Real investment and risk dynamics

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Real Investment, Risk and Risk Dynamics

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Abstract

The spread in average returns between low and high asset growth and investment portfolios is largely accounted for by their spread in systematic risk, as measured by the Chen, Roll and Ross (1986) factors. In addition, systematic risk and volatility fall sharply during large investment periods. Consistent with the predictions of both the q-theory and real options models, the systematic risk spread and fall in risk and volatility are largest for high q firms. Moreover, investment and asset growth factors can predict economic growth. Our evidence implies that much of negative investment (asset growth)-future returns relationship can be explained by rational pricing.

JEL Classification: G0, G12, G31.

Keywords: Real Investment, Expected Returns, Systematic Risk, Mispricing, Tobin's q, Real Options.

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1 Introduction

Recent empirical work finds a strong negative cross-sectional relationship between real investment (and asset growth) and future stock returns. Anderson and Garcia-Feijoo (2006) find that growth in capital expenditures captures the cross-section of average stock returns and explains the returns on size and book to market portfolios. Xing (2006) finds that in the cross-section, portfolios of firms with low investment growth rates, or low investment to capital ratios, have significantly higher average returns than those with high investment growth rates or high investment to capital ratios. Cooper, Gulen and Schill (2007) show that firms' asset growth is an important predictor of average stock returns. Specifically, high asset growth firms subsequently earn substantially lower average returns than low asset growth firms. They find that "the firm asset growth rate is the strongest determinant of future returns, with t-statistics of more than twice those obtained by other previously documented predictors of the cross-section".

A set of related empirical work finds that an investment factor, defined as the return on a portfolio of low investment stocks over the return on a portfolio of high investment stocks, can explain much of the cross-section of average returns. Xing (2006) finds that an investment factor contains information similar to the Fama and French (1993) value factor (HML), and can explain the value effect about as well as the HML. Lyandres, Sun and Zhang (2007) find that the post SEO underperformance substantially diminishes when an investment factor portfolio is added as a common risk factor. Chen and Zhang (2008) show that a three factor model, where the factors are the market portfolio, an investment factor and a productivity factor, explains much of the average return spreads across test assets formed on momentum, financial distress, investment, profitability, net stock issues and valuation ratios.

In view of these empirical findings two closely related natural questions arise. First, what drives the negative investment (asset growth)-future returns relationship. Second, can the investment factor be interpreted as an economic risk factor related to the business cycle that investors require a premium for holding. These issue are particularly noteworthy since the empirical findings about the negative investment (asset growth)-future returns relationship are consistent with explanations that rely on a rational optimizing agent theory, as well as explanations based on a behavioral model that assumes some form of mispricing. Determining the role played by risk in the negative investment (asset growth)-future returns relationship is important given the competing explanations and the compelling empirical evidence surrounding its existence.

In this paper, we explore empirically the extent to which risk accounts for the negative cross-sectional investment (asset growth)-future returns relationship, and whether the investment (as well as an asset growth) factor can be interpreted as a macroeconomic risk factor. We examine the extent to which the negative investment (asset growth)-future returns relationship is accounted for by the spread in systematic risk between low investment (asset growth) and high investment (asset growth) firms. As in Liu and Zhang (2007), we measure systematic risk using the five Chen, Roll and Ross (1986) macroeconomic factors (which we intermittently refer to as the CRR factors). These factors capture the state of the business cycle and, as opposed to characteristic-based return factors, are easily interpreted as economic risk factors.

We also examine whether the fraction of the spread in average returns between low investment (asset growth) firms and high investment (asset growth) firms that is accounted for by the spread in systematic risk is particularly large when the high investment (asset growth) firms also have a high Tobin's q. This question is particularly important because the rational based explanations, namely the q-theory and real options models, assume optimal investment behavior, implying that firms invest when they have valuable investment opportunities as reflected by high q. These models predict that firms with high investment have particularly low risk and firms with low investment have particularly high risk. Therefore, finding that the fraction of the average return spread explained by the spread in systematic risk between firms with low investment and firms with both high investment and a high q is large would be evidence consistent with the predictions of the rational based models. Firms with high investment but low q are possibly overinvesting, and therefore the rational-based models do not pertain to these firms.

