Demand Risk in Supply Factors?

Richard Ogden*
The Ohio State University

December 2020†

Abstract

This paper provides comprehensive tests for the presence of demand-side risks in investment and profitability premiums. Consumption risk, intermediary risk, macroeconomic risk, and investor sentiment are all considered as potential demand-side drivers of return. Factors based on the consumption and macroeconomic risk models have only a limited ability to price portfolios sorted on size and investment and are unable to price portfolios based on size and profitability. Of the two intermediary models, only the broker-dealer leverage factor succeeds in pricing both premiums, but this performance disappears with an updated version of the underlying data for broker-dealer leverage. Sentiment is unable to price either set of portfolios. All in all, the demand models considered are unlikely to explain empirically the supply-based premiums.

*Fisher College of Business, The Ohio State University, 760 Fisher Hall, 2100 Neil Avenue, Columbus OH 43210. E-mail: ogden.116@fisher.osu.edu.

†I have benefited from the useful comments of Kewei Hou, René Stulz, Lu Zhang and the seminar participants in Busfin 8290. All remaining errors are my own.

1 Introduction

An emerging literature has documented the relations of a firm's investment and profitability with its expected return. Linear factor models based on these relations have proven successful in explaining the cross section of stock returns.[1] This paper examines several possible demand-side drivers of the return premium earned by these supply-side factors.

In the q-theory of investment, the optimal behavior of the supplier of a risky equity security fully characterizes the relation of investment and profitability with its expected return. However, this framework is silent about what might be driving the discount factor from the demand-side. To fill this gap, this paper conducts a comprehensive empirical investigation on the possible demand-side sources of supply-side factor premiums. These possible sources include macroeconomic risk, consumption risk, intermediary risk, and behavioral explanations.

To test these models as drivers of returns in the supply-based factors, this paper looks at how well linear factor representations of each of the prominent models price portfolios sorted on size and either investment or profitability. The consumption models include the fourth-quarter-to-fourth-quarter (Q4-Q4) growth factor of Jaganathan and Wang (2007), the three-year "ultimate consumption" risk factor of Parker and Julliard (2005), and the "without garbage" consumption factor of Kroencke (2017)[2]. The intermediary models focus on the intermediary capital ratio factor of He, Kelly, and Manela (2017) and the broker-dealer leverage factor of Adrian, Etula, and Muir (2014). The Chen, Roll, and Ross (1986) model represents macroeconomic risks. The behavioral model is represented by sentiment as defined in Baker and Wurgler (2006).

The success of a factor is measured by its ability to generate an insignificant intercept and a significant price of risk when pricing the portfolios in a two-stage Fama Macbeth (1973) framework. Based on this criterion, the three-year ultimate risk factor, The Q4-Q4 factor, broker-dealer leverage factor, and Chen, Roll and Ross (CRR) macro risk model are all able to price portfolios sorted on

[1] See for example Hou, Xue, and Zhang (2015) and Fama and French (2015).
[2] Data for Asset Pricing with Garbage (2011) were unavailable.

size and investment. Put differently, the return pattern of the investment portfolio with the highest average return exhibits a greater sensitivity to the three-year growth rate in consumption, the Q4-Q4 consumption growth rate, the change in the leverage of broker-dealers, and innovations in the 5 CCR macroeconomic measures than the investment portfolio with the lowest average return.

For portfolios sorted on size and profitability, the three-year factor, CRR model, and broker-dealer leverage model all produce a significant price of risk, but only the leverage factor yields an insignificant intercept. The remaining models based on the filtered "no garbage" factor, the intermediary capital factor, and the sentiment model are unsuccessful in pricing either set of portfolios.

Finally, the most successful result based on broker-dealer leverage is hampered by an update to the underlying data used in generating the factor. Aggregated broker-dealer leverage is taken from the Flow of Funds accounts (Z.1). In 2014, the data for security repurchase agreements (repos) associated with broker-dealers was updated in two important ways. First, repos went from being reported as a net position in the liabilities column (repo liabilities -repo assets) to each component being separated. This level shift in both assets and liabilities changes the value of the leverage calculation used to construct the factor. Second, improvements were made in identifying which source data to include as repos for both banks and broker-dealers. The resulting series is intended to better reflect the actual positions held by these sectors. These changes to the underlying data result in a new factor which is unable to price either size-investment or size-profitability sorted portfolios.

This evidence suggests that the tested models are unlikely to be good candidates for completely explaining the supply-based premiums. Alternatively, either linear factor representations or the portfolios might be a noisy characterization of the underlying theories. A more rigorous application of theory linking the two sides might prove a lucrative extension.

This paper is related to Cooper and Priestly (2011), who test for the presence of macroeconomic risks in portfolios sorted based on measures of investment. This paper contributes by empirically testing several prominent models as potential drivers of the investment and profitability premiums.

The rest of the paper proceeds as follows. Section 2 outlines the data and sources of both the test portfolios and factors. Section 3 describes the methodology. Section 4 walks through the results for each of the factor models. Section 5 reports robustness tests. Section 6 concludes.

2 Data

2.1 Testing Portfolios

To construct testing portfolios, I use all firms from the Center for Research in Security Prices (CRSP) monthly stock file that are listed on the NYSE, Amex, or Nasdaq. These are filtered for those that have ordinary common equity (security type 10 or 11), and financial firms are removed (SIC codes 6000 – 6999).

Testing portfolios for investment and profitability are constructed based on the measures from Hou, Xue, and Zhang (2015). Investment is the growth in year-to-year firm assets. Data on assets are taken from Compustat and matched back to monthly returns following the methodology of Fama and French (1992). That is, return data from July of year t to June of year t+1 is matched to accounting information from the fiscal year ending in calendar year t–1.

Profitability is a firm's quarterly return on equity (ROE) measured by income before extraordinary items (Compustat quarterly item IBQ) divided by 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. Shareholders' equity is measured one of three potential ways depending on data availability. In order of priority, I use either stockholders' equity (item SEQQ), common equity (item CEQQ) plus the carrying value of preferred stock (item PSTKQ), or total assets (item ATQ) minus total liabilities (item LTQ). The quarterly earnings data from Compustat is merged to CRSP monthly returns in months subsequent to the most recent public earnings announcement (item RDQ). The announcement must also be within six months of the return month.

Finally, sorts based on both investment and profitability include an independent sort based on size. Size is measured as the market value of a firm in June of year t, and is matched to monthly returns from July t to June t+1. These characteristics are used to organize firms into three sets of portfolios. These are 25 portfolios sorted on size and investment, 25 sorted on size and profitability, and 125 sorted on size, investment, and profitability. All sorts are based on independent quintile sorts of the characteristics using NYSE breakpoints. Returns are calculated using value weights based on the firm's size in the previous month.

Size-value, size-momentum, and size-value-momentum are also calculated to provide a comparison to size-investment, size-profitability and size-investment-profitability sorted portfolios, respectively. Comparisons of factors in Hou, Xue, and Zhang (2015) indicate a strong correlation between investment and value as well as profitability and momentum. Value is calculated as book-to-market as outlined in Fama and French (1993). Momentum is calculated using (2-12) prior returns.

Average monthly portfolio returns for each of the 25 size-investment and 25 size-profitability portfolios can be found in Table 1. Portfolios based on investment and value begin in January 1967 and run through June of 2019. Portfolios based on profitability and momentum begin in January 1972 and end in June 2019. These monthly portfolios form the basis for the annual and quarterly versions that will be used to test the consumption and intermediary models.

2.2 Factor Models

The factor models of interest are taken from several papers, and many of the factors are provided on the author's web page. Those factors that are taken from the authors have slight variations in the end date of the portfolio tests. A list of factors, their authors, and end dates can be found in Table 2.

The Q4-Q4 consumption growth rate of Jagannathan and Wang (2007) is constructed from the rate of growth in per-capita real consumption using raw data from the National Income and Product Accounts (NIPA). Consumption is measured as the nominal level of nondurable consumption (Table 2.3.5-q, line 8) deflated by its price deflator (Table 2.3.5-q, line 13) plus the nominal level of service consumption (Table 2.3.5-q, line 13) deflated by its price deflator (Table 2.3.4-q, line 13) all divided by population (Table 2.1-q, line 40). The final factor is then calculated from the percent change in the described measure between subsequent fourth quarters. The factor is then merged contemporaneously with the annual version of the portfolio returns described above.

The three-year growth rate of consumption of Julliard and Parker (2005) uses deflated nondurables to measure consumption. For comparability, this paper implements an annual version of this factor that includes both nondurables and services. That is, the annual return over the calendar year is merged with the growth rate in deflated nondurables beginning in the contemporaneous year and extending to cover three full calendar years.

The without garbage measure of Kroencke (2017) uses an "unfiltering" process to remove filters put in place by the Bureau of Economic Analysis when reporting consumption series. The paper has several versions of this unfiltered series. The version used here includes growth in both nondurables and services from Q4-Q4.

The two intermediary models tested are both attempts to capture the intermediary sector's marginal value of wealth. The first from He, Kelly, and Manela (HKM) (2017) measures innovations in the aggregate intermediary capital ratio. Financial data are taken from parent companies of Federal Reserve primary dealers to create the aggregate measure. The capital ratio is defined as total market equity divided by the sum of market equity and book debt.

The second factor from Adrian, Etula, and Muir (AEM) (2014) measures innovations in the leverage ratio of broker-dealers. This series is constructed from data published in the Financial Accounts of the United States (Z.1), which provides sector level data for the entire US economy. In 2014, the data for security repurchase agreements (repos) associated with broker-dealers was updated in two important ways. First, repos went from being reported as a net position in the liabilities column (repo liabilities -repo assets) to each of the two components being separated. This level shift in both assets and liabilities changes the value of the leverage calculation used to construct the factor. Second, improvements were made in identifying which source data to include as repos for both banks and broker-dealers. An outline of the changes is provided by Holmquist and Gallin (2014). The resulting repo series better reflect the actual positions held by these sectors.

The seminal model of Chen, Roll, and Ross (1986) uses five important macroeconomic measures theorized to have a material impact on equity prices as pricing factors. The factors are defined as follows. Monthly industrial production (MP) is the change in the log of the Industrial Production: Total Index (indpro). The measure is lagged for comparison to returns. UPR captures changes in the default premium and is calculated as the yield spread between Moody's Baa and Aaa bond yields. UTS captures the term spread and is measured as the yield spread between the 10 year and 1 year treasury. To capture the impact of inflation the models uses two measures. Unexpected inflation (UI) is the difference between realized inflation and expected inflation, $UI_t = I_t – E[I_t|t-1]$. The change in expected inflation is measured as $E[I_{t+1}|t] - E[I_t|t-1]$, where $E[I_t|t-1] = r_{ft} – E[RHO_t|t-1]$ or the difference between the 1 month treasury rate and the ex-ante real rate.

The ex-ante real rate, $E[RHO_t|t-1]$, is measured using the methodology of Fama and Gibbons (1984). In their paper, the change in the real rate is modeled as a moving average, $RHO_t – RHO_{t-1} = u_t + \theta u_{t-1}$. The model estimates are then used to calculated the ex-ante real rate, $E[RHO_t|t-1] = (r_{ft-1}) - \hat{u_t} - \hat{\theta} \hat{u_{t-1}}$. Realized inflation is measured using the seasonally adjusted consumer price index. All series can be found on the Federal Reserve Economic Data (FRED) webpage.

The sentiment index of Baker and Wurgler (2006) is a composite of several sentiment proxies combined using principal component analysis. The elements include the value weighted dividend premium from Baker and Wurgler (2004), the first-day returns on IPOs and IPO volume from Ibbotson, Sindelar, and Ritter (1994), the closed end fund discount of Neal and Wheatley (1998), and the equity share in new issues from Baker and Wurlger (2000).

The principal component is calculated for each index element as well as their lags. These 12 loadings are used to calculate a first stage index. Finally, the index is calculated as the first principal component of the correlation matrix of the proxies, using either the lead or the lag dependent on which has the highest correlation with the first stage index. All elements are rescaled to give the index a unit variance.

A second, orthogonal index is constructed with the key difference being that each proxy is made orthogonal to business cycle variation. Each raw index element is regressed against growth in the industrial production index, growth in consumer durables, nondurables and services, and a dummy variable for NBER recessions. The residual is then used in the construction procedure defined above.

3 Methodology

To test the relation between the supply-based model of asset prices, and the expected return generated by the prominent demand-side models I focus on how well the demand-based factors price portfolios constructed using the supply-based characteristics. I interpret the ability of the demand factors to explain the premium earned by these portfolios as risk underlying these various supply-based factors.

The primary specification uses two-stage Fama MacBeth (1973) regressions. Each factor is tested separately to see how it performs in pricing the portfolios. A second test including value-weighted average portfolio characteristics in the second stage is included to control for a characteristic explanation.

In robustness results I test how well each factor model prices portfolios based on 3-way sorts of size, investment, and profitability. Results for the 3-way sort, including figures and risk prices can be found in the Internet Appendix. These generally support the core findings.

Additionally, the primary results use full sample beta estimates when in the first stage of the Fama-MacBeth testing procedure when measuring prices of risk among the various factor models. Results from full sample betas should be equally or less attenuated then those based on rolling or extending window beta estimates. Appendix tables 2 and 3 outline results using a five-year rolling window and an extending window with minimum of five years of returns. In line with the attenuation interpretation, results for all models appear weaker when estimated using these alternative beta estimates.

4 Testing the Models

This section goes through the results for each of the factor models considered in this study. A summary of each factor is provided for context. Results are provided for both the primary specification, factor pricing using a two-stage Fama MacBeth framework, as well as how the model performs controlling for the characteristics of the portfolios.

