deciles in January 1969.

FP We construct failure probability (FP) following Campbell, Hilscher, and Szilagyi (2008, the third column in Table IV):

$$\begin{aligned} \mathrm{FP}_t \equiv & -9.164 - 20.264\, NIMTAAVG_t + 1.416\, TLMTA_t - 7.129\, EXRETAVG_t \\ & + 1.411\, SIGMA_t - \ 0.045\, RSIZE_t - 2.132\, CASHMTA_t + 0.075\, MB_t - 0.058\, PRICE_t \end{aligned} \tag{D5}$$

in which

$$NIMTAAVG_{t-1,t-12} \equiv \frac{1-\phi^3}{1-\phi^{12}} \left(NIMTA_{t-1,t-3} + \cdots + \phi^9 NIMTA_{t-10,t-12}\right) \tag{D6}$$

$$EXRETAVG_{t-1,t-12} \equiv \frac{1-\phi}{1-\phi^{12}} \left(EXRET_{t-1} + \cdots + \phi^{11} EXRET_{t-12}\right), \tag{D7}$$

and $\phi = 2^{-1/3}$. $NIMTA$ is net income (Compustat quarterly item NIQ) divided by the sum of market equity (share price times the number of shares outstanding from CRSP) and total liabilities (item LTQ). The moving average $NIMTAAVG$ captures the idea that a long history of losses is a better predictor of bankruptcy than one large quarterly loss in a single month. $EXRET \equiv \log(1 + R_{it}) - \log(1 + R_{\mathrm{S\&P500},t})$ is the monthly log excess return on each firm's equity relative to the S&P 500 index. The moving average $EXRETAVG$ captures the idea that a sustained decline in stock market value is a better predictor of bankruptcy than a sudden stock price decline in a single month.

$TLMTA$ is the ratio of total liabilities divided by the sum of market equity and total liabilities. $SIGMA$ is the annualized three-month rolling sample standard deviation: $\sqrt{\frac{252}{N-1}\sum_{k\in\{t-1,t-2,t-3\}} r_k^2}$, in which k is the index of trading days in months $t-1, t-2$, and $t-3$, r_k is the firm-level daily return, and N is the total number of trading days in the three-month period. $SIGMA$ is treated as missing if there are less than five nonzero observations over the three months in the rolling window. $RSIZE$ is the relative size of each firm measured as the log ratio of its market equity to that of the S&P 500 index. $CASHMTA$, used to capture the liquidity position of the firm, is the ratio of cash and short-term investments (Compustat quarterly item CHEQ) divided by the sum of market equity and total liabilities (item LTQ).

MB is the market-to-book equity, in which book equity is measured in the same way as the denominator of ROE. Following Campbell et al., we add 10% of the difference between the market equity and the book equity to the book equity to alleviate measurement issues for extremely small book equity values. For firm-month observations that still have negative book equity after this adjustment, we replace these negative values with $1 to ensure that the market-to-book ratios for these firms are in the right tail of the distribution. $PRICE$ is each firm's log price per share, truncated above at $15. We further eliminate stocks with prices less than $1 at the portfolio formation date. We winsorize the variables on the right-hand side of equation (D5) at the 5th and 95th percentiles of their pooled distributions each month.

To construct the FP deciles, at the beginning of each month t, we split stocks into deciles based on FP calculated with accounting data from the fiscal quarter ending at least four months ago. Because unlike earnings, other quarterly data items in the definition of FP might not be available upon earnings announcement, we impose a four-month gap between the fiscal quarter end and portfolio formation to guard against look-ahead bias. We calculate decile returns for the subsequent six months after the portfolio formation from month t to $t+5$ and rebalance the deciles at the beginning of $t+1$. Because of the six-month holding period, there exist six sub-deciles for a given FP decile in each month. We take the simple average of the sub-decile returns as the monthly return of the FP decile. Due to limited data coverage, we start the FP deciles in February 1976.

O We follow Ohlson (1980, Model One in Table 4) and Dichev (1998) to construct O-score:

$$\begin{aligned} &-1.32 - 0.407\log(TA) + 6.03\,TLTA - 1.43\,WCTA + 0.076\,CLCA \\ &\quad - 1.72\,OENEG - 2.37\,NITA - 1.83\,FUTL + 0.285\,INTWO - 0.521\,CHIN \end{aligned}$$

in which TA is total assets (Compustat annual item AT). $TLTA$ is the leverage ratio defined as the book value of debt (item DLC plus item DLTT) divided by total assets. $WCTA$ is working capital divided by total assets, (item ACT minus item LCT)/item AT. $CLCA$ is current liability (item LCT) divided by current assets (item ACT). $OENEG$ is one if total liabilities (item LT) exceeds total assets (item AT) and is zero otherwise. $NITA$ is net income (item NI) divided by total assets. $FUTL$ is the fund provided by operations (item PI) divided by liability (item LT). $INTWO$ is equal to one if net income (item NI) is negative for the last two years and zero otherwise. $CHIN$ is $(NI_t - NI_{t-1})/(|NI_t| + |NI_{t-1}|)$, in which NI_t is net income (item NI).