To the extent that a high q potentially reflects stock overpricing, rational and behavioral based explanations for the negative investment (asset growth)-future returns relationship would have different predictions concerning firms investing when their q is high. If high q firms are overpriced, then their average returns will be lower than their expected returns implied by their risk factor loadings. Therefore, the average return spread between low investment firms and firms with high investment and high q would likely be larger than their expected return spread implied by their risk spread.[1] Finding evidence consistent with this would constitute evidence against the rational-based models and for the behavioral-based explanations.

We also examine the dynamics of systematic risk and volatility around high investment (asset growth) periods, for which risk-based explanations offer the clear prediction that both systematic risk and volatility fall during high investment (asset growth) periods. We also focus separately on systematic risk and volatility dynamics of high q firms because the q-theory and the real options models pertain to these firms the most. Finding that systematic risk and volatility of high q firms does not fall during high investment periods would constitute evidence against the predictions of the rational-based models.

Finally, we test whether the profitability of the investment (and asset growth) factor can be linked to future industrial production growth. Thus, we tie the ability of these factors to capture the cross-section of portfolio returns to the macroeconomy.

Several models provide rational-based explanations for the negative investment (asset growth)-future returns relationship. Berk, Green and Naik (1999) and Gomes, Kogan and Zhang (2003) present models showing that the level of investment increases with the availability of low risk projects. Consequently, investing in these projects reduces expected returns because the firm's systematic risk is the average of the systematic risk of its mix of assets in place. Investment will, therefore, be followed by low average returns. Berk, Green and Naik (2004) present a model of a multistage investment project in which uncertainty is resolved with investment, implying that the risk premium declines with investment.

Li, Livdan and Zhang (2007) and Liu, Whited and Zhang (2008) show that the neo-

[1] This inequality would hold unless low investment firms are also overpriced, and more so than high investment and high q firms. This, however, seems to us unlikely.

classical q theory of investment predicts a negative relationship between investment and future returns. The intuition behind this result is that firms will invest when their cost of capital is low. Thus, a low discount rate implies more projects attain a positive NPV and hence will trigger real investment by firms. Therefore, according to the q theory, firms with low systematic risk will invest more. Moreover, firms which receive discount rate shocks that reduce their cost of capital will also respond by undertaking investment. Thus, a fall in risk during periods of investment is consistent with the prediction of the q theory.

Real options models (see, for example, McDonald and Siegel (1986), Majd and Pindyck (1987), Pindyck (1988) and Carlson, Fisher and Giammarino (2006)) also predict that firms undertaking investment projects experience a fall in their systematic risk because undertaking real investment exercises a risky real option.

Behavioral type explanations for the negative investment (asset growth)-future returns relationship are based on investor overreaction, management overinvestment, and market timing. Using Carhart's (1997) four factor model, Titman, Wei and Xie (2004) uncover negative abnormal returns following investment. They argue that their evidence is consistent with investors being slow to react to overinvestment by empire building managers. Cooper, Gulen and Schill (2007) argue that investors overreact to asset growth, which is not necessarily overinvestment, and that the negative abnormal returns after investment are a correction for the overreaction. An alternative argument for the negative relationship is that mangers are timing the market and invest when their stocks are overpriced and hence the negative abnormal returns reflect a correction for the overpricing of the stocks (see Stein (1996), Baker, Stein and Wurgler (2003) and Lamont and Stein (2006)).

Our findings provide substantial support for the rational based explanations of the negative investment (asset growth)-future returns relationship and can be summarized as follows. First, we show that the spread in average returns between low and high investing firms is to a large degree captured by their spread in expected returns as measured by the product of their loadings with respect to the Chen, Roll and Ross (1986) macroeconomic factors and the estimated risk premia on these factors. Furthermore, consistent with rational-based models, namely the q-theory and real options models, for firms investing when they have good investment opportunities as measured by high Tobin's q, the negative investment (asset growth)-future returns relationship is accounted for by differences in expected returns to an even greater extent.

The second piece of evidence that provides support for rational based explanations for the negative investment (asset growth)-future returns relationship is based on the dynamics of systematic risk around investment. We show that firms' loadings with respect to the CRR factors fall (rise) substantially during the period in which the investment (disinvestment) is undertaken. Similarly, the loadings fall sharply in periods of high asset growth (and rise during negative asset growth years). While the risk based theories predict that the low (high) average returns after high (negative) investment is a result of a fall (increase) in systematic risk, current behavioral explanations do not have a clear prediction concerning a change in systematic risk following investment or disinvestment. Therefore, our findings concerning risk dynamics are consistent with the rational-based explanations but not necessarily with the behavioral explanations. Our methodology is complementary to other studies of the investment-future negative return relationship in that it provides evidence on the risk dynamics of firms around investment periods.