4.1 Consumption

4.1.1 Three-Year Consumption Growth

The consumption model comes from a longstanding literature directly linking the investment decision to its impact on future consumption.[3] The linear representations tested in this paper represent only a sliver of the literature. The "ultimate" consumption risk of Julliard and Parker (2005) aims to capture the eventual consumption risk that an investor will face through the purchase of a given asset or group of assets. The three-year specification matches returns in a given year to consumption growth over the course of the contemporaneous year and the subsequent two years. Measuring consumption in this format allows for a slow adjustment to consumption, as well as measurement error in consumption.

Table 3 presents the pricing results for 25 size-investment portfolio. The three-year consumption growth factor is able to price the 25 size-investment portfolios. The insignificant intercept implies that a portfolio with returns orthogonal to ultimate consumption growth is predicted to earn the risk-free rate. The positive and significant slope coefficient of 3.05 indicates that a portfolio

[3] This idea was first developed by Rubinstein (1976) and Breeden (1979).

that exhibits an additional one unit of covariance with consumption growth is expected to earn an additional 305 basis points annually. The factor loses its explanatory power once portfolio characteristics are controlled for, which I interpret as characteristics being more accurately measured than covariances.

Table 4 contains pricing results for 25 size-profitability portfolios. Ultimate consumption growth is unable to fully price the 25 size-profitability sorted portfolios. The significant intercept indicates that a portfolios with returns orthogonal to ultimate consumption growth still earns an excess return of 5.7 percent annually. Even so, the factor is able to capture some variation in returns. The significant slope estimate of 1.95 indicates that a portfolio with an additional one unit of elasticity with consumption growth is expected to earn an additional 195 basis points annually. Overall, the three-year factor is only able to partially span the premium generated by the two sets of portfolios.

4.1.2 Q4-Q4 Consumption Growth

The Q4-Q4 growth model represents the most successful specification tested by Jagannathan and Wang (2007). The premise of their work is that individuals make joint consumption-investment decisions infrequently throughout the year. The period in which this decision is most likely to be made should exhibit a consumption-return relation stronger than other periods. The authors focus on the fourth quarter as the most likely period in which investors are making their joint decisions, and therefore the contemporaneous consumption return relation from the end of Q4 to a subsequent quarter should be significant. The authors choose to focus on Q4-Q4 growth to avoid seasonality in the data, and they explicitly state that this period represents their most convincing results.

The results reported in table 4 show that the Q4-Q4 consumption growth factor can price the 25 size-investment portfolios. The intercept is not statistically different from zero, indicating that a portfolio with returns orthogonal to consumption growth will, on average, earn the risk free rate. The positive and significant slope of 1.46 indicates that a portfolio with an additional one unit of covariance with consumption growth will earn an additional excess return of 146 basis points.

The pricing results for the 25 size-profitability, shown in table 4, indicate that the model is unable to capture the variation in portfolio returns. A significant intercept of 6.93 implies that a zero beta portfolio will earn an excess return of 6.93 percent annually. Overall, the Q4-Q4 model is only able to account for the premium earned by the investment driven portfolios.

4.1.3 Without Garbage, Unfiltered Consumption

The without garbage model of Kroencke (2017) is based off an earlier finding by Savov (2011) that growth in the amount of garbage (solid waste) produced by the economy acts a proxy for consumption in predicting expected returns. Kroencke postulates the improvement of garbage over the standard measure of consumption coming from the National Income and Product Accounts (NIPA) is due to the fact that the garbage series is unfiltered. More specifically, the Bureau of Economic Analysis (BEA) filters the consumption data to correct for measurement error. If the measurement error is uncorrelated with returns, then the filters may produce a consumption series with reduced explanatory power for returns. The without garbage factor uses an "unfiltering" process detailed in the paper to remove the filters put in place by the BEA.

The filtered consumption factor produces an insignificant intercept, but only a marginally significant price of risk when tested using size-investment portfolios. The direction of the price of risk is comparable to findings in the original paper. The slope of 2.42 implies that a one unit increase in covariance between portfolio returns and consumption growth is associated with a 242 basis point increase in excess returns. The test here differ from the original paper, as the original paper looks only at the factor exposure (beta) across 10 portfolios independently sorted on investment growth. The relation grows weaker when portfolio characteristics are included in the test.

The 25 size-profitability portfolios produce an insignificant price of risk and significant intercept. The intercept implies that a zero covariance portfolio still earns a 9 percent excess return. The results using the factor alone match findings in the original paper in which factor exposure predicts a reversed premium on portfolios sorted using operating profitability. Overall, I conclude that the without garbage measure is unable to account for the premiums earned by investment and profitability sorted portfolios.

4.2 Intermediary

4.2.1 Primary Dealer Capital Ratio

A newer literature has focused on a representative intermediary as the marginal investor for a variety of asset classes.[4] The primary dealer capital ratio of He, Kelly and Manela (2017) uses a two factor specification based on the market factor and shocks to intermediaries' aggregate capital ratio. The authors calculate the aggregate capital ratio from holding companies of New York Federal Reserve primary dealers. Primary dealers are those intermediaries that act as counter parties for the Fed as it engages in open market operations.

Table 5 reports the results from pricing tests of 25 size-investment portfolios. Estimates are reported based on quarterly returns. The two factor model produces a positive and significant intercept and marginal price of risk. The intercept of 2.54 implies that a zero risk portfolio is predicted to earn 10.16 percent annually. The marginally significant slope of 4.54 indicates that a one unit increase in covariance between portfolio returns and innovations in intermediary capital is associated with an additional 18 percentage points of excess return. Including portfolio characteristics into the model further reduces the explanatory power of the factors.

Table 6 reports pricing outcomes for intermediary models on 25 size-profitability portfolios. Estimates are reported based on quarterly returns. The two factor specification on its own again produces a positive and significant intercept and a marginally significant price of risk. The intercept estimate of 3.27 indicates that a zero covariance portfolio is expected to still earn an excess return of 13 percent. The factor slope of 4.19 indicates that a one unit increase in the covariance between portfolio returns and innovations in the measure is associated with an increase of 12.8 percentage points in expected return. Inclusion of portfolio characteristics improves the outcome resulting in

[4]For theory work see He and Krishnamurthy (2013) or Brunnermeier and Sannikov (2014).

a positive and significant price of risk.

4.2.2 Broker-Dealer Leverage

The broker-dealer leverage factor of Adrian, Etula, and Muir (2014) uses aggregated data from the Flow of Funds accounts (Z.1) published by the Federal Reserve. These sector level data allow the authors to construct a series based on innovations in the leverage of broker-dealers. The underlying data for this series have undergone an update since the paper was published, leading to changes in the historic series. The revision reflects a new way of handling gross versus net repurchase agreements and impacts the way that assets and liabilities are counted. I test two versions of the series. The first is the original with the new data starting at the end of the series used for the original publication. The second includes the complete historical revision, which I refer to as the “new” series.

The original series performs the best of all tested factors. Results reported in table 5 indicates that the model produces an insignificant intercept and positive and significant price of risk when pricing size-investment portfolios. The slope estimates of 15.47 indicates that a one unit increase in covariance between portfolio and innovations in broker-dealer leverage is associated with an excess return of 62 percent annually. Table 6 shows that the factor also produces a positive and significant price of risk with insignificant intercepts for size-profitability portfolios. The slope estimate of 25.8 implies that a one unit increase in covariance between portfolio returns and the factor is associated with an additional 103 percentage point excess return annually.

For the 25 size-profitability portfolios, the inclusion of characteristics results in no loss of significance for the factor’s price of risk. Including characteristics when pricing the 25 size-investment portfolios has the opposite impact, dramatically reducing the significance of the price of risk.

The new series based on revised underlying data challenges the original findings. Tests of the model in pricing the 25 size-investment portfolios lead to a statistically weak and an economically smaller slope coefficient while generating a positive and significant intercept. The intercept of 1.33 implies that a risk free portfolio is still expected to earn an excess return of 5.3 percent annually.

The tests of the 25 size-profitability portfolios present a better fit, with a positive and significant price of risk both with and without portfolio characteristics. The test without characteristics still generates a positive intercept. The intercept of 1.45 implies that the risk free portfolio is expected to earn and excess return of 5.8 percent annually. Overall, while the AEM generates the best fit of any of the models tested, there are several gaps in the robustness of the results indicating it may not be sufficient as a full explanation.

4.3 Chen, Roll and Ross Macro Factors

Chen, Roll, and Ross (1986) construct five macroeconomic factors on the premise that fundamental economic changes should represent a systematic and undiversifiable risk to investors. They motivate the selection of their specific measures using the identity that price is equal to expected discounted dividends. From this they derive their five primary factors as monthly industrial production (MP), unexpected inflation (UI), change in expected inflation (DEI), the default premium (UPR), and the term premium (UTS). In their model, innovation in these state variables should coincide with movements in asset prices.

Tables 7 reports results from testing the macro factors using 25 size-investment portfolios. Estimates are based on monthly portfolio returns. Tests of the model in pricing the 25 size-investment sorted portfolios yield a small and insignificant intercept as well as several significant prices of risk. Winners have smaller loadings on the two inflation measures, unexpected inflation and the change in the expected inflation. They also have a higher sensitivity to the term structure and a higher sensitivity to industrial production that is only marginally significant. Only the term structure premium survives the inclusion of the characteristics.

Results for the 25 size-profitability sorted portfolios are reported in table 8. Estimates are based on monthly portfolio returns. Tests of these portfolios produce a significant intercept of 1.01 indicating a portfolio in which the returns are orthogonal to all five factors is still expected to earn 12.1 percent points of additional excess return. Several factors produce significant prices of risk.

Winners load higher on industrial production and the default premium, and lower for the change in expected inflation and term premium. The inclusion of characteristics leaves results for both industrial production and the term premium. Overall, while the results for the CRR model looks promising for explaining investment, mirroring a finding by Cooper and Priestly (2011), it does not appear that the factors can explain the premium earned by profitability sorted portfolios.

4.4 Sentiment

The sentiment measure of Baker and Wurgler (2006) uses principal component analysis to reduce several elements related to sentiment into a single index. The accompanying orthogonal version uses those same elements, but made orthogonal to business cycle variation. The timing of return prediction is important for testing sentiment's potential relation to portfolio return. The authors use the level of sentiment at the end of the prior year to predict monthly returns in the current year. The idea being that sentiment distorts prices of certain types of stocks more so than others, and that these particular stocks may have a differential capacity to be arbitraged. The alignment of the index with returns indicates a long term price recovery from a previous mispricing.

Tables 9 reports the results from tests on 25 size-investment portfolios and estimates are all based on monthly portfolio returns. Both sentiment, and its orthogonal counterpart yield identical results. Tests of the 25 size-investment portfolios yield neither an insignificant intercept nor positive elasticity. Based on these results, high return portfolios do not outperform due to a higher sensitivity to the prior end-of-year sentiment. Tests of size-profitability sorted portfolios, shown in table 10, yield a marginally stronger relation but the interpretation remains the same. While sentiment does not appear to successfully price the supply motivated portfolios, the absence of a formal behavioral theory implies that the current specification could be a misrepresentation of the model. Other formulations, including sentiment or alternative measures, might prove more promising.

5 Robustness

5.1 Size-Investment-Profitability sorts

I confirm the findings above by testing the performance of each model in pricing 125 portfolios independently sorted on size, investment, and profitability. A successful model should be able to capture both dimensions of expected return simultaneously. Table A.1 in the internet appendix reports pricing tests for all considered models.

Tests using the 125 portfolios yield identical results to those found in the previous section. Models based on consumption generate an intercept implying that a risk free portfolio is expected to earn an excess return of between 6 and 8 percent. Only the ultimate consumption model produces a positive and significant price of risk. The slope estimate of 2.02 indicates that a one unit increase in covariance is associated with an additional 2 percentage points in expected return.

Tests of the intermediary model again indicate that the broker-dealer leverage model of Adrian, Etula, and Muir provides the best prediction of expected return. The intercept is small and only marginally significant, while the estimated slope indicates that a one unit increase in covariance between portfolio returns and innovations in broker-dealer leverage is associated with a 13.51 percentage point higher excess return. The factor based on new broker-dealer leverage data produces a small but significant price or risk and a significant slope estimate. The intercept of 1.67 implies a risk free portfolio is expected to generate an excess return of 6.7 percentage points. The slope estimate of 4.63 indicates that a one unit increase in covariance is associated with an increase in excess returns of 18.5 percent annually. Finally results based on the primary dealer capital ratio yield a significant intercept and insignificant price of risk. The intercept estimate of 3.2 implies that a risk free portfolio is expected to return 12.8 percent annually.

Results for both measures of sentiment appear to perform more strongly in this specification. Sentiment produces a significant intercept equivalent to an excess return of 9.6 percent. The slopes of both measures become marginally significant when pricing investment and profitability simultaneously. In the case of sentiment, a one unit increase in the covariance of returns and prior end of year sentiment is associated with an increase in portfolio return of 4.8 percent annually.

Results for the Chen, Roll, and Ross macro factors match those reported above. The positive and significant intercept of 0.92 indicates that a zero risk portfolio is expected to earn an excess return of 11 percent. The model also produces several significant prices or risk. Winning portfolios load higher on industrial production and the default premium and lower on the change in expected inflation, unexpected inflation and term structure.

5.2 Alternative Beta Estimates

The core results calculate the price of risk using a 2-stage Fama Macbeth procedure with full sample beta estimates. That is, in calculating the covariance (beta) between the portfolio returns and the chosen factor I use the entire available time series. The covariances are then used in calculating the price of risk in the second stage. In doing so I bias toward finding significant results by incorporating forward looking information.

To verify this, I rerun the core results using two alternate specification of beta. Rolling betas are calculated using a 5 year rolling window up to but not including the current period. Extending window betas are calculated using all periods prior to but not including the present. I use a minimum of five years of data.

Table A.2 reports results from all models on size-investment portfolios using both alternate beta specifications. The estimates confirm that full sample beta provide a more generous estimate in terms of finding a relationship. None of the models that originally were able to capture variation in returns hold up in the alternate results. All model estimates produce a significant constant and insignificant to marginal price of risk. One interesting exception is that sentiment generates a significant price of risk in the rolling beta estimates, though not the extending window estimates.