At the end of June of each year t, we split stocks into deciles based on O-score 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 $t+1$.

C.5 Intangibles

There are ten anomaly variables in this category, including OC/A, BC/A, Ad/M, RD/S, RD/M, RC/A, H/N, OL, G, and AccQ.

OC/A Following Eisfeldt and Papanikolaou (2013), we construct a measure of organization capital using Selling, General, and Administrative (SG&A) expenses (Compustat annual item XSGA). The stock of organization capital, OC, is constructed with the perpetual inventory method:

$$\mathrm{OC}_{it} = (1-\delta)\mathrm{OC}_{it-1} + \mathrm{SG\&A}_{it}/CPI_t, \tag{D8}$$

in which CPI_t is the consumer price index during year t and δ is the annual depreciation rate of OC. The initial stock of OC is $\mathrm{OC}_{i0} = \mathrm{SG\&A}_{i0}/(g+\delta)$, in which $\mathrm{SG\&A}_{i0}$ is the first valid SG&A observation (zero or positive) for firm i and g is the long-term growth rate of SG&A. Following Eisfeldt and Papanikolaou, we assume a depreciation rate of 15% for OC and a long-term growth rate of 10% for SG&A. Missing SG&A values after the starting date are treated as zero. For portfolio formation at the end of June of year t, we require SG&A to be nonmissing for the fiscal year ending in calendar year $t-1$ because this SG&A value receives the highest weight in OC. In addition, we exclude firms with zero OC. We form organization capital-to-assets (OC/A) by scaling OC with total assets (item AT) from the same fiscal year.

Following Eisfeldt and Papanikolaou (2013), we industry-standardize OC/A using the FF (1997) 17-industry classification. We demean a firm's OC/A by its industry mean and then divide the demeaned OC/A by the standard deviation of OC/A within its industry. When computing industry mean and standard deviation, we winsorize OC/A at the 1 and 99 percentiles of all firms each year. At the end of June of each year t, we sort stocks into deciles based on OC/A 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 $t+1$.

BC/A Following Belo, Lin, and Vitorino (2014), we construct brand capital (BC) by accumulating advertising expenses (Compustat annual item XAD) via the perpetual inventory method:

$$\mathrm{BC}_{it} = (1-\delta)\mathrm{BC}_{it-1} + \mathrm{XAD}_{it}. \tag{D9}$$

in which δ is the annual depreciation rate of BC. The initial stock of BC is $\mathrm{BC}_{i0} = \mathrm{XAD}_{i0}/(g+\delta)$, in which XAD_{i0} is first valid XAD (zero or positive) for firm i and g is the long-term growth rate of XAD. Following Belo et al., we assume a depreciation rate of 50% for BC and a long-term growth rate of 10% for XAD. Missing values of XAD after the starting date are treated as zero. For the portfolio formation at the end of June of year t, we exclude firms with zero BC and require XAD to be nonmissing for the fiscal year ending in calendar year $t-1$. We form brand capital-to-assets (BC/A) by scaling BC with total assets (item AT) from the same fiscal year.

At the end of June of each year t, we sort stocks into deciles based on BC/A 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 sufficient XAD data start in 1972, the BC/A decile returns start in July 1973.

Ad/M At the end of June of each year t, we sort stocks into deciles based on advertising expenses-to-market (Ad/M), which is advertising expenses (Compustat annual item XAD) for the fiscal year ending in calendar year $t-1$ divided by the market equity (from Compustat or CRSP) at the end of December of $t-1$. We keep only firms with positive advertising expenses. Monthly decile returns are calculated from July of year t to June of $t+1$. Because sufficient XAD data start in 1972, the BC/A decile returns start in July 1973.

RD/S At the end of June of each year t, we sort stocks into deciles based on R&D-to-sales (RD/S), which is R&D expenses (Compustat annual item XRD) divided by sales (item SALE) for the fiscal year ending in calendar year $t-1$. We keep only firms with positive R&D expenses. Monthly decile returns are calculated from July of year t to June of $t+1$. Because the accounting treatment of R&D expenses was standardized in 1975 (by Financial Accounting Standards Board Statement No. 2), the RD/S decile returns start in July 1976.