As noted earlier, both the real options theory and the q-theory pertain to firms optimally exercising valuable investment opportunities (that is, firms with high q at the time of the investment) and not to firms that may be overinvesting. Consistent with the predictions of these models, we find that the fall in systematic risk following large investment (high growth rate of asset) is particularly sharp when the high investment (high asset growth) firms also have high q in the investment (asset growth) period.

Our third finding concerns the volatility of stock returns around investment periods. The real options theory predicts that before investing a firm's stock return volatility is high because the 'moneyness' of its real option to invest is high. By investing, the firm is exercising its growth option and consequently volatility should drop. The q-theory also predicts a fall in volatility during high investment and asset growth periods. The rationale is that discount rate shocks that reduce a firm's systematic risk will reduce the firm's cost of capital and render more investment projects positive NPV projects. By reducing systematic risk these shocks will also reduce total stock return volatility, assuming idiosyncratic risk does not increase.

We find that volatility drops during high investment (asset growth) periods. Moreover, high investment (asset growth) firms that also have a high Tobin's q (in the top quintile of firms), which we interpret as investing optimally, experience a much more drastic decline in stock return volatility upon investing. Specifically, their annualized volatility falls sharply, by approximately 15 percentage points during the investment period. This finding lends further support for the predictions of real options models and of the q-theory and is complementary to the empirical results in Grullon, Lyandres and Zhdanov (2008) who find that the sensitivity of firms' value to changes in measures for volatility of fundamentals (e.g. demand volatility) drops following investment.

Our fourth finding that supports a rational explanation for the investment-future returns relationship is that an investment factor, defined as the return difference between firms with low investment (bottom decile) and firms with high investment (top decile) can predict future industrial production growth at quarterly frequencies. When predicting the industrial production growth, the coefficients on the investment factor is positive, implying that the factor, like the market portfolio, earns low returns just before recessions. This finding is consistent with the interpretation that the investment factor constitutes a risk factor that varies with the business cycle, and, therefore, on average earns a positive risk premium.[2] This evidence is important in view of the findings of Xing (2006), Lyandres, Sun and Zhang (2007) and Chen and Zhang (2008) that an investment factor captures much of the cross-section of average returns of portfolios formed by various firm characteristics and can explain several asset pricing anomalies. Our paper is complementary to these papers.

Papers related to ours are Carlson, Fisher and Giammarino (2009) who examine beta and volatility dynamics following SEOs and Hackbarth and Morellec (2008) who study beta dynamics during mergers and acquisitions. Our paper is complementary to these

[2] The result also holds, to a somewhat lesser extent, for an asset growth factor.

papers.

The rest of the paper is organized as follows. Section 2 describes the data and variable construction. Section 3 provides evidence that the Chen, Roll and Ross factors are priced risk factors, quantifies the effect of the loadings with respect to the factors in driving the investment (asset growth)-future returns relationship and explores the dynamics of systematic risk and return volatility around periods of high asset growth and high capital investment. Section 3 also presents evidence that the asset growth and investment factors can predict real activity, before finally providing robustness tests. The paper concludes in Section 4.

2 Data and Variable Construction

We use all NYSE, AMEX and NASDAQ nonfinancial firms listed on the CRSP monthly stock return files and the COMPUSTAT annual industrial firms file from 1961 through to 2005, excluding firms in regulated industries with 4-digit SIC codes between 4000 and 4999 and financial firms with SIC codes between 6000 and 6999. Only firms with ordinary common equity (security type 10 or 11 in CRSP) are used in constructing the sample. To reduce survivorship bias firms are not included in the sample until they are on the COMPUSTAT database for 3 years. A further requirement to be included in the sample is that a firm has 36 months of stock return data. These requirements reduce the influence of small firms in the initial stages of their development. Following the conventions in Fama and French (1992) stock returns from July of year t to June of year $t+1$ are matched with accounting information from the fiscal year ending in calendar year $t-1$ in COMPUSTAT. For accounting ratios that are scaled by price or market value, we use price or market value from December of year $t-1$.