Table A.3 reports results from all models on size-profitability portfolios using both alternate beta specifications. Again, the estimates confirm the original results in that the models generally produce a significant intercept and insignificant price of risk. There is one exception with the Chen, Roll, and Ross model. The model produces an insignificant price of risk and several marginally significant prices of risk. In the rolling beta estimates winners appear to load less on the change in expected inflation and industrial production, while in the extending window estimates winners appear to load more on unexpected inflation and less on industrial production.

5.3 Alternate testing portfolios

As a supplement I also report prices of risk for all models in testing 25 size-value and 25 size-momentum sorted portfolios. The procedure is identical to the core results, and estimates with average portfolios characteristics are included for comparison. Again, all results can be found in the internet appendix.

Table A.4 reports results for consumption models on 25 size-value sorted portfolios. Unsurprisingly, all consumption factor models are able to price the portfolios. The Q4-Q4, three-year, and unfiltered consumption factor models all produce insignificant intercepts and positive and significant prices or risk.

Table A.5 reports the results from testing 25 size-momentum portfolios. The Q4-Q4 model produces an insignificant intercept and a positive and significant price of risk. The estimate of 1.49 indicates that a one unit increase in covariance between returns and the factor is associated with an expected excess return that is 149 basis points higher. The three-year consumption growth has a similar interpretation, while the without garbage model is unable to price the portfolios. The intercept from the without garbage model indicates that a zero risk portfolio is expected to earn an excess return of 10 percent annually.

Table A.6 reports estimates from the intermediary models on 25 size-value sorted portfolios. Again, all models are able to price these widely used portfolios. This includes the updated version of the broker-dealer leverage model, though the results appear weaker.

Table A.7 reports results for the 25 size-momentum portfolios. Only the original broker-dealer leverage model produces an insignificant intercept and positive and significant price of risk. The slope estimate of 13.4 implies that a one unit increase in covariance between portfolio returns and innovations in broker-dealer leverage is associated with an excess return that is 54 percentage points annually. Both the updated version of the series, and the primary dealer leverage ratio models produce significant constants and insignificant or negative prices of risk.

Table A.8 reports the results from Chen, Roll, and Ross factors pricing of 25 size-value portfolios. The model is able to capture variation in returns for these portfolio coming from several significant factors. Winners load more on industrial production and the default premium. Table A.9 reports the results for 25 size-momentum portfolios. The significant intercept of 0.98 implies a zero risk portfolio is still expected to earn an excess return of 11.9 percent. Size-momentum winners appear to load more on industrial production.

Table A.10 and A.11 reports the results from testing sentiment's ability to capture return variation in 25 size-value and 25 size-momentum portfolios. Results from both tables indicates the models inability to capture variation in returns for either set of portfolios.

6 Conclusion

This paper empirically tests for demand-side determinants of the discount factor that may explain premiums earned by portfolios sorted based on investment and profitability. The partial equilibrium setup of the q-theory of investment means that the predictability of returns from these characteristics represents the firm optimizing for a discount factor that is jointly determined with investors who demand the risky securities the firm supplies. The theory remains silent on what determines this discount factor from the demand-side.

Using standard two-stage Fama MacBeth regressions, I test several linear factor representations spanning the consumption, intermediary, macroeconomic risk, and behavioral models of the return premium. Of these models, the broker-dealer leverage factor of Adrian, Etula, and Muir (2014) is best able to price both the size-investment and size-profitability sorted portfolios. That said, it is hampered by the change in underlying data which meaningfully alters the performance in the series in pricing both investment and profitability.

The evidence suggests that the models tested here are unlikely to yield a sufficiently robust explanation for the supply-side premiums. Further exploration is needed to ultimately determine what is driving the investment and profitability return relation. Given that both the supply driven portfolios and linear factor models are both imperfect representations of their theories, the noise in estimation may contribute to the lack of evidence. A more rigorous application of theory may be necessary to resolve the disconnect.

References

Tobias Adrian, Erkko Etula, and Tyler Muir. Financial Intermediaries and the Cross-Section of Asset Returns. *Journal of Finance*, 69(6):2557–2596, 2014.

Malcolm Baker and Jeffrey Wurgler. The equity share in new issues and aggregate stock returns. *Journal of Finance*, 55(5):2219–2257, 2000.

Malcolm Baker and Jeffrey Wurgler. A catering theory of dividends. *Journal of Finance*, 59(3):1125–1165, 2004.

Malcolm Baker and Jeffrey Wurgler. Investor sentiment and the cross-section of stock returns. *Journal of Finance*, 61(4):1645–1680, 2006.

Douglas T. Breeden. An intertemporal asset pricing model with stochastic consumption and investment opportunities. *Journal of Financial Economics*, 7:265 – 296, 1979.

Markus K. Brunnermeier and Yuliy Sannikov. A macroeconomic model with a financial sector. *American Economic Review*, 104(2):379–421, 2014.

Nai-fu Chen, Richard Roll, and Stephen A Ross. Economic Forces and the Stock Market. The *Journal of Business*, 59(3):383–403, 1986.

Ilan Cooper and Richard Priestley. Real investment and risk dynamics. *Journal of Financial Economics*, 101(1):182–205, 2011.

Russell W. Cooper and John C. Haltiwanger. On the nature of capital adjustment costs. *Review of Economic Studies*, 73(3):611–633, 2006.

Eugene F. Fama and Kenneth R. French. Common risk factors in the returns on stocks and bonds. *The Journal of Financial Economics*, 33:3–56, 1993.

Eugene F. Fama and Kenneth R. French. A five-factor asset pricing model. *Journal of Financial Economics*, 116(1):1–22, 2015.

Eugene F. Fama and Michael R. Gibbons. A comparison of inflation forecasts. *Journal of Monetary Economics*, 13(3):327–348, 1984.

Eugene F. Fama and James MacBeth. Risk, Return, and Equilibrium: Empirical Tests. *Journal of Political Economy*, 81(3):607–636, 1976.

Zhiguo He, Bryan Kelly, and Asaf Manela. Intermediary asset pricing: New evidence from many asset classes. *Journal of Financial Economics*, 126(1):1–35, 2017.

Zhiguo He and Arvind Krishnamurthy. Intermediary asset pricing. *American Economic Review*, 103(2):732–770, 2013.

Elizabeth Holmquist and Joshua Gallin. Repurchase Agreements in the Financial Accounts of the United States. *FEDS Notes*, pages 1–5, 2014.

Kewei Hou, Chen Xue, and Lu Zhang. Digesting anomalies: An investment approach. *Review of Financial Studies*, 28(3):650–705, 2015.

Roger G. Ibbotson, Jody L. Sindelar, and Jay R Ritter. the Market's Problems With the Pricing of Initial Public Offerings. *Journal of Applied Corporate Finance*, 7(1):66–74,1994.

Ravi Jagannathan and Yong Wang. Lazy investors, discretionary consumption, and the cross-section of stock returns. *Journal of Finance*, 62(4):1623–1661, 2007.

Tim A. Kroencke. Asset Pricing without Garbage. *Journal of Finance*, 72(1):47–98,2017.

Robert Neal and Simon M. Wheatley. Do Measures of Investor Sentiment Predict Returns? *Journal of Financial and Quantitative Analysis*, 33(4):523–547, 1998.16

Jonathan A. Parker and Christian Julliard. Consumption risk and the cross section of expected returns. *Journal of Political Economy*, 113(1):185–222, 2005.

Mark Rubinstein. The Valuation of Uncertain Income Streams and the Pricing of Options. *The Bell Journal*, 7(2):407–425, 1979.

Alexi Savov. Asset Pricing with Garbage. *The Journal of Finance*, 66(1):177–201, 2011.

Tables

Table 1: Average Monthly Portfolio Returns

This table shows the average monthly return for the 25 size-investment, 25 size-profitability portfolios, 25 size-value, and 25 size-momentum sorted portfolios. Annual and quarterly portfolios used in testing the consumption and intermediary models are calculated from monthly portfolios. Portfolios are calculated using NYSE breakpoints and value weights. Investment is defined as the growth in assets, profitability is measured from quarterly ROE, value is the book to market ratio, and momentum is measured as the (12-2) prior returns. Size-investment and size-value portfolios begin in January 1967. Size-profitability and size-momentum portfolios begin in January 1972. All portfolios end in June 2019.

Table 1a: 25 Size-Investment

	Low	2	3	4	High	Low-High
Small	1.27	1.27	1.32	1.15	0.65	0.63
2	1.14	1.20	1.23	1.17	0.77	0.37
3	1.15	1.19	1.11	1.09	0.81	0.35
4	0.99	1.07	1.11	1.07	0.94	0.04
Large	1.10	0.95	0.88	0.93	0.85	0.26

Table 1b: 25 Size-Profitability

	Low	2	3	4	High	High-Low
Small	0.52	0.94	1.33	1.57	1.87	1.34
2	0.53	0.98	1.06	1.17	1.49	0.96
3	0.70	0.86	0.98	1.14	1.35	0.65
4	0.74	0.88	0.98	1.16	1.23	0.49
Large	0.62	0.71	0.97	0.91	0.97	0.35

Table 1c: 25 Size-value

	Low	2	3	4	High	High-Low
Small	0.66	1.15	1.18	1.28	1.35	0.69
2	0.79	1.13	1.18	1.24	1.22	0.43
3	0.83	1.10	1.10	1.09	1.26	0.43
4	1.00	0.99	1.07	1.07	1.15	0.14
Large	0.90	0.91	0.89	0.95	0.88	-0.02

Table 1d: 25 Size-Momentum

	Low	2	3	4	High	High-Low
Small	0.44	0.92	1.16	1.32	1.60	1.16
2	0.48	0.94	1.10	1.18	1.43	0.95
3	0.59	0.89	1.06	1.09	1.35	0.76
4	0.74	0.92	1.06	1.13	1.24	0.50
Large	0.65	0.89	0.85	0.97	1.17	0.52

Table 2: Linear Factor Models

The following models of expected return are tested on the testing portfolios specified in table 1.

Model	Authors	Frequency	Period
Q4-Q4	Jagannathan and Wang (2007)	annual	start – 2018
Three Year	Julliard and Parker (2005)	annual	start – 2018
Without Garbage	Kroencke (2017)	annual	start – 2018
Capital Ratio	He, Kelly, and Manela (2017)	quarterly	1971q1 – 2018q3
Broker-Dealer Leverage	Adrian, Etula, Muir (2014)	quarterly	1968q1 – 2017q3
CRR Macro Factors	Chen, Roll, and Ross (1986)	monthly	start – Jun 2019
Sentiment	Baker and Wurgler (2006)	monthly	start – Dec 2018

Table 3: Consumption Factors, 25 Size-Investment Portfolios

This table presents pricing tests of the consumption factor models on 25 size-investment sorted portfolios. Coefficients are calculated from two-stage Fama MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize* is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price times number of shares outstanding, assigned annually. *avginv* is the is the value weighted portfolio average of growth in assets of firms in a portfolio measured in June of year t-1. Adj R-squared is the average from second stage cross-sectional regressions.

Q4-Q4

	Intercept	Factor	avgsize	avginv	Adj R-squared
Estimate	3.98	1.46			0.04
t-stat	1.27	1.97			
Estimate	7.60	0.72	-0.26	-4.00	0.37
t-stat	3.09	0.91	-1.51	-1.47	

Three Year

	Intercept	Factor	avgsize	avginv	Adj R-squared
Estimate	4.41	3.05			0.16
t-stat	1.56	1.95			
Estimate	6.44	2.16	-0.20	-2.02	0.44
t-stat	2.54	1.28	-1.53	-0.57	

Without Garbage

	Intercept	Factor	avgsize	avginv	Adj R-squared
Estimate	0.52	2.42			0.22
t-stat	0.11	1.48			
Estimate	4.45	1.53	-0.15	-3.21	0.44
t-stat	1.05	1	-1.64	-1.05	

Table 4: Consumption Factors, 25 Size-Profitability Portfolios

This table presents pricing tests of the consumption factor models on 25 size-profitability sorted portfolios. Coefficients are calculated from two-stage Fama MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize* is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price times number of shares outstanding, assigned annually. *avgroe* is the value weighted portfolio average of the ROE of firms in the portfolio calculated as in Hou, Xue, and Zhang (2015). Adj R-squared is the average from second stage cross-sectional regressions.

Q4-Q4

	Intercept	Factor	avgsize	avgroe	Adj R-squared
Estimate	6.93	0.38			0.02
t-stat	2.31	0.85			
Estimate	5.20	0.49	-0.25	66.52	0.40
t-stat	1.82	1.23	-1.51	4.29	

Three Year

	Intercept	Factor	avgsize	avgroe	Adj R-squared
Estimate	5.70	1.95			0.03
t-stat	2.24	3.03			
Estimate	4.87	1.51	-0.23	65.24	0.42
t-stat	1.82	2.35	-1.44	4.2	

Without Garbage

	Intercept	Factor	avgsize	avgroe	Adj R-squared
Estimate	9.07	-0.27			0.06
t-stat	3.8	-0.33			
Estimate	3.01	1.05	-0.19	71.55	0.42
t-stat	1.08	1.39	-1.31	4.43	

Table 5: Intermediary Models, 25 Size-Investment Portfolios

This table presents pricing tests of the intermediary factor models on 25 size-investment sorted portfolios. Coefficients are calculated from two-stage Fama MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize* is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price times number of shares outstanding, assigned annually. *avginv* is the is the value weighted portfolio average of growth in assets of firms in a portfolio measured in June of year t-1. Adj R-squared is the average from second stage cross-sectional regressions.