RD/M At the end of June of each year t, we split stocks into deciles based on R&D-to-market (RD/M), which is R&D expenses (Compustat annual item XRD) for the fiscal year ending in calendar year $t-1$ divided by the market equity (from Compustat or CRSP) at the end of December of $t-1$. We keep only firms with positive R&D expenses. 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 accounting treatment of R&D expenses was standardized in 1975, the RD/M decile returns start in July 1976.

RC/A Following Li (2011), we measure R&D capital (RC) as a weighted average of annual R&D expenses (Compustat annual item XRD) over the last five years with a depreciation rate of 20%:

$$\mathrm{RC}_{it} = \mathrm{XRD}_{it} + 0.8\,\mathrm{XRD}_{it-1} + 0.6\,\mathrm{XRD}_{it-2} + 0.4\,\mathrm{XRD}_{it-3} + 0.2\,\mathrm{XRD}_{it-4}. \tag{D10}$$

We scale RC with total assets (item AT) to form R&D capital-to-assets (RC/A). At the end of June of each year t, we split stocks into deciles based on RC/A for the fiscal year ending in calendar year $t-1$. We keep only firms with positive RC. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$. For portfolio formation at the end of June of year t, we require R&D expenses to be nonmissing for the fiscal year ending in calendar year $t-1$, because this value of R&D expenses receives the highest weight in RC. Finally, because RC requires past five years of R&D expenses data and the accounting treatment of R&D expenses was standardized in 1975, the RC/A decile returns start in July 1980.

H/N Following Belo, Lin, and Bazdresch (2014), at the end of June of year t, we measure the firm-level hiring rate (H/N) as $(N_{t-1} - N_{t-2})/(0.5N_{t-1} + 0.5N_{t-2})$, in which N_{t-j} is the number of employees (Compustat annual item EMP) from the fiscal year ending in calendar year $t-j$. At the end of June of year t, we sort stocks into deciles based on H/N. We exclude firms with zero H/N (these observations are often due to stale information on firm employment). Monthly decile returns are calculated from July of year t to June of $t+1$.

OL Operating leverage (OL) is operating costs scaled by total assets (Compustat annual item AT, the denominator is current, not lagged, assets per Novy-Marx (2011)). Operating costs are the cost of goods sold (item COGS) plus selling, general, and administrative expenses (item XSGA). At the end of June of year t, we sort stocks into deciles based on OL for the fiscal year ending in calendar year $t-1$, and calculate monthly decile returns from July of year t to June of $t+1$.

G The data for Gompers, Ishii, and Metrick's (2003) firm-level corporate governance index (G, from September 1990 to December 2006) are from Andrew Metrick's Web site. To form the G portfolios, we use the following breakpoints: $G \leq 5, 6, 7, 8, 9, 10, 11, 12, 13$, and ≥ 14 (see Table VI, Gompers et al.). We rebalance the portfolios in the months immediately following each publication of the G-index, and calculate monthly portfolio returns between two adjacent publication dates. The first months following the publication dates are September 1990, July 1993, July 1995, February 1998, November 1999, January 2002, January 2004, and January 2006.

AccQ Following Francis, Lafond, Olsson, and Schipper (2005), we estimate accrual quality (AccQ) with the following cross-sectional regression (all variables are scaled by lagged total assets):

$$TCA_{it} = \phi_{0,i} + \phi_{1,i}CFO_{it-1} + \phi_{2,i}CFO_{it} + \phi_{3,i}CFO_{it+1} + \phi_{4,i}\triangle REV_{it} + \phi_{5,i}PPE_{it} + v_{it}, \quad \text{(D11)}$$

in which TCA_{it} is firm i's total current accruals in year t, CFO_{it} is cash flow from operations in t, $\triangle REV_{it}$ is change in revenues (Compustat annual item SALE) between $t-1$ and t, and PPE_{it} is gross property, plant, and equipment (item PPEGT) in t. $TCA_{it} = \triangle CA_{it} - \triangle CL_{it} - \triangle CASH_{it} + \triangle STDEBT_{it}$, in which $\triangle CA_{it}$ is firm i's change in current assets (item ACT) between year $t-1$ and t, $\triangle CL_{it}$ is change in current liabilities (item LCT), $\triangle CASH_{it}$ is change in cash (item CHE), and $\triangle STDEBT_{it}$ is change in debt in current liabilities (item DLC, zero if missing). $CFO_{it} = NIBE_{it} - TA_{it}$, in which $NIBE_{it}$ is income before extraordinary items (item IB). $TA_{it} = \triangle CA_{it} - \triangle CL_{it} - \triangle CASH_{it} + \triangle STDEBT_{it} - DEPN_{it}$, in which $DEPN_{it}$ is depreciation and amortization expense (item DP, zero if missing).