We focus on two real investment based variables known to capture the cross-section of average stock returns. Our first measure, IK, is the ratio of investment in year t to the capital stock in year $t-1$, where investment is item 128 in COMPUSTAT (capital expenditures) and capital is item 8 in COMPUSTAT (property, plant and equipment). Xing (2006) shows that portfolios of low IK firms earn substantially higher average returns than portfolios of high IK firms. Our second measure is the year-on-year percentage change in total assets (COMPUSTAT item 6), which we denote AG (for asset growth). This measure is used by Cooper, Gulen and Schill (2007) who show that it is a strong determinant of the cross-section of average stock returns.

We now turn to the allocation of stocks into portfolios based on asset growth or capital investment. At the end of June in year t stocks are allocated into portfolios based on information published in their financial statements from the fiscal year ending in calendar year $t-1$. Portfolios of stocks are then formed from July of year t through June of year $t+1$. We form 10 equally-weighted portfolios based on either asset growth or on the investment to capital ratio. Our first cross-sectional test examines the fraction of the average return spread between low investment (asset growth) firms and high investment (asset growth) firms that can be explained by the spread between the expected returns of these two portfolios.

We also examine the fraction of average returns spread that is accounted for by the spread in expected returns between low investment (asset growth) firms and firms that have high investment (asset growth) as well as a high Tobin's q. We define the portfolio of high investment (asset growth) and high q firms in year t as the intersection of the top decile IK (AG) portfolio in year t and the portfolio of firms with the highest (top quintile) average of Tobin's q across years $t-1$ and t. Tobin's q is defined as the market value of assets divided by the book value of assets (COMPUSTAT item 6), where the market value of assets is computed as book value of assets plus the market value of common stock minus the sum of the book value of common stock (COMPUSTAT item 60) and balance sheet deferred taxes (COMPUSTAT item 74). All book values for fiscal year t (from COMPUSTAT) are combined with the market value of common equity at the calendar end of year t.

In order to examine the dynamics of systematic risk around large investment periods, we define two portfolios: the pre-investment portfolio and the post-investment portfolio. In year t the pre-investment period portfolio is the equally-weighted portfolio of firms whose IK (AG) will be in the top decile IK (AG) of all firms in either year $t+4$ or $t+3$

or year $t + 2$ (or in any two of the three years, or in all three years). The pre-investment portfolio does not include firms with top decile investment (asset growth) in year $t + 1$ because systematic risk can decline already in the year before investment for the following reason. If the firm receives a discount rate shock that reduces its cost of capital, or if it decides to exercise a real option, investment in some cases could take place a period later due to investment planning (e.g. Lamont, 2000). Therefore, in order to clearly distinguish between the pre-investment period, in which the firm has not yet received a discount rate shock, to the post-investment period, we exclude these firms from the pre-investment portfolio. The post-investment portfolio in year t is the equally-weighted portfolio of the firms whose IK (AG) was in the top decile IK (AG) in year $t - 1$. Overall, we have a time-series of 504 monthly returns for pre-investment and post-investment portfolios from January 1963 through December 2004.

We obtain data on the five Chen, Roll and Ross factors from Laura Xiaolei Liu's website.[3] These variables, all given in monthly frequency from January 1960 to December 2004, include the monthly growth rate of industrial production (MP), unexpected inflation (UI), the change in expected inflation (DEI), the term premium (UTS), defined as the difference between the yield to maturity on long term government bonds and one-year treasury bills, and the default premium (UPR), which is the yield spread between Baa and Aaa corporate bonds.[4]

Cochrane (2001, page 101) and Ferson, Siegel and Xu (2004), among others, recommend using mimicking portfolios when the risk factors in the model are not traded assets. We follow Breeden, Gibbons and Litzenberger (1989), Ferson and Harvey (1991, 1993), Eckbo, Masulis and Norli (2000) and Lamont (2001), among others, and form mimicking portfolios for the five Chen, Roll and Ross factors. Among the CRR factors, three are non-traded assets while two are. To put all factors on equal footings, we construct mimicking portfolios for all five. Importantly, untabulated results show that our risk premium estimates using the mimicking portfolios are the same as the risk premium estimates

[3] We are grateful to Laura Xiaolei Liu and Lu Zhang for graciously making this data available on the internet.

[4] Note that following Chen, Roll, and Ross (1986), Liu and Zhang (2007) lead the MP variable by one month to align the timing of macroeconomic and financial variables.

when using the five CRR factors themselves. Moreover, the investment and asset growth portfolios' loadings with respect to the five mimicking portfolios are very similar to their loadings with respect to the five macroeconomic CRR factors themselves. We follow the methodology in Eckbo, Masulis and Norli (2000) when forming the mimicking portfolios. We form these portfolios from the 10 book-to-market, 10 size, 10 momentum and 10 asset growth portfolios.