AEM

	Intercept	Factor	Mkt	avgsize	avginv	Adj R-squared
Estimate	0.64	15.47				0.11
t-stat	0.78	2.61				
Estimate	1.89	4.50		-0.03	-0.83	0.30
t-stat	2.45	0.85		-1.44	-1.4	

AEM New

	Intercept	Factor	Mkt	avgsize	avginv	Adj R-squared
Estimate	1.33	4.20				0.27
t-stat	2.12	1.38				
Estimate	1.85	2.71		-0.01	-1.22	0.42
t-stat	3.17	0.9		-1.3	-2.35	

HKM

	Intercept	Factor	Mkt	avgsize	avginv	Adj R-squared
Estimate	2.54	4.53	-0.31			0.44
t-stat	3.02	1.67	-0.33			
Estimate	2.07	2.46	0.31	-0.03	-0.91	0.50
t-stat	2.21	0.97	0.31	-2.43	-2.06	

Table 6: Intermediary Models, 25 Size-Profitability Portfolios

This table presents pricing tests of the intermediary factor models on 25 size-profitability sorted portfolios. Coefficients are calculated from two-stage Fama MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize* is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price times number of shares outstanding, assigned annually. *avgroe* is the value weighted portfolio average of the ROE of firms in the portfolio calculated as in Hou, Xue, and Zhang (2015). Adj R-squared is the average from second stage cross-sectional regressions.

AEM

	Intercept	Factor	Mkt	avgsize	avgroe	Adj R-squared
Estimate	0.42	25.80				0.11
t-stat	0.49	3.49				
Estimate	1.03	11.59		-0.04	13.07	0.32
t-stat	1.11	1.98		-1.44	4.71	

AEM New

	Intercept	Factor	Mkt	avgsize	avgroe	Adj R-squared
Estimate	1.45	6.08				0.19
t-stat	2.17	1.86				
Estimate	1.02	5.97		-0.02	16.23	0.37
t-stat	1.33	2.15		-1.28	5.12	

HKM

	Intercept	Factor	Mkt	avgsize	avgroe	Adj R-squared
Estimate	3.27	4.19	-1.04			0.32
t-stat	3.35	1.7	-0.96			
Estimate	0.10	4.91	1.31	-0.01	17.13	0.48
t-stat	0.1	2.19	1.22	-0.87	4.73	

Table 7: Chen, Roll, and Ross model, 25 Size-Investment Portfolios

This table presents pricing tests of the Chen, Roll, and Ross macroeconomic measures on 25 size-investment sorted portfolios. Coefficients are calculated from two-stage Fama MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize* is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price times number of shares outstanding, assigned annually. *avginv* is the value weighted portfolio average growth in assets of firms in the portfolio calculated as in Hou, Xue, and Zhang (2015). Adj R-squared is the average from second stage cross-sectional regressions.

CRR

	Con	DEI	MP	UI	UPR	UTS	avgsize	avginv	Adj R-squared
Estimate	0.10	-0.41	0.41	-0.50	0.07	0.88			0.38
t-stat	0.40	-2.45	1.68	-3.27	0.42	2.06			
Estimate	0.24	-0.03	-0.05	-0.06	0.17	0.99	0.003	-0.40	0.42
t-stat	0.94	-0.22	-0.23	-0.49	0.52	2.47	0.61	-2.54	

Table 8: Chen, Roll, and Ross model, 25 Size-Profitability Portfolios

This table presents pricing tests of the Chen, Roll, and Ross macroeconomic measures on 25 size-profitability sorted portfolios. Coefficients are calculated from two-stage Fama MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize* is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price times number of shares outstanding, assigned annually. *avgroe* is the value weighted portfolio average of the ROE of firms in the portfolio calculated as in Hou, Xue, and Zhang (2015). Adj R-squared is the average from second stage cross-sectional regressions.

CRR

	Con	DEI	MP	UI	UPR	UTS	avgsize	avgroe	Adj R-squared
Estimate	1.01	-0.36	0.48	-0.03	0.41	-1.92			0.28
t-stat	4.51	-2.61	2.56	-0.37	2.09	-4.10			
Estimate	0.78	-0.04	0.55	0.02	0.14	-1.05	-0.004	5.11	0.35
t-stat	2.86	-0.35	2.69	0.28	0.88	-2.61	-0.83	4.11	

Table 9: Sentiment Index, 25 Size-Investment Portfolios

This table presents pricing tests of the sentiment index on 25 size-investment sorted portfolios. Coefficients are calculated from two-stage Fama MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize* is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price times number of shares outstanding, assigned annually. *avginv* is the value weighted portfolio average growth in assets of firms in the portfolio calculated as in Hou, Xue, and Zhang (2015). Adj R-squared is the average from second stage cross-sectional regressions.

Sentiment

	Intercept	Factor	avgsize	avginv	Adj R-squared
Estimate	0.72	0.09			0.25
t-stat	4.65	0.32			
Estimate	0.70	-0.20	-0.01	-0.62	0.36
t-stat	3.9	-0.69	-2.31	-4.27	

Sentiment, Orthogonal

	Intercept	Factor	avgsize	avginv	Adj R-squared
Estimate	0.70	0.05			0.26
t-stat	4.48	0.19			
Estimate	0.70	-0.20	-0.01	-0.60	0.37
t-stat	3.93	-0.67	-2.28	-4.34	

Table 10: Sentiment Index, 25 Size-Profitability Portfolios

This table presents pricing tests of the sentiment index on 25 size-profitability sorted portfolios. Coefficients are calculated from two-stage Fama MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize* is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price times number of shares outstanding, assigned annually. *avgroe* is the value weighted portfolio average of the ROE of firms in the portfolio calculated as in Hou, Xue, and Zhang (2015). Adj R-squared is the average from second stage cross-sectional regressions.

Sentiment

	Intercept	Factor	avgsize	avgroe	Adj R-squared
Estimate	0.81	0.37			0.18
t-stat	4.63	1.21			
Estimate	0.46	-0.16	-0.01	5.45	0.31
t-stat	2.44	-0.54	-1.82	4.47	

Sentiment, Orthogonal

	Intercept	Factor	avgsize	avgroe	Adj R-squared
Estimate	0.82	0.44			0.17
t-stat	4.71	1.48			
Estimate	0.46	-0.16	-0.01	5.59	0.31
t-stat	2.48	-0.54	-1.75	4.40	

Figures

Figure 1: Three-Year Consumption Growth

This figure summarizes the relation between the actual expected portfolio return and that predicted by the three-year consumption growth model. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

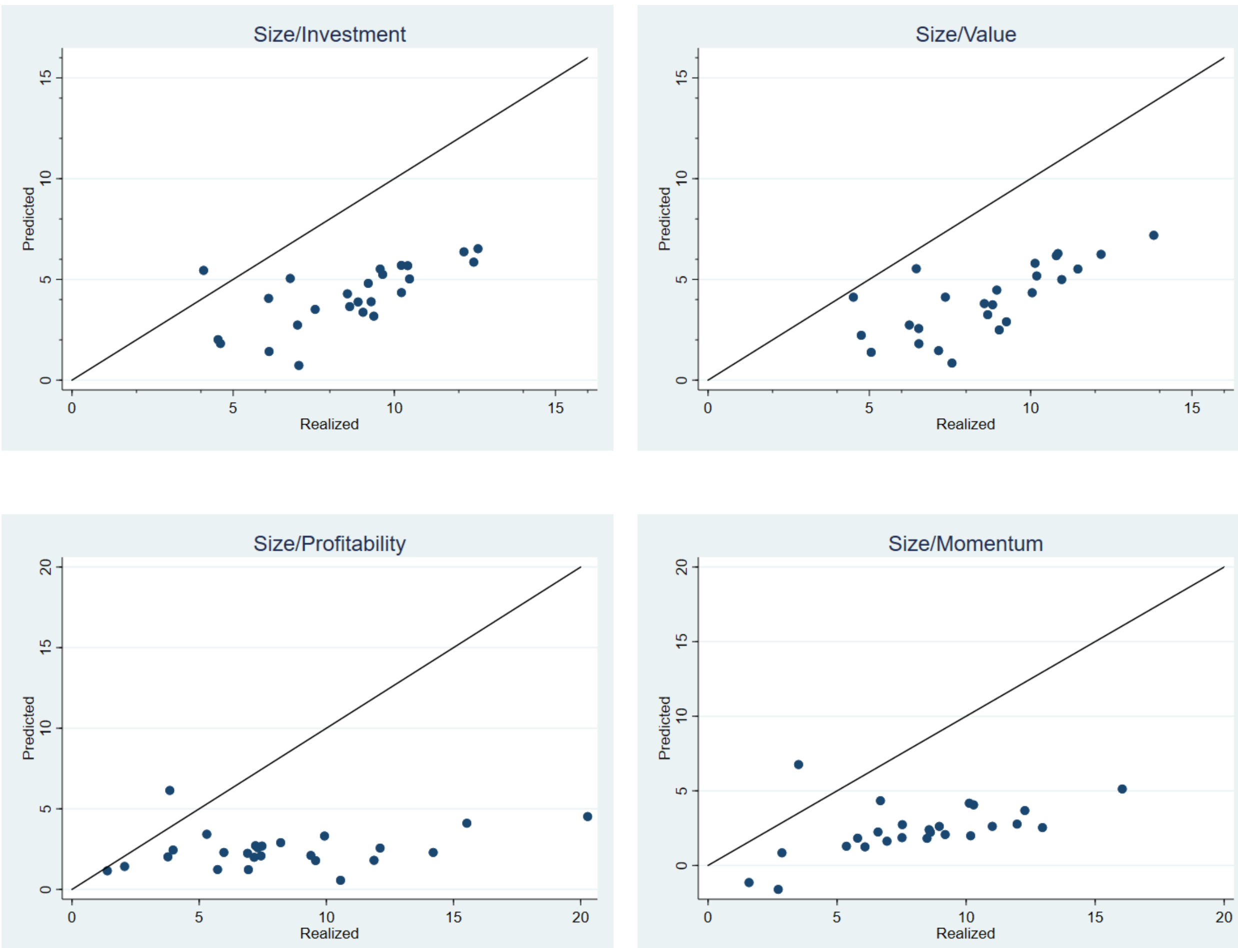


Figure 2: Q4-Q4 Consumption Growth

This figure summarizes the relation between the actual expected portfolio return and that predicted by the Q4-Q4 consumption growth model. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

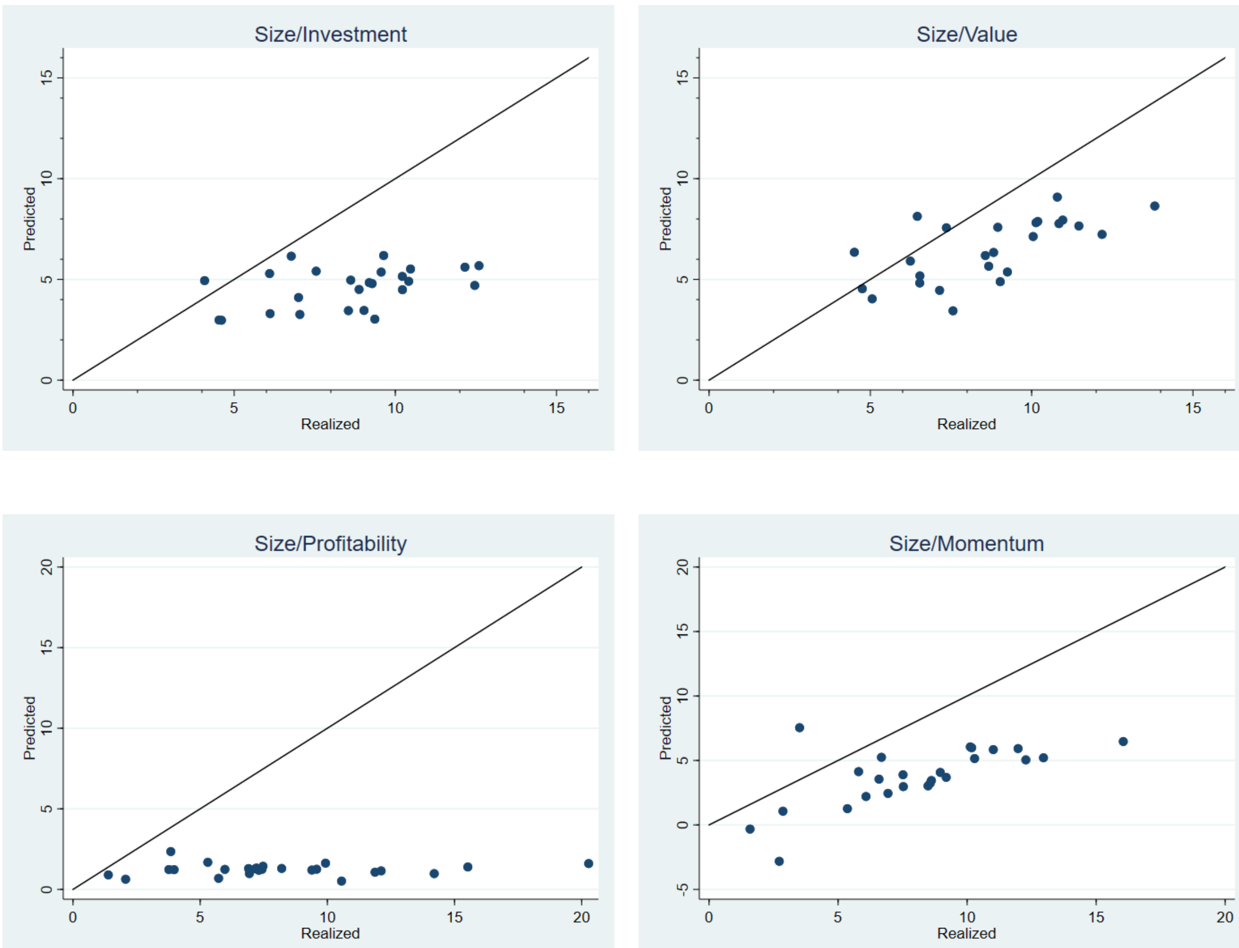


Figure 3: Without Garbage Unfiltered Consumption

This figure summarizes the relation between the actual expected portfolio return and that predicted by the without garbage unfiltered consumption growth model. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