Following Francis, Lafond, Olsson, and Schipper (2005), we estimate annual cross-sectional regressions in equation (D11) for each of FF (1997) 48 industries (excluding four financial industries) with at least 20 firms in year t. We winsorize the regressors at the 1 and 99 percentiles of all firms each year. The annual cross-sectional regressions yield firm- and year-specific residuals, v_{it}. We measure accrual quality, $\text{AccQ}_{it} = \sigma(v_i)_t$ as the standard deviation of firm i's residuals, v_{it}, calculated over years $t-4$ through t.

At the end of June of each year t, we sort stocks into deciles based on AccQ for the fiscal year ending in calendar year $t-2$. To avoid look-ahead bias, we do not sort on AccQ for the fiscal year ending in $t-1$, because the regression in equation (D11) requires the next year's CFO. Monthly decile returns are calculated from July of year t to June of $t+1$, and the deciles are rebalanced in June of $t+1$.

C.6 Trading Frictions

There are 13 anomaly variables in this category, including ME, Ivol, Tvol, Svol, MDR, β, D-β, S-Rev, Disp, Turn, 1/P, Dvol, and Illiq.

ME Market equity (ME) is price times shares outstanding from CRSP. At the end of June of each year t, we sort stocks into deciles based on the June-end ME, and calculate monthly decile returns from July of year t to June of $t+1$.

Ivol Following Ang, Hodrick, Xing, and Zhang (2006), we measure a stock's idiosyncratic volatility (Ivol) as the standard deviation of the residuals from regressing the stock's returns in excess of one-month Treasury bill rates on the FF (1993) three factors. At the beginning of each month t, we sort stocks into deciles based on the Ivol estimated with daily returns 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 $t+1$.

Tvol Following Ang, Hodrick, Xing, and Zhang (2006), we measure a stock's total volatility (Tvol) as the standard deviation of its daily returns. At the beginning of each month t, we sort stocks into deciles based on the Tvol estimated with the daily returns 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 $t+1$.

Svol Following Ang, Hodrick, Xing, and Zhang (2006), we measure systematic volatility (Svol) as $\beta^i_{\triangle \text{VXO}}$ from the bivariate regression:

$$r^i_d = \beta^i_0 + \beta^i_{MKT} MKT_d + \beta^i_{\triangle \text{VXO}} \triangle \text{VXO}_d + \epsilon^i_d, \tag{D12}$$

in which r^i_d is stock i's excess return on day d, MKT_d is the market factor return, and $\triangle\text{VXO}_d$ is the aggregate volatility shock measured as the daily change in the Chicago Board Options Exchange S&P 100 volatility index (VXO). At the beginning of each month t, we sort stocks into deciles based on $\beta^i_{\triangle \text{VXO}}$ estimated with the daily returns 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 $t+1$. Because the VXO data start in January 1986, the Svol decile returns start in February 1986.

MDR Following Bali, Cakici, and Whitelaw (2011), at the beginning of each month t, we sort stocks into deciles based on the maximal daily return (MDR) in 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 $t+1$.

β Following Frazzini and Pedersen (2013), we estimate β for firm i as:

$$\hat{\beta}_i = \hat{\rho}\frac{\hat{\sigma}_i}{\hat{\sigma}_m}, \tag{D13}$$

in which $\hat{\sigma}_i$ and $\hat{\sigma}_m$ are the estimated volatilities for stock i and the market, and $\hat{\rho}$ is their correlation. To estimate the volatilities, we compute the standard deviation of daily log returns over a one-year rolling window (with at least 120 daily returns). To estimate correlations, we use overlapping three-day log returns, $r_{it}^{3d} = \sum_{k=0}^{2} \log(1 + r_{t+k}^{i})$, over a five-year rolling window (with at least 750 daily returns). At the beginning of each month t, we sort stocks into deciles based on $\hat{\beta}_i$ estimated at the end of month $t-1$. Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of month $t+1$.