Panel A of Table 1 reports the average monthly returns of portfolios sorted by the investment-to-capital ratio. The average returns of low investment-to-capital firms are substantially higher than those of high investment-to-capital firms (the difference is 0.73% per month, or 9.12 percentage points for annualized returns). Panel B of Table 1 reports the average monthly returns of portfolios sorted by the growth rate of assets. As in Cooper, Gulen and Schill (2007), we find that average returns decrease sharply with the growth rate of assets. The average return spread between the low and high asset growth portfolios is 1.21 percent per month, an annual equivalent of 15.52 percent.

Preliminary evidence regarding the ability of systematic risk to explain the spread in average returns across high and low investment-to-capital portfolios is presented in the second to sixth rows of Panel A where we report the loadings of the 10 portfolios returns with respect to the Chen, Roll and Ross factors. The loadings generally decline with IK, and assuming that the Chen, Roll and Ross factors are priced risk factors, this implies that low investment-to-capital ratio firms are riskier than high investment-to-capital ratio firms and similarly, as seen in Panel B of the Table, low asset growth firms are riskier than high asset growth firms.

Considering Panel A in more detail, the loadings with respect to the industrial production factor decline with the investment-to-capital ratio. Notably, the loading of the high investment-to-capital ratio portfolio is more than three times smaller than for the low investment-to-capital portfolio (0.120 versus 0.395). The difference in the coefficients is highly statistically significant (in a regression of the low minus high investment portfolio on the five CRR factors the t-statistic of the coefficient on the industrial production factor is 4.37).

The loadings with respect to the unexpected inflation factor (UI) decline, though non-monotonically, from -4.233 for the low investment-to-capital portfolio to -4.847 for the high investment-to-capital portfolio. The t-statistic for the difference in the loadings is 2.44. The loadings with respect to the change in expected inflation initially fall from 10.338 for the low investment-to-capital portfolio to 5.007 for portfolio 6, before increasing again to 8.107 for the top decile investment-to-capital portfolio. The difference in the loadings is statistically significant with t-statistic of 3.10.

The term premium factor loadings generally fall with IK. The low investment portfolio's loading on this factor is 0.750, whereas the high investment portfolio's loading on this factor is lower at 0.616. The difference in the loadings is statistically significant, with a t-statistic of 3.80. Finally, the low investment portfolio loads higher than the high investment portfolio on the default spread factor (1.546 vs. 1.449), although the difference is not statistically significant.

Panel B of Table 1 presents the results for portfolios sorted by asset growth. The loadings with respect to the industrial production factor generally decline with asset growth, with the notable exception of the second decile portfolio which loads higher than the low investment portfolio on the industrial production factor (0.484 versus 0.334). The loading of the bottom decile portfolio with respect to the industrial production factor is more than three times larger than the loading for the top decile asset growth portfolio (0.334 versus 0.096) and the difference is statistically significant with a t-statistic of 3.22.

The unexpected inflation factor loadings initially increase with asset growth from -4.521 for the bottom decile asset growth portfolio up to -3.729 for the seventh decile portfolio, before falling sharply to -4.823 for the top decile asset growth portfolio. However, the difference between the loadings of the low investment and high investment portfolio is not statistically significant. The loadings with respect to the change in expected inflation factor (DEI) fall monotonically from 11.131 for the bottom decile portfolio to 4.114 for portfolio 7, before increasing to 7.126 for the high asset growth decile portfolio. The difference between the low and high investment portfolios' loadings is statistically significant with a t-statistic of 4.75.

The term premium factor loadings fall sharply from 0.849 for the bottom decile portfolio to 0.534 for the top decile portfolio, and the difference between the loadings is highly statistically significant, with a t-statistic of 7.67. The loadings on the default spread factor fall, though non-monotonically from 1.662 for the low asset growth portfolio to 1.572 for the high asset growth portfolio although the difference between the loadings of the bottom and top decile portfolio loadings is statistically insignificant.

Overall, the loadings with respect to each of the five factors are higher for the low asset growth portfolio than for the high asset growth portfolio. Especially notable are the large differences in the loadings with respect to two factors that are tightly related to the business cycle, namely the industrial production factor and the term spread factor.