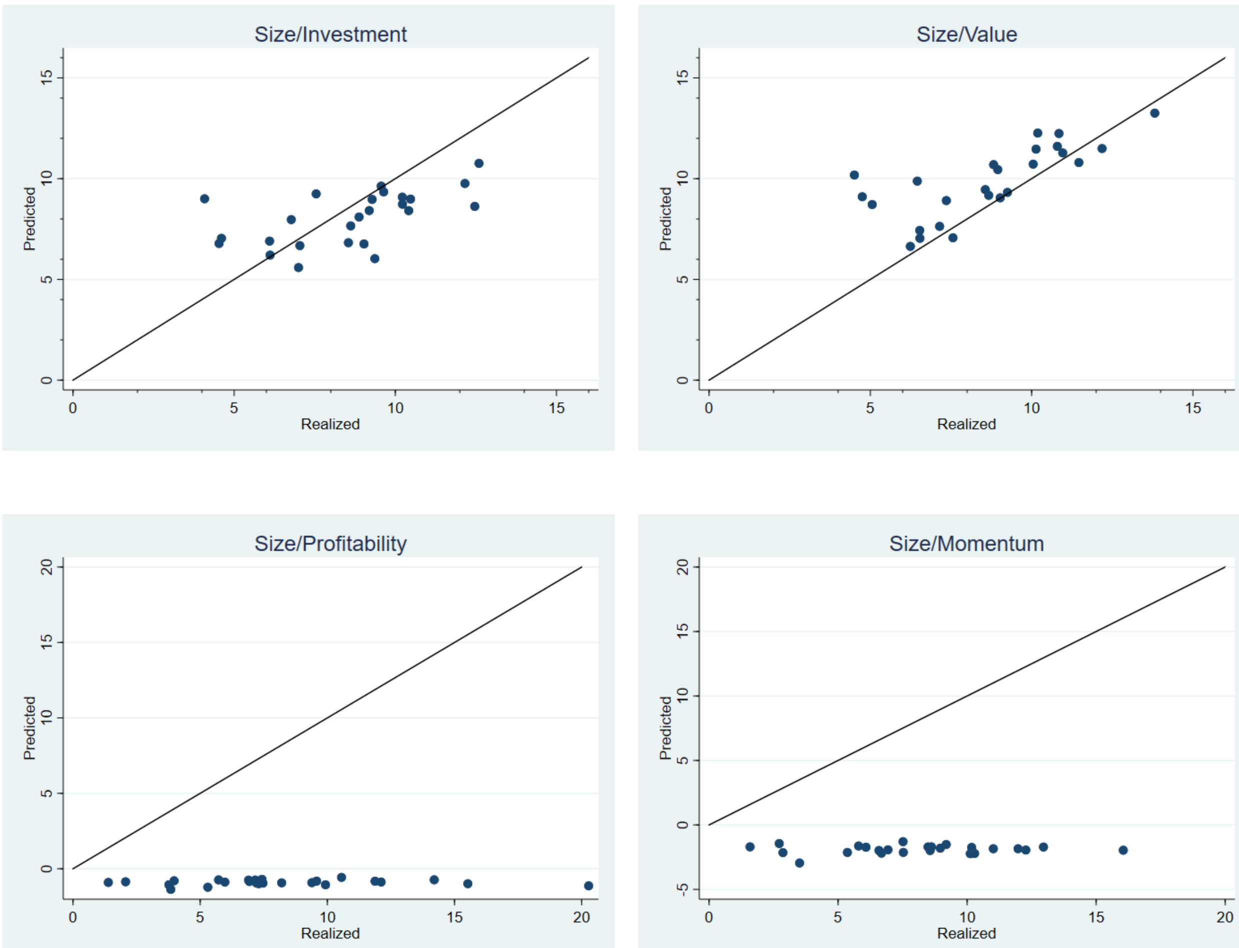


Figure 4: Primary Dealer Capital Ratio

This figure summarizes the relation between the actual expected portfolio return and that predicted by the primary dealer capital ratio two factor model. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

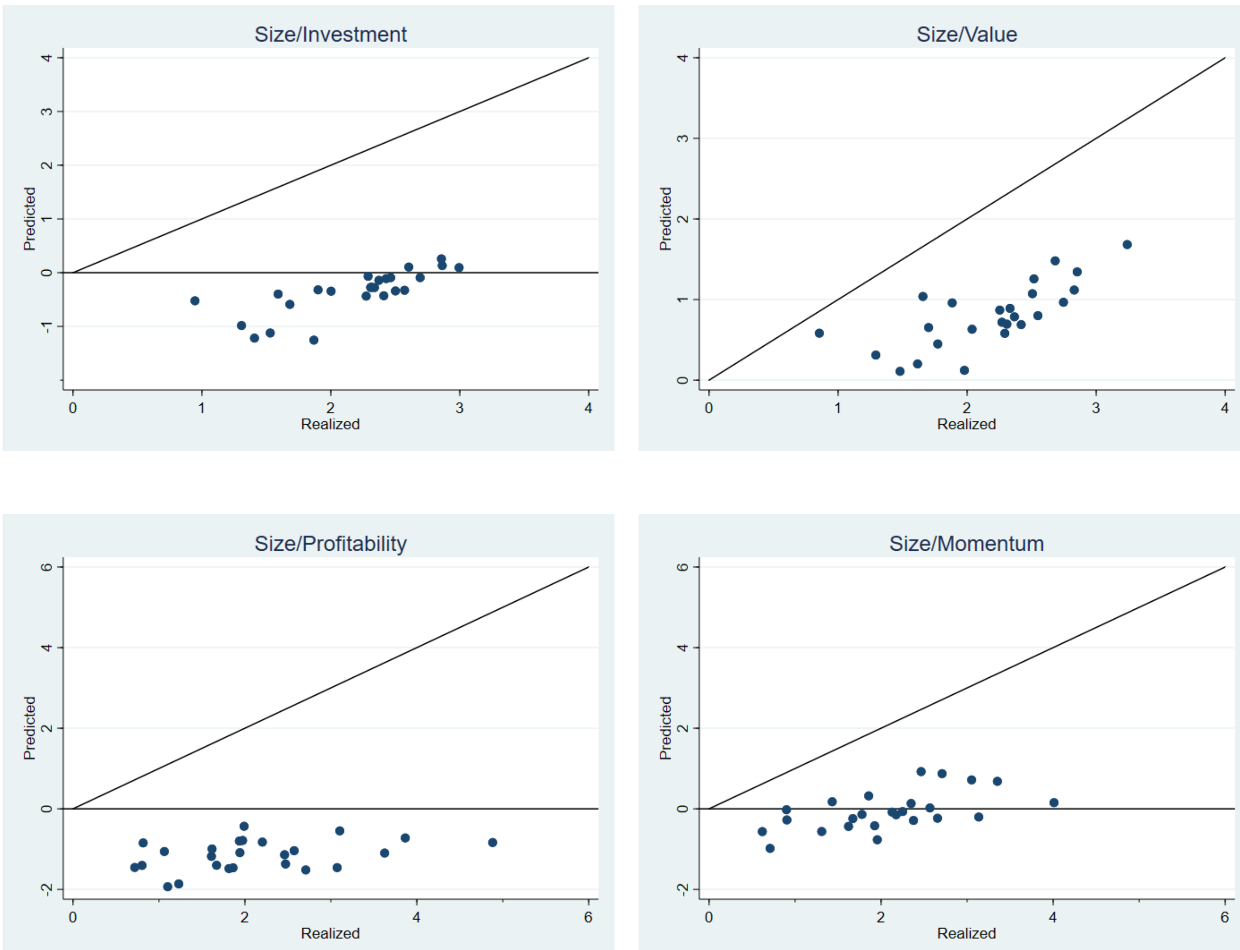


Figure 5: Broker-Dealer Leverage

This figure summarizes the relation between the actual expected portfolio return and that predicted by innovations in broker-dealer leverage. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

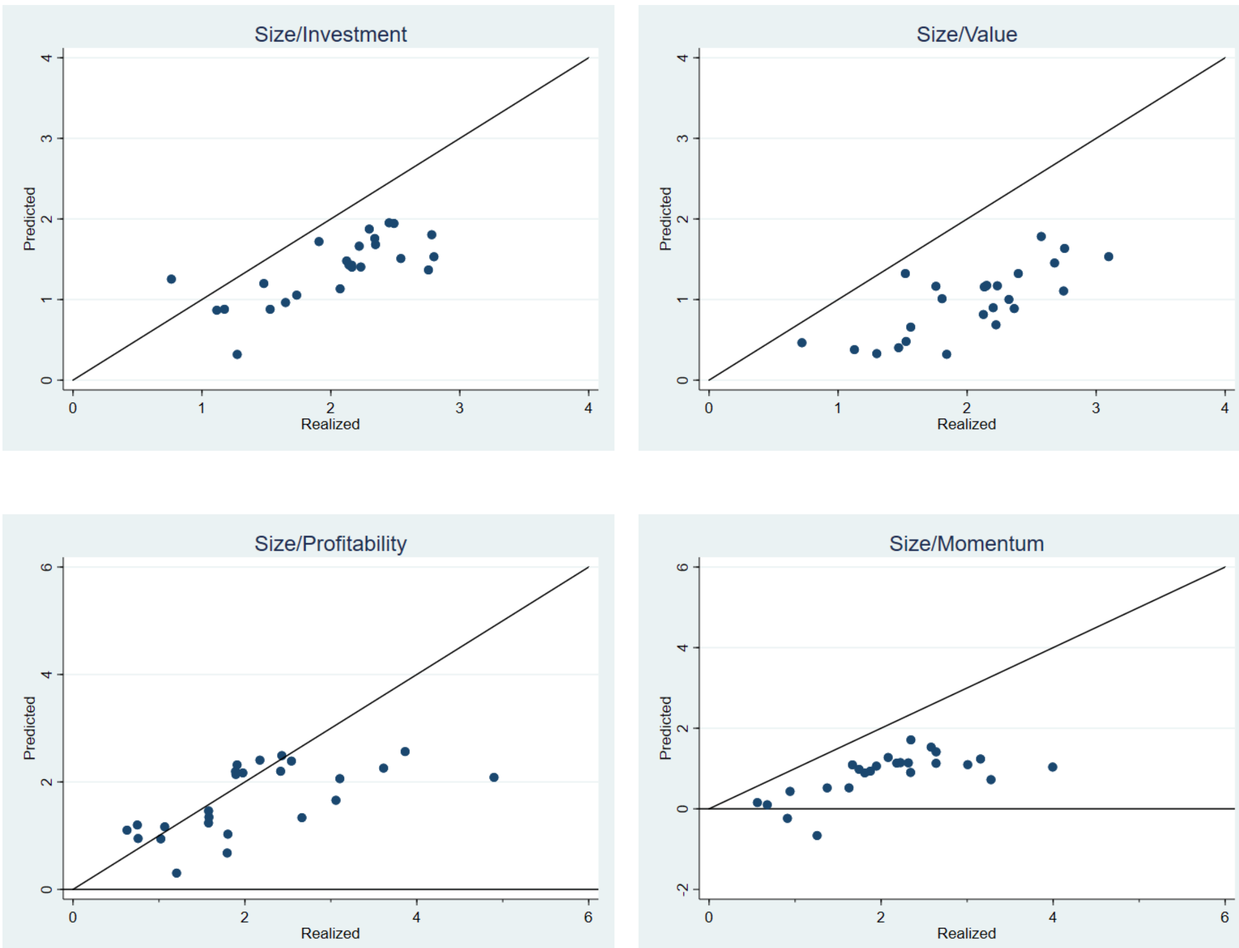


Figure 6: NEW Broker-Dealer Leverage

This figure summarizes the relation between the actual expected portfolio return and that predicted by innovations in broker-dealer leverage using a version of the series based on updated underlying data. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