D-β Following Dimson (1979), we use the lead and the lag of the market return, along with the current market return, when estimating beta (D-β):

$$r_{id} - r_{fd} = \alpha_i + \beta_{i1}(r_{md-1} - r_{fd-1}) + \beta_{i2}(r_{md} - r_{fd}) + \beta_{i3}(r_{md+1} - r_{fd+1}) + \epsilon_{id}, \tag{D14}$$

in which r_{id} is the return on stock i on day d, r_{md} is the market return, and r_{fd} is the risk-free rate. We estimate the Dimson market regression for each stock using daily returns from the prior month. We require a minimum of 15 daily returns. The market beta of stock i is calculated as D-$\beta_i \equiv \hat{\beta}_{i1} + \hat{\beta}_{i2} + \hat{\beta}_{i3}$. At the beginning of each month t, we sort stocks into deciles based on D-β_i estimated with the daily returns from month $t-1$, and calculate monthly decile returns for month t. The deciles are rebalanced at the beginning of month $t+1$.

S-Rev To construct the Jegadeesh (1990) short-term reversal (S-Rev) deciles, at the beginning of each month t, we sort stocks into deciles based on the return in month $t-1$. To be included in a decile in month t, a stock must have a valid price at the end of month $t-2$ and a valid return for month $t-1$. Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of month $t+1$.

Disp Following Diether, Malloy, and Scherbina (2002), we measure analyst earnings forecasts dispersion (Disp) as the ratio of the standard deviation of earnings forecast (IBES unadjusted file, item STDEV) to the absolute value of the consensus mean forecast (unadjusted file, item MEANEST). We use the earnings forecast for the current fiscal year (fiscal period indicator = 1). Stocks with a mean forecast of zero are assigned to the highest dispersion group. In addition, we exclude stocks with a price less than \$5. At the beginning of each month t, we sort stocks into deciles based on Disp in month $t-1$. Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of month $t+1$. Because the forecast data start in January 1976, the Disp decile returns start in February 1976.

Turn Following Datar, Naik, and Radcliffe (1998), at the beginning of month t, we calculate a stock's share turnover (Turn) as its average daily share turnover over the prior six months from $t-6$ to $t-1$. We require a minimum of 50 daily observations. Daily turnover is the number of shares traded on a given day divided by the number of shares outstanding on that day.[14] At the beginning

[14]Following Gao and Ritter (2010), we adjust the trading volume for NASDAQ stocks to account for the institutional features of the way that NASDAQ and NYSE-Amex volume are reported. Prior to February 1, 2001,

of month t, we sort stocks into deciles based on Turn and calculate decile returns for month t.

1/P At the beginning of each month t, we sort stocks into deciles based on the reciprocal of the share price (1/P) at the end of month $t-1$. We calculate decile returns for the current month t and rebalance the deciles at the beginning of month $t+1$.

Dvol At the beginning of each month t, we sort stocks into deciles based on their average daily dollar trading volume (Dvol) over the prior six months from $t-6$ to $t-1$. We require a minimum of 50 daily observations. Dollar trading volume is share price times the number of shares traded. We adjust the trading volume of NASDAQ stocks per Gao and Ritter (2010). Monthly decile returns are calculated for the current month t, and the deciles are rebalanced at the beginning of month $t+1$.

Illiq We calculate the Amihud (2002) illiquidity measure (Illiq) as the ratio of absolute daily stock return to daily dollar trading volume, averaged over the prior six months. We require a minimum of 50 daily observations. Dollar trading volume is share price times the number of shares traded. We adjust the trading volume of NASDAQ stocks per Gao and Ritter (2010). At the beginning of each month t, we sort stocks into deciles based on Illiq over the prior six months from $t-6$ to $t-1$. We calculate decile returns for month t and rebalance the deciles at the beginning of month $t+1$.

we divide NASDAQ volume by 2.0. This adjustment accounts for the practice of counting as trades both trades with market makers and trades among market makers. On February 1, 2001, according to the director of research of NASDAQ and Frank Hathaway (the chief economist of NASDAQ), a "riskless principal" rule goes into effect and results in a reduction of approximately 10% in reported volume. As such, from February 1, 2001 to December 31, 2001, we divide NASDAQ volume by 1.8. During 2002, securities firms began to charge institutional investors commissions on NASDAQ trades, rather than the prior practice of marking up or down the net price. This practice results in a further reduction in reported volume of approximately 10%. As such, for 2002 and 2003, we divide NASDAQ volume by 1.6. For 2004 and later years, in which the volume of NASDAQ (and NYSE) stocks has mostly been occurring on crossing networks and other venues, we use a divisor of 1.0. This practice reflects the fact that there are no longer important differences in the NASDAQ and NYSE volume.