The findings in Table 1 provide suggestive evidence that high investment-to-capital (asset growth) firms are less risky than low investment-to-capital (asset growth) firms as reflected in their lower loadings with respect to each of the five Chen, Roll and Ross factors. However, before any specific conclusions regarding firms' risk and expected returns around high and low investment periods can be made and, in particular, how much of the average return difference can be explained by differences in expected return implied by risk factor loadings, it is necessary to assess the extent to which the CRR factors are priced.

3 Empirical Results

This section of the paper presents results on the spread of systematic risk and implied expected returns across investment to capital and asset growth portfolios based on the loadings with respect to the CRR factors and the risk premia commanded by these factors. Specifically, after estimating the CRR factor risk premia, we assess the extent to which the average return spread between the low and high asset growth and investment portfolios can be accounted for by the expected return spread that is implied by the product of the loadings of these portfolios with respect to the CRR factors and the factors' estimated risk premia. We also focus on high investment (asset growth) firms whose Tobin's q is high. The reason for this is that the predictions of the rational-based models explaining the negative investment (asset growth)-future returns pertain to firms investing when they have valuable investment opportunities as reflected in a high Tobin's q.

As opposed to behavioral explanations of the negative investment (asset growth)-future returns relationship, rational-based models have clear predictions concerning the dynamics of systematic risk and return volatility around high investment (asset growth) periods. In light of this, we also examine the dynamics of systematic risk and return volatility during high investment and asset growth periods. Finally, in order to further link the spread in average returns on the low and high investment portfolios to economic fundamentals, and to examine whether a return factor related to investment can be interpreted as a risk factor, we asses the ability of the low minus high investment and asset growth factors to forecast economic growth.

3.1 Estimation of the risk premia on the CRR factors

We estimate the risk premia associated with the five CRR factors using the two-step Fama and MacBeth cross-sectional regression methodology. The test assets are portfolios of stock returns that display a wide spread in average returns. To this end, we use 40 test assets including ten size, ten book-to-market, ten momentum (the 30 portfolios used by Liu and Zhang (2007) and by Bansal, Dittmar, and Lundblad (2005)), as well as 10 portfolios based on asset growth.[5] Our motivation for including the asset growth portfolios as test assets when estimating the factor risk premiums is our interest in the asset growth effect in stock returns and the finding in Cooper, Gulen and Schill (2007) that asset growth is the strongest determinant of average stock returns.

Following Black, Jensen, and Scholes (1972), Fama and French (1992), Lettau and Ludvigson (2001) and Liu and Zhang (2007) we use the full sample to estimate factor loadings in the first step estimation. As Liu and Zhang (2007) note, if the true factor loadings are constant, the full-sample estimates should be the more precise than estimates based on rolling regressions and extending windows. Indeed, untabulated results show that the first-step loadings are estimated much more precisely when employing the full-sample regressions. The standard errors for the full sample loadings are about one-

[5] We obtain the size and book-to-market portfolio from Kenneth French's webiste and the ten momentum portfolios from Laura Xiaolei Liu's website.

third of the corresponding standard errors for the rolling-window loadings across the test assets. Because the attenuation bias is less severe, using an extending-window or full-sample loadings in the first-step regressions is expected to yield higher and less biased risk premium estimates than when using rolling windows. As robustness checks, we also employ extending windows and rolling windows in the first-step estimation of portfolio factor loadings. The rolling windows estimation uses 60 months of returns. The extending windows always start in January 1963 and ends in month t, in which we perform the second-step cross-sectional regressions of portfolio excess returns from t to $t+1$ on factor loadings estimated using information up to month t.

The first row of Table 2 presents the results for the case in which the first stage estimation uses the full sample. Most of the factors' estimated risk premiums are positive and statistically significant. The industrial production factor commands the largest risk premium at 1.425 percent per month. The premium is highly statistically significant with a Shanken-corrected t-statistic of 5.33. The second largest premium is associated with the term spread factor and is estimated at 0.94 percent per month, with a Shanken-corrected t-statistic of 2.76. The default spread factor earns a premium of 0.312 percent per month and the unexpected inflation factor earns a similar premium of 0.271 percent per month, both are statistically significant, with Shanken t-statistic of 2.19 and 2.45, respectively. The change in expected inflation factor's premium is economically small and statistically insignificant.