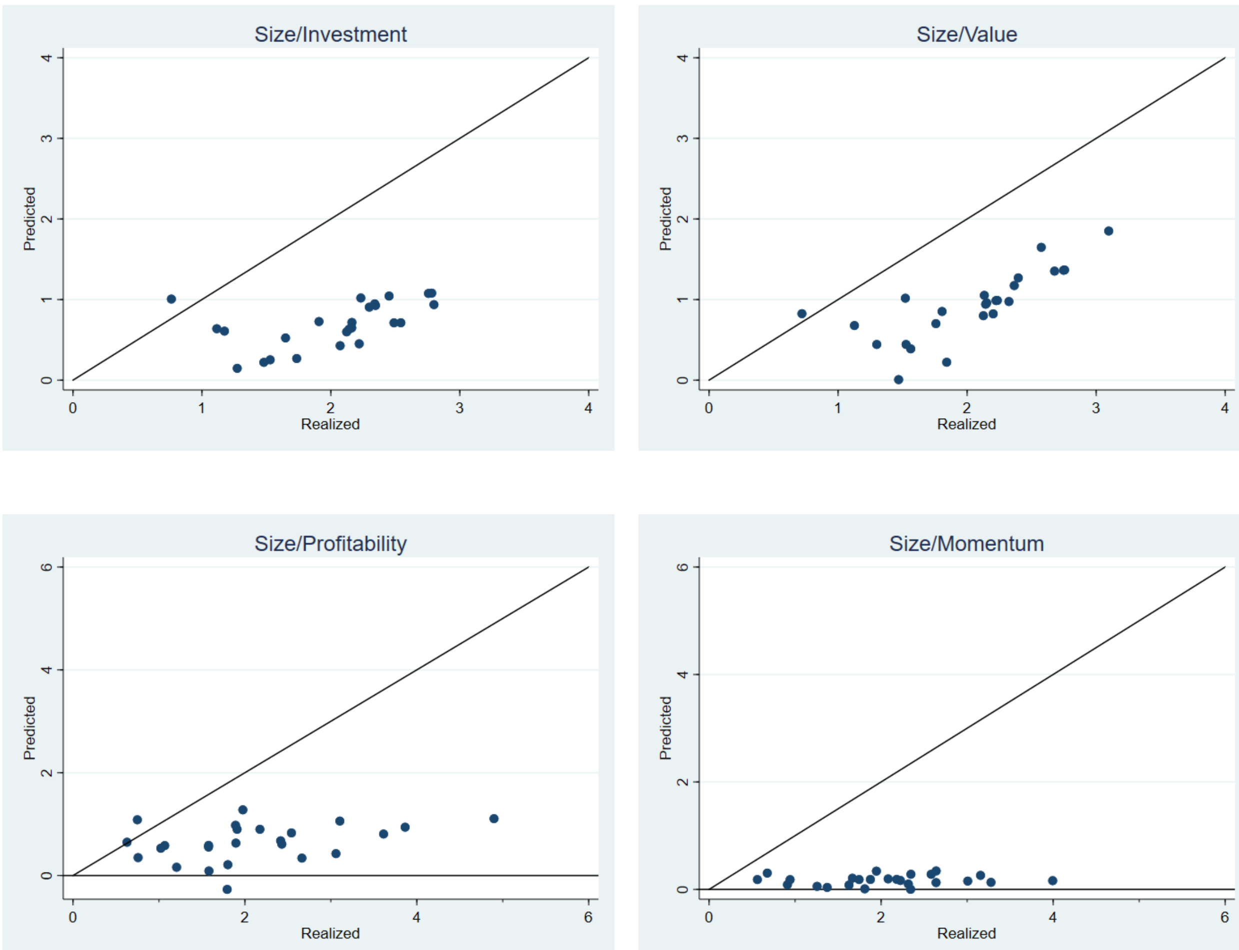


Figure 7: Chen, Roll, and Ross Macro Factors

This figure summarizes the relation between the actual expected portfolio return and that predicted by innovations in the five Chen, Roll, and Ross macro factors. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

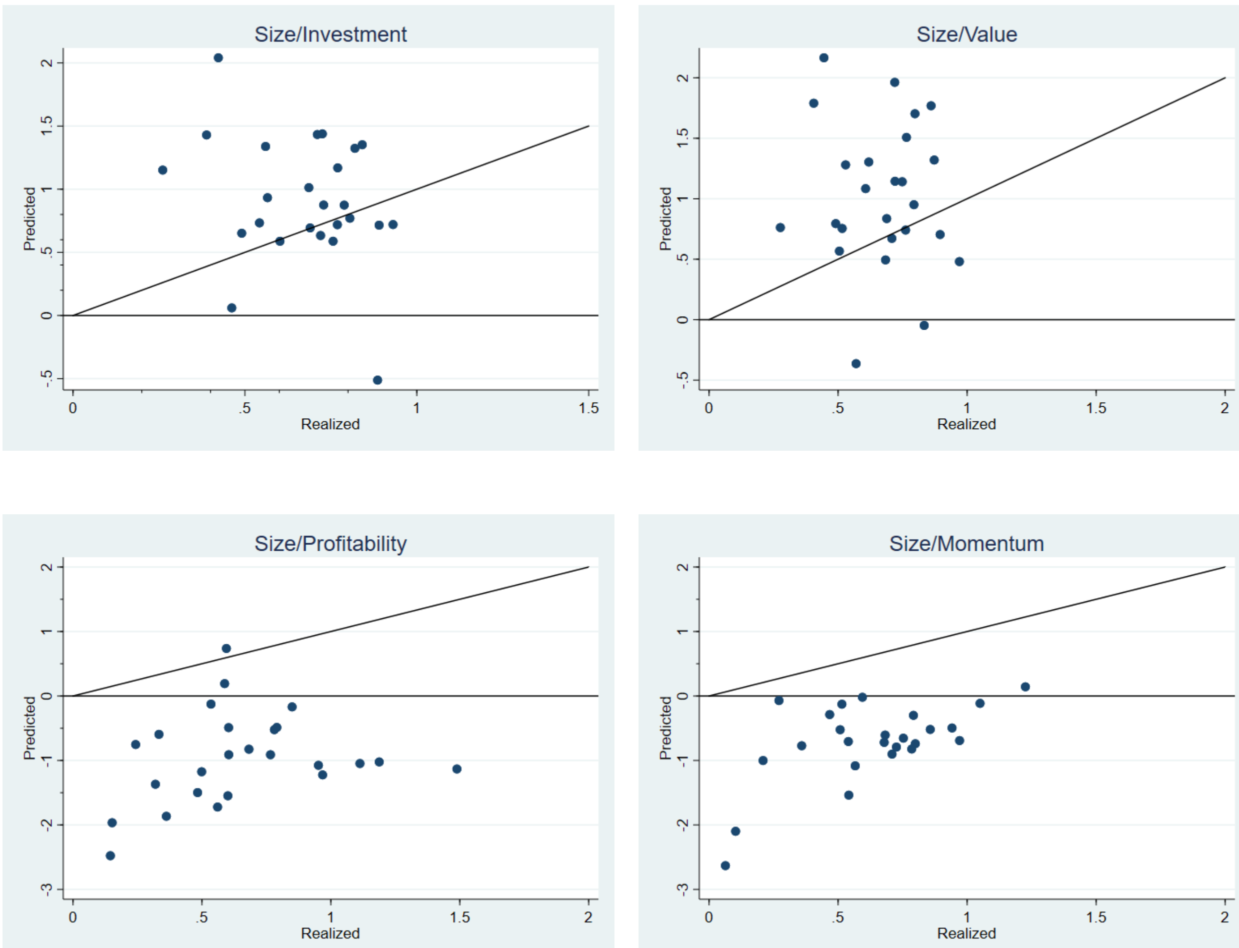


Figure 8: Sentiment

This figure summarizes the relation between the actual expected portfolio return and that predicted by previous end of year sentiment index level. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

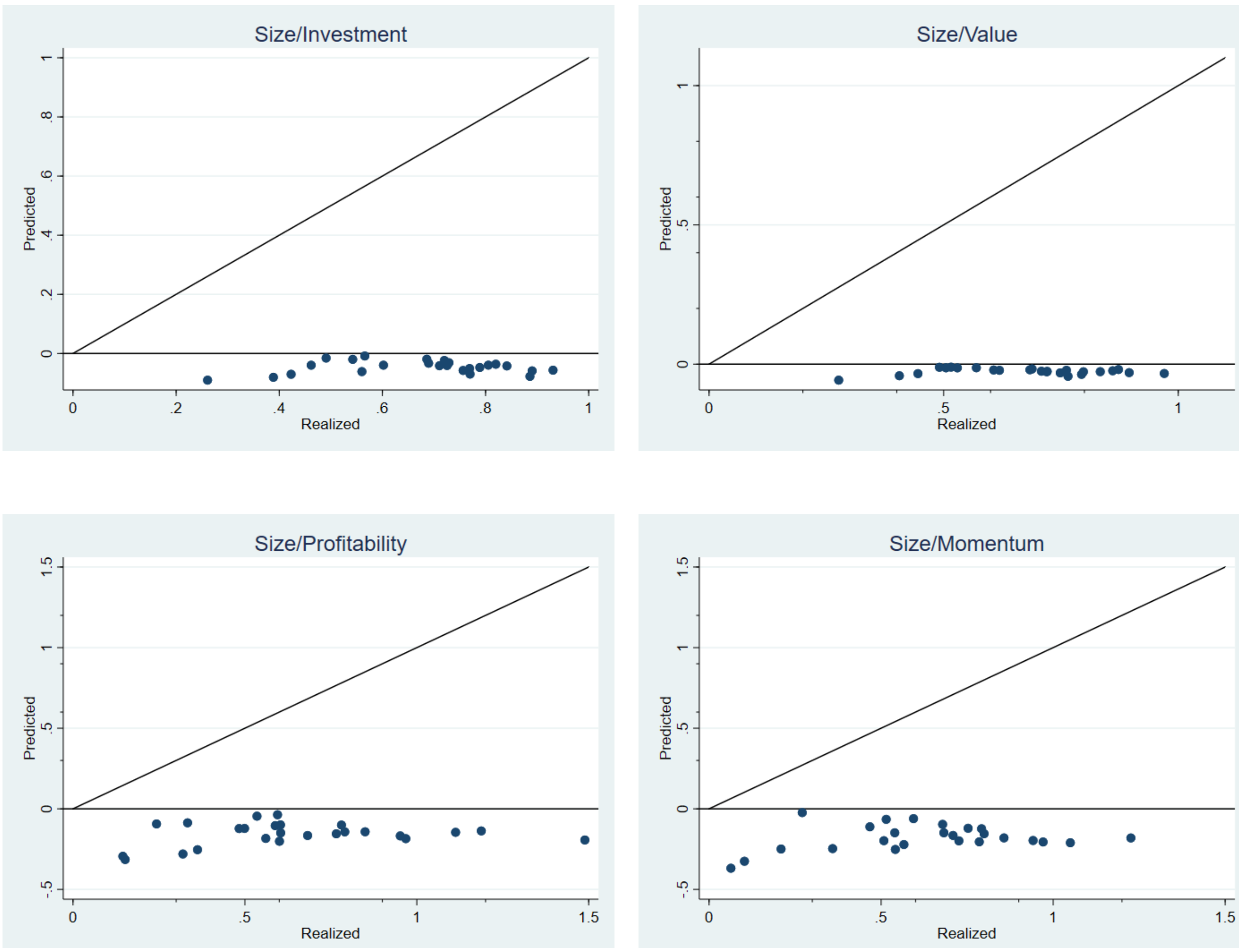
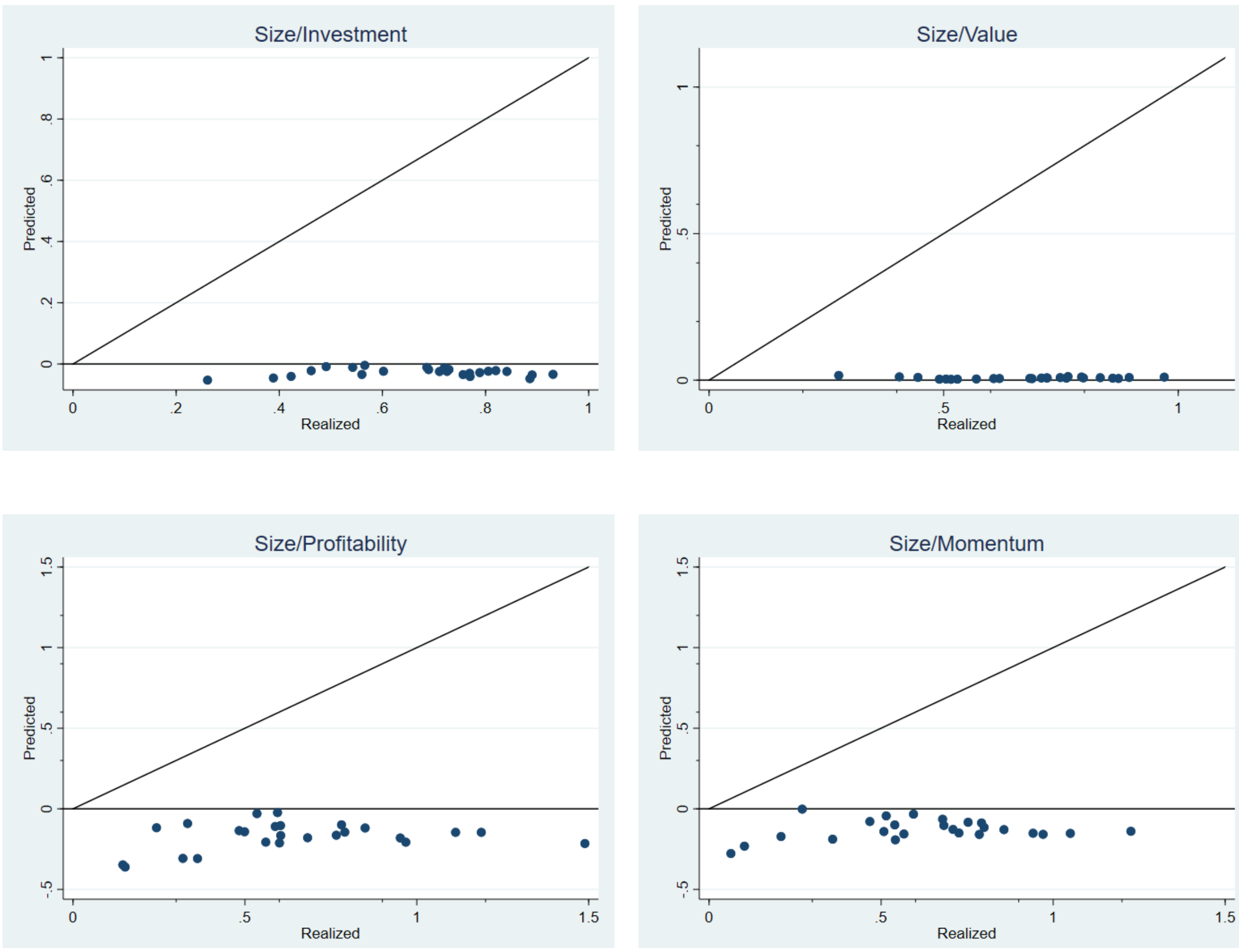


Figure 9: Sentiment, Orthogonal

This figure summarizes the relation between the actual expected portfolio return and that predicted by previous end of year sentiment index level, calculated using elements made orthogonal to the business cycle. Each graph represents a set of 25 independently sorted portfolios based on size and a second characteristic. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.



Internet Appendix (Not for Publication)

Table A.1: Price of Risk

The following results document the performance of all factor models in pricing 125 size-investment-profitability sorted portfolios. Three-Year is the ultimate consumption risk of Julliard and Parker (2005), Q4-Q4 consumption growth rate comes from Jagannathan and Wang (2006), Without garbage is the unfiltered consumption model of Kroencke (2017), AEM is the broker-dealer leverage ratio of Adrian, Etula, and Muir (2014) which includes updates to the underlying data (AEM New), HKM is the primary dealer capital ratio of He, Kelly, and Manela (2017), Sentiment is a proxy coming from Baker and Wurgler (2006), and CRR represents the 5 macroeconomic risk factors of Chen, Roll, and Ross (1986). T-stats are adjusted for heteroskedasticity and autocorrelations. Adj R-squared is average from second stage cross sectional regressions.

	Intercept	Slope	Mkt	Adj R-Squared
Three-Year	6.17	2.02		0.04
T-stat	2.21	3.24		
Q4-Q4	7.16	0.49		0.02
t-stat	2.37	1.62		
Witout Garbage	6.84	0.56		0.03
t-stat	2.70	0.52		
AEM	1.23	13.51		0.03
t-stat	1.69	3.92		
AEM New	1.67	4.63		0.06
t-stat	2.62	2.37		
HKM	3.20	3.08	-0.97	0.15
t-stat	4.13	1.56	-1.07	
Sentiment	0.84	0.40		0.05
t-stat	4.74	1.93		
Sentiment, Orthogonal	0.82	0.36		0.05
t-stat	4.51	1.73		

	Intercept	DEI	MP	UI	UPR	UTS	Adj R-Squared
CRR	0.92	-0.15	0.17	-0.10	0.18	-0.85	0.08
t-stat	5.33	-2.47	1.65	-2.19	1.99	-3.57	

Appendix: Alternate Beta Estimates

Table A.2 Price of Risk Using Alternate Betas, Size-Investment

The following results document the performance of all factor models in pricing 25 size-investment sorted portfolios using rolling and extending window betas. Three-Year is the ultimate consumption risk of Julliard and Parker (2005), Q4-Q4 consumption growth rate comes from Jagannathan and Wang (2006), Without garbage is the unfiltered consumption model of Kroencke (2017), AEM is the broker-dealer leverage ratio of Adrian, Etula, and Muir (2014) which includes updates to the underlying data (AEM New), HKM is the primary dealer capital ratio of He, Kelly, and Manela (2017), Sentiment is a proxy coming from Baker and Wurgler (2006), and CRR represents the 5 macroeconomic risk factors of Chen, Roll, and Ross (1986). T-stats are adjusted for heteroskedasticity and autocorrelations. Adj R-squared is average from second stage cross sectional regressions.

Table A.2a: Consumption

	Intercept	Slope	Adj R-Squared
Three-Year			
Rolling	6.91	0.55	0.16
t-stat	2.48	1.71	
Extending	4.72	0.99	0.20
t-stat	1.84	1.12	
Q4-Q4			
Rolling	8.43	-0.03	0.16
t-stat	2.70	-0.13	
Extending	5.52	0.39	0.10
t-stat	1.71	0.70	
Without Garbage			
Rolling	7.66	0.17	0.18
t-stat	2.55	0.34	
Extending	4.25	0.87	0.22
t-stat	1.05	0.76	

Table A.2b: Intermediary

	Intercept	Slope	Mkt	Adj R-Squared
AEM				
Rolling	1.90	3.76		0.16
t-stat	2.53	1.63		
Extending	1.65	2.57		0.21
t-stat	1.85	0.61		
AEM New				
Rolling	2.32	4.09		0.18
t-stat	3.66	3.11		
Extending	1.75	1.26		0.28
t-stat	2.45	0.59		
HKM				
Rolling	2.32	1.96	0.28	0.30
t-stat	2.90	1.11	0.31	
Extending	2.03	5.15	0.71	0.36
t-stat	2.01	1.53	0.65	

Table A.2c: Sentiment

	Intercept	Slope	Adj R-Squared
Sentiment			
Rolling	0.66	0.25	0.14
t-stat	3.18	2.20	
Extending	0.69	0.08	0.24
t-stat	4.07	0.34	
Sentiment, Orthogonal			
Rolling	0.68	0.26	0.14
t-stat	3.34	2.12	
Extending	0.69	0.07	0.24
t-stat	4.08	0.30	

Table A.2d: Chen, Roll, and Ross

	Intercept	DEI	MP	UI	UPR	UTS	Adj R-Squared
CRR							
Rolling	0.81	0.04	0.15	0.01	-0.04	-0.07	0.34
t-stat	3.95	0.63	1.26	0.17	-0.64	-0.61	
Extending	0.41	-0.06	0.22	-0.15	0.08	0.56	0.35
t-stat	1.34	-0.48	0.97	-1.39	0.59	1.49	

Table A.3 Price of Risk Using Alternate Betas, Size-Profitability

The following results document the performance of all factor models in pricing 25 size-profitability sorted portfolios using rolling and extending window betas. Three-Year is the ultimate consumption risk of Julliard and Parker (2005), Q4-Q4 consumption growth rate comes from Jagannathan and Wang (2006), Without garbage is the unfiltered consumption model of Kroencke (2017), AEM is the broker-dealer leverage ratio of Adrian, Etula, and Muir (2014) which includes updates to the underlying data (AEM New), HKM is the primary dealer capital ratio of He, Kelly, and Manela (2017), Sentiment is a proxy coming from Baker and Wurgler (2006), and CRR represents the 5 macroeconomic risk factors of Chen, Roll, and Ross (1986). T-stats are adjusted for heteroskedasticity and autocorrelations. Adj R-squared is average from second stage cross sectional regressions.

Table A.3a: Consumption

	Intercept	Slope	Mkt	Adj R-Squared
Three-Year				
Rolling	7.08	-0.19		0.11
t-stat	2.59	-0.69		
Extending	7.59	-0.88		0.10
t-stat	2.77	-1.39		
Q4-Q4				
Rolling	5.73	0.07		0.11
t-stat	1.76	0.29		
Extending	11.09	-0.95		0.12
t-stat	2.60	-1.58		
Without Garbage				
Rolling	6.77	-0.16		0.11
t-stat	2.11	-0.36		
Extending	10.73	-1.06		0.14
t-stat	2.55	-1.08		

Table A.3b: Intermediary

	Intercept	Slope	Mkt	Adj R-Squared
AEM				
Rolling	1.69	1.89		0.13
t-stat	2.48	1.00		
Extending	1.75	5.45		0.16
t-stat	2.07	1.40		
AEM New				
Rolling	2.26	1.31		0.12
t-stat	3.57	1.14		
Extending	1.73	1.97		0.20
t-stat	2.39	1.00		
HKM				
Rolling	0.64	2.77	1.50	0.26
t-stat	0.75	1.79	1.76	
Extending	-0.42	2.74	2.34	0.30
t-stat	-0.35	0.98	1.99	

Table A.3c: Sentiment

	Intercept	Slope	Mkt	Adj R-Squared
Sentiment				
Rolling	0.72	0.03		0.11
t-stat	3.41	0.40		
Extending	0.53	0.05		0.21
t-stat	2.65	0.16		
Sentiment, Orthogonal				
Rolling	0.70	0.05		0.11
t-stat	3.30	0.56		
Extending	0.57	0.19		0.20
t-stat	2.83	0.63		

Table A.3d: Chen, Roll, and Ross

	Intercept	DEI	MP	UI	UPR	UTS	Adj R-Squared
CRR							
Rolling	0.31	-0.08	-0.18	-0.06	0.00	0.03	0.30
t-stat	1.39	-1.67	-2.19	-1.41	0.06	0.22	
Extending	-0.23	0.05	-0.89	0.23	0.12	-0.27	0.32
t-stat	-0.69	0.34	-4.26	2.07	1.01	-0.86	

Table A.4: Consumption Factors, 25 Size-Value Portfolios

This table presents pricing tests of the consumption factor models on 25 size-value sorted portfolios. Coefficients are calculated from 2-stage Fama-MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize*is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price time number of shares outstanding in the month of June of year t-1. *avgb2m* is the value weighted portfolio average of the book to market ratio of firms in the portfolio. Adj R-squared is average from second stage cross sectional regressions.

Q4-Q4

	Intercept	Factor	avgsize	avgb2m	Adj R-squared
Estimate	2.17	1.87			0.17
t-stat	0.64	2.24			
Estimate	4.64	0.83	-0.17	1.75	0.40
t-stat	1.56	0.86	-1.04	1.04	

Three Year

	Intercept	Factor	avgsize	avgb2m	Adj R-squared
Estimate	4.67	2.62			0.19
t-stat	1.78	2.22			
Estimate	5.35	1.67	-0.14	1.29	0.44
t-stat	1.9	1.07	-0.99	0.65	

Without Garbage

	Intercept	Factor	avgsize	avgb2m	Adj R-squared
Estimate	-1.20	2.84			0.24
t-stat	-0.28	1.93			
Estimate	-0.08	2.17	0.00	1.45	0.45
t-stat	-0.02	1.29	0.02	0.91	

Table A.5: Consumption Factors, 25 Size-Momentum Portfolios

This table presents pricing tests of the consumption factor models on 25 size-momentum sorted portfolios. Coefficients are calculated from 2-stage Fama-MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize*is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price time number of shares outstanding in the month of June of year t-1. *avgmom* is the value weighted portfolio average of the prior (2-12) returns of firms in the portfolio. Adj R-squared is average from second stage cross sectional regressions.

Q4-Q4

	Intercept	Factor	avgsize	avgmom	Adj R-squared
Estimate	4.30	1.49			0.20
t-stat	1.07	1.99			
Estimate	5.83	0.60	-0.15	0.07	0.48
t-stat	1.68	1.12	-1.08	2.47	

Three Year

	Intercept	Factor	avgsize	avgmom	Adj R-squared
Estimate	5.67	2.44			0.08
t-stat	1.66	2.03			
Estimate	5.47	1.53	-0.14	0.08	0.48
t-stat	1.77	1.82	-0.94	2.46	

Without Garbage

	Intercept	Factor	avgsize	avgmom	Adj R-squared
Estimate	9.97	-0.62			0.05
t-stat	3.26	-0.75			
Estimate	2.78	1.19	-0.12	0.09	0.46
t-stat	0.77	1.39	-0.77	2.64	

Table A.6: Intermediary Models, 25 Size-Value Portfolios

This table presents pricing tests of the intermediary factor models on 25 size-value sorted portfolios. Coefficients are calculated from 2-stage Fama-MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize*is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price time number of shares outstanding in the month of June of year t-1. *avgb2m* is the value weighted portfolio average of the book to market ratio of firms in the portfolio. Adj R-squared is average from second stage cross sectional regressions.

AEM

	Intercept	Factor	Mkt	avgsize	avgb2m	Adj R-squared
Estimate	1.06	9.40				0.14
t-stat	1.32	2.47				
Estimate	1.23	6.72		-0.02	0.08	0.33
t-stat	1.36	1.74		-0.77	0.29	

AEM New

	Intercept	Factor	Mkt	avgsize	avgb2m	Adj R-squared
Estimate	1.11	5.02				0.17
t-stat	1.63	2.4				
Estimate	1.07	4.37		0.00	0.24	0.40
t-stat	1.43	1.61		0.12	0.61	

HKM

	Intercept	Factor	Mkt	avgsize	avgb2m	Adj R-squared
Estimate	1.38	5.38	0.57			0.46
t-stat	1.31	1.99	0.52			
Estimate	1.83	4.34	0.21	-0.02	0.03	0.51
t-stat	1.76	1.52	0.2	-1.13	0.12	

Table A.7: Intermediary Models, 25 Size-Momentum Portfolios

This table presents pricing tests of the intermediary factor models on 25 size-momentum sorted portfolios. Coefficients are calculated from 2-stage Fama-MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize*is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price time number of shares outstanding in the month of June of year t-1. *avgmom* is the value weighted portfolio average of the prior (2-12) returns of firms in the portfolio. Adj R-squared is average from second stage cross sectional regressions.

AEM

	Intercept	Factor	Mkt	avgsize	avgmom	Adj R-squared
Estimate	1.20	13.40				0.11
t-stat	1.39	2.8				
Estimate	1.30	5.78		-0.03	0.02	0.39
t-stat	1.59	1.55		-1.01	2.64	

AEM New

	Intercept	Factor	Mkt	avgsize	avgmom	Adj R-squared
Estimate	1.88	1.55				0.11
t-stat	2.92	0.59				
Estimate	1.00	3.85		-0.01	0.02	0.40
t-stat	1.46	1.78		-0.62	2.62	

HKM

	Intercept	Factor	Mkt	avgsize	avgmom	Adj R-squared
Estimate	2.13	-4.88	0.19			0.34
t-stat	2.44	-1.92	0.19			
Estimate	2.93	2.14	-1.27	-0.04	0.03	0.52
t-stat	3.27	0.84	-1.41	-2.26	3.43	

Table A.8: Chen, Roll, and Ross Model, 25 Size-Value Portfolios

This table presents pricing tests of the Chen, Roll, and Ross macroeconomic measures on 25 size-value sorted portfolios. Coefficients are calculated from 2-stage Fama-MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize*is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price time number of shares outstanding in the month of June of year t-1. *avgb2m* is the value weighted portfolio average of the book to market ratio of firms in the portfolio. Adj R-squared is average from second stage cross sectional regressions.