The average $\overline{R}^2$ across the cross-sectional regressions is 48% which is comparable to findings in other studies.[6] The constant in the regression is quite large suggesting that while the factors can explain a large proportion of the cross-sectional variation in the average returns of the tests assets as reflected in the $\overline{R}^2$, the model does poorly in simultaneously pricing the zero-beta rate. This finding is common among models that use macroeconomic factors (see, for example, Jagannathan and Wang (1986) and Lettau and Ludvigson (2001)) and has been related to the possible effect greater sampling error

[6] For example, Liu and Zhang (2007), using 30 portfolios, single-sorted by book-to-market, size and past six months returns, find that the average $\overline{R}^2$ in Fama MacBeth cross-sectional regressions, where the factors are the three Fama French (1993) factors and the first stage estimation uses the full sample, is 53%.

in the estimated betas has on the upward bias in the zero-beta estimates when using macroeconomic factors (see Lettau and Ludvigson (2001) for a detailed discussion of this issue). While our use of estimated betas with respect to mimicking portfolios, and not with respect to the macroeconomic factors themselves, reduces the sampling error of the beta estimates, the formation of the mimicking portfolios involves estimating the loadings of each of the 40 test assets with respect to the macroeconomic factors, which in itself introduces sampling error. Interestingly, the intercept from the Fama French three factor model is very similar in terms of size and statistical significance (see Liu and Zhang, 2007, in Panel C of Table 5).

When using the extending window, reported in the second row of Table 2, the industrial production factor premium is still the largest, estimated at 1.235% per month. The magnitudes of factor premia decline relative to the full sample whereas the estimated intercept is larger. The final row of the Table reports the results when using a rolling window in the first stage. In this case, the risk premium associated with the industrial production and the term spread factor are the largest at 0.677% per month and 0.641% per month, respectively. The lower economic and statistical significance of the estimates using the extending windows and rolling windows methodologies follow in large part from the imprecise estimation of the portfolio loadings on the five factors relative to the full sample estimation, which produces considerably more precise factor loading estimates.

The results presented above indicate that the CRR risk factors provide a good description of the cross section of expected returns. Below we analyze whether the expected returns on high and low investment (asset growth) portfolios, which are defined as the product of the factor loadings and risk premia, can account for the spread in average returns on these portfolios.

3.2 The Negative Investment-Future Return Relationship and Investment Opportunities

Having estimated the five Chen, Roll and Ross factors risk premiums, we now turn to testing whether the negative cross-sectional relationship between investment (asset growth) and future returns can be accounted for by the spread in the portfolios' systematic risk. For this purpose, we calculate the fraction of average return spread that can be accounted for by the spread in expected returns as implied by portfolios' estimated factor loadings multiplied by the estimated factor risk premiums.

Implied expected returns are calculated as the product of the estimated factor risk premia reported in Table 2 and the portfolio loadings with respect to the factors reported in Table 1. That is, as in Liu and Zhang (2007), after having estimated the five CRR factor risk premiums we estimate for portfolio P the following equation

$$r_{Pt} = \alpha + \beta_{MP} MP_t + \beta_{UI} UI_t + \beta_{DEI} DEI_t + \beta_{UTS} UTS_t + \beta_{UPR} UPR_t + \epsilon_{Pt}, \quad (1)$$

where r_{Pt} is the portfolio return. Next, we calculate portfolio P's implied expected returns as

$$E(r_P) = \widehat{\beta}_{MP}\widehat{\gamma}_{MP} + \widehat{\beta}_{UI}\widehat{\gamma}_{UI} + \widehat{\beta}_{DEI}\widehat{\gamma}_{DEI} + \widehat{\beta}_{UTS}\widehat{\gamma}_{UTS} + \widehat{\beta}_{UPR}\widehat{\gamma}_{UPR}, \quad (2)$$

where the $\widehat{\beta}s$ are the estimated factor loadings and the $\widehat{\gamma}s$ are estimated risk premiums.

Panel A of Table 3 presents the results for portfolios of high and low IK firms where the first stage estimation of the factor premiums uses the full sample. The second through sixth columns show the loadings of the portfolios with respect to the five factors. The seventh column presents the average return spread between the low investment decile portfolio and the high investment decile portfolio (third row), or a portfolio which is the intersection of the high investment decile portfolio and high q portfolio (fourth row). The eighth column presents the expected return spreads. The penultimate column shows the ratio of expected return spread to average return spread. A ratio of one implies that all of the average return spread is accounted for by the systematic risk spread. The final column reports a t-test of the null hypothesis that the expected return spread and the average return spread are the same.