Chen, Roll, and Ross Macro Factors

	Intercept	DEI	MP	UI	UPR	UTS	avgsize	avgb2m	Adj R-squared
Estimate	0.05	-0.30	0.56	-0.34	0.01	0.99			0.31
t-stat	0.25	-1.22	2.59	-1.49	0.11	3.41			
Estimate	-0.04	-0.23	0.45	-0.20	0.10	0.78	-0.001	0.11	0.42
t-stat	-0.13	-1.02	2.45	-1	0.84	2.74	-0.2	1.26	

Table A.9: Chen, Roll, and Ross Model, 25 Size-Momentum Portfolios

This table presents pricing tests of the Chen, Roll, and Ross macroeconomic measures on 25 size-momentum sorted portfolios. Coefficients are calculated from 2-stage Fama-MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize*is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price time number of shares outstanding in the month of June of year t-1. *avgmom* is the value weighted portfolio average of the prior (2-12) returns of firms in the portfolio. Adj R-squared is average from second stage cross sectional regressions.

Chen, Roll, and Ross Macro Factors

	Intercept	DEI	MP	UI	UPR	UTS	avgsize	avgmom	Adj R-squared
Estimate	0.98	-0.05	0.69	0.13	0.01	-1.20			0.43
t-stat	3.58	-0.23	2.77	0.70	0.10	-3.24			
Estimate	0.75	-0.06	0.33	0.08	-0.18	-0.20	-0.01	0.01	0.52
t-stat	2.65	-0.31	1.77	0.45	-1.21	-0.59	-2.61	2.52	

Table A.10: Sentiment Index, 25 Size-Value Portfolios

This table presents pricing tests of the sentiment model on 25 size-value sorted portfolios. Coefficients are calculated from 2-stage Fama-MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize*is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price time number of shares outstanding in the month of June of year t-1. *avgb2m* is the value weighted portfolio average of the book to market ratio of firms in the portfolio. Adj R-squared is average from second stage cross sectional regressions.

Sentiment

	Intercept	Factor	avgsize	avgb2m	Adj R-squared
Estimate	0.70	0.05			0.25
t-stat	4.08	0.16			
Estimate	0.62	0.09	-0.01	0.08	0.41
t-stat	3.06	0.3	-1.47	0.88	

Sentiment, Orthogonal

	Intercept	Factor	avgsize	avgb2m	Adj R-squared
Estimate	0.66	-0.01			0.24
t-stat	3.93	-0.05			
Estimate	0.60	0.07	-0.01	0.09	0.41
t-stat	3.01	0.22	-1.33	1.00	

Table A.11: Sentiment Index, 25 Size-Momentum Portfolios

This table presents pricing tests of the sentiment model on 25 size-momentum sorted portfolios. Coefficients are calculated from 2-stage Fama-MacBeth regressions. T-stats are adjusted for heteroskedasticity and autocorrelations. Results are presented both with and without average portfolios characteristics. *avgsize*is the value weighted portfolio average of the size (in millions) of firms in the portfolio calculated as the share price time number of shares outstanding in the month of June of year t-1. *avgmom* is the value weighted portfolio average of the prior (2-12) returns of firms in the portfolio. Adj R-squared is average from second stage cross sectional regressions.

Sentiment

	Intercept	Factor	avgsize	avgmom	Adj R-squared
Estimate	0.81	0.41			0.16
t-stat	4.28	1.25			
Estimate	0.69	0.43	-0.01	0.01	0.41
t-stat	3.21	1.41	-2.2	3.01	

Sentiment, Orthogonal

	Intercept	Factor	avgsize	avgmom	Adj R-squared
Estimate	0.76	0.33			0.16
t-stat	4.03	0.98			
Estimate	0.64	0.37	-0.01	0.01	0.42
t-stat	3.04	1.23	-2.10	3.03	

Figure A1: Three-Year Consumption Growth

This figure summarizes the relation between the actual expected portfolio return and that predicted by the three-year consumption growth model. Each graph represents a set of 125 portfolios independently sorted on either size-investment-profitability or size-value-momentum. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

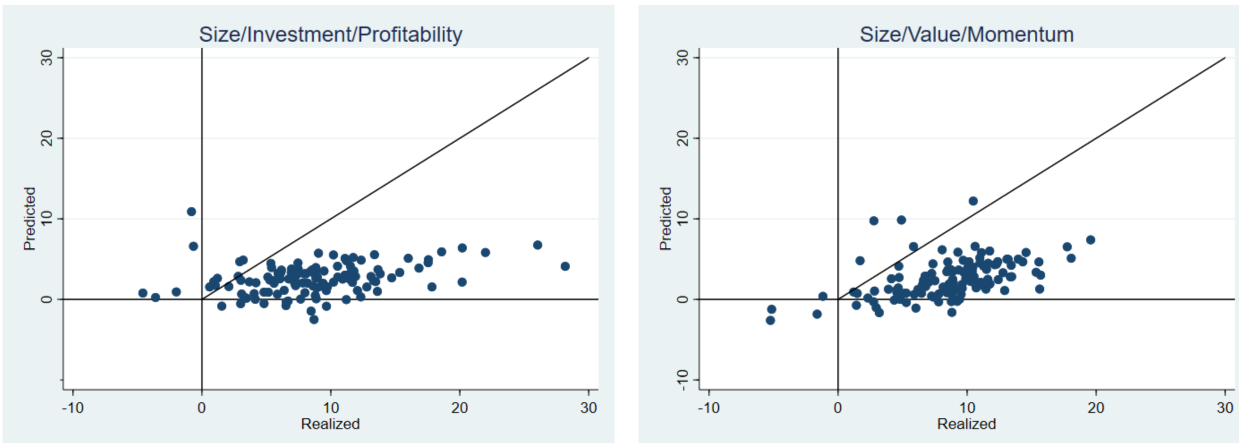


Figure A2: Q4-Q4 Consumption Growth

This figure summarizes the relation between the actual expected portfolio return and that predicted by the Q4-Q4 consumption growth model. Each graph represents a set of 125 portfolios independently sorted on either size-investment-profitability or size-value-momentum. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

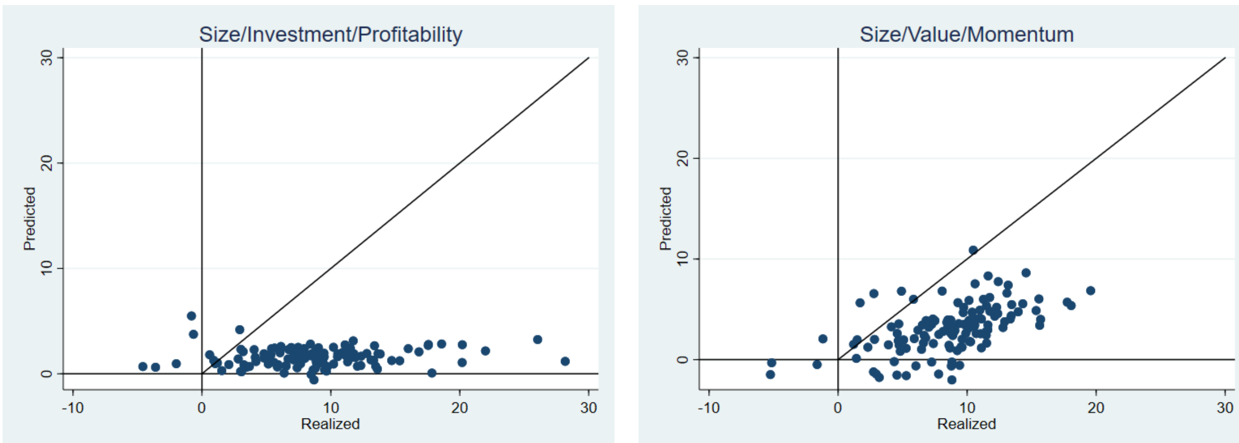


Figure A3: Without Garbage Unfiltered Consumption

This figure summarizes the relation between the actual expected portfolio return and that predicted by the without garbage unfiltered consumption growth model. Each graph represents a set of 125 portfolios independently sorted on either size-investment-profitability or size-value-momentum. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

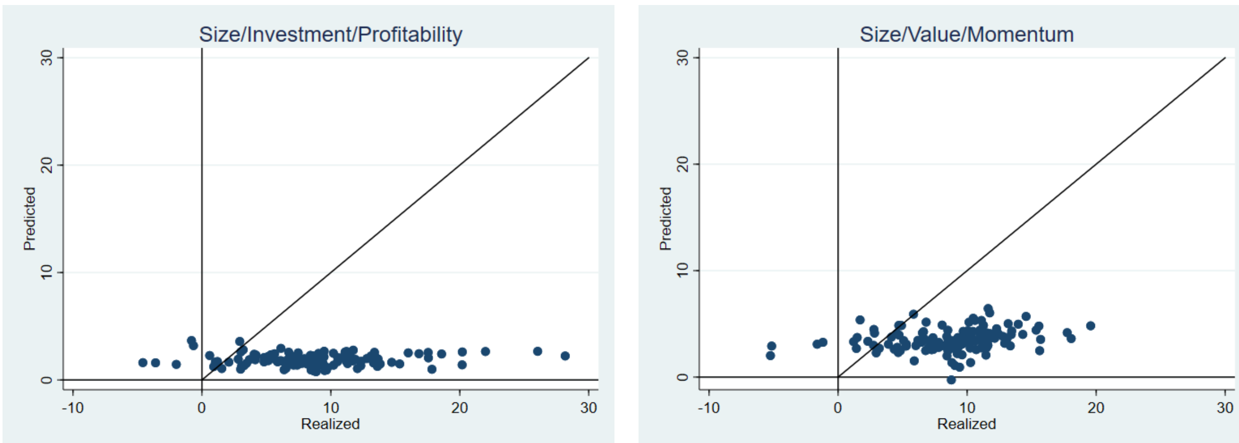


Figure A4: Primary Dealer Capital Ratio

This figure summarizes the relation between the actual expected portfolio return and that predicted by the primary dealer capital ratio two factor model. Each graph represents a set of 125 portfolios independently sorted on either size-investment-profitability or size-value-momentum. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

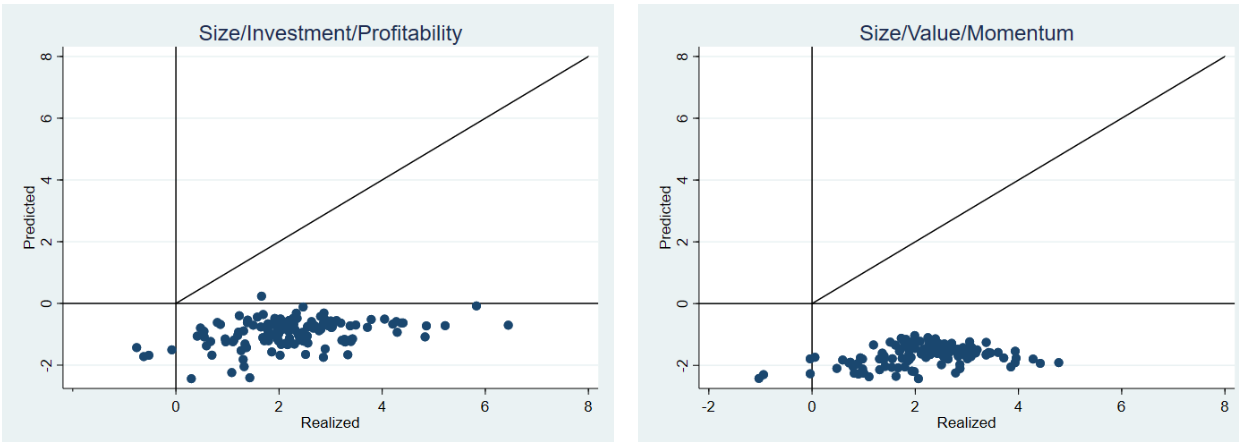


Figure A5: Broker-Dealer Leverage

This figure summarizes the relation between the actual expected portfolio return and that predicted by innovations in broker-dealer leverage. Each graph represents a set of 125 portfolios independently sorted on either size-investment-profitability or size-value-momentum. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.

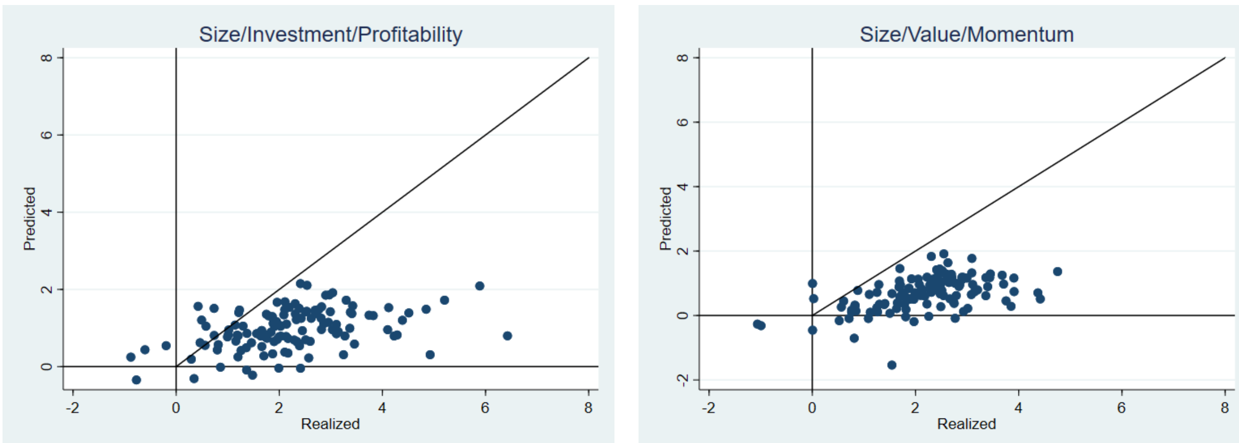


Figure A6: NEW Broker-Dealer Leverage

This figure summarizes the relation between the actual expected portfolio return and that predicted by innovations in broker-dealer leverage using a version of the series based on updated underlying data. Each graph represents a set of 125 portfolios independently sorted on either size-investment-profitability or size-value-momentum. Predicted is the product of the portfolio beta, calculated using the full sample, and the estimated price of risk. Realized is the average excess return of the portfolio over the sample period.