The high IK portfolio, which includes firms in the top decile IK, has lower loadings with respect to all five factors than the low IK portfolio which includes firms in the bottom decile IK (this is seen when comparing the first and second rows). Particularly noticeable is the large difference in the loadings with respect to the industrial production factor (0.395 for the low investment portfolio and 0.120 for the high investment portfolio). Recalling that the industrial production factor's estimated risk premium is 1.425% per month, these differences in the factor loadings imply a large expected return difference. Given the large risk premium earned by the term spread factor (0.94 percent per month), the difference in the loadings with respect to this factor (0.750 for the low IK portfolio compared to 0.616 for the high IK portfolio) is also substantial.

The average return difference between the low and high IK portfolios is 0.73 percent per month (9.12 percent in annual terms), whereas the implied expected return difference is 0.70 percent per month. Thus, the fraction of the average return spread that is accounted for by the spread in expected returns is 96 percent. The final column reports that the difference between the average return spread and the expected return spread is statistically insignificant, with a t-statistic of 0.17. This implies that practically all of the investment effect in stock returns can be explained by the spread in systematic risk implied by the macroeconomic variables. This evidence lends strong support for the rational based explanations for the real investment effect, namely the q-theory of investment and the real options models.

Our second test uses the above procedure to compare the average return spread that is accounted for by the spread in expected returns between low investment firms and firms with both high investment and high q at the time of investment, as opposed to the spread between low investment firms and all high investment firms. This test is performed for the following reason. Rational based models that tie firm investment to expected returns assume optimal investment behavior. In these models firms will invest optimally when their Tobin's q is high. Consequently, investment will be followed by low systematic risk and low expected returns. Thus, rational based models explain the negative investment (asset growth)-future returns relationship by high investment firms having low systematic risk and also low investment firms having high systematic risk. Therefore, focusing on firms with both high investment (asset growth) and high q firms constitutes a direct test of a central prediction of the rational-based models.

We define a firm to have a high q at the time of investment if the average of its Tobin's q in the year in which it invested and in the previous year is in the top quintile of Tobin's q in that period. Consequently, our portfolio of high investment and high q firms in year t consists of all firms in the intersection of the top decile investment to capital ratio in year t and in the top quintile of the average of q in the years t and $t-1$.

The following row of the Table shows the results for firms with both high IK and high Tobin's q. Examining the first and third rows of the Table, the high IK and high q portfolio has much lower loadings with respect to each of the five CRR factors than the low decile investment portfolio. The difference in the loadings with respect to the industrial production factor is very large: 0.395 for the low investment portfolio versus -0.070 for the high investment and high q portfolio. There is also a large difference in the loadings with respect to the term premium (0.750 versus 0.486) and with respect to the default premium (1.546 versus 1.357). Overall, the spread in expected returns between the low IK portfolio and the high IK and high q portfolio is 1.29% per month, whereas the spread in average returns across these two portfolios is smaller (1.06% per month). Thus, the ratio of implied expected returns spread to average return spread is 1.21. The difference between the average return spread and the expected return spread is statistically indistinguishable from zero (t-statistic of -1.15). Thus, all of the average return spread is accounted for by the spread in expected returns for these firms.

Panel B of Table 3 presents the same results as Panel A but employs the asset growth portfolios. The high AG portfolio, which includes firms in the top decile AG, has lower loadings with respect to all five factors than the low AG portfolio (this is seen when comparing the first and second rows). The difference is particularly large for the loadings with respect to the industrial production factor (0.334 versus 0.100) and the term premium (0.849 versus 0.536), two factors related to the business cycle. The average return difference between the low and high AG portfolios is 1.21 percent per month, whereas the implied expected return difference is 0.73 percent per month. Thus, the fraction of the average return spread that is accounted for by the spread in expected returns is 60%. This implies that much of the asset growth effect in stock returns can be explained by the spread in systematic risk. However, the difference between the average return spread of low and high asset growth firms is statistically significant (t-statistic of 2.84). Therefore, our findings suggest that there is still a potential role for mispricing as an explanation for part of the asset growth effect, or a misspecification of the asset pricing model.

The following row of Panel B presents the results for firms with both high AG and high Tobin's q. As in the case for the IK portfolios, if these firms are investing optimally, we would expect that the predictions of both the q-theory and the real options model apply most to them. Comparing the first and the third rows of Panel B reveals that the loadings with respect to each of the five CRR factors of the high AG and high q portfolio are substantially lower than the loadings of the low AG portfolio. As in the above comparison between the low and high IK portfolios and between the low and high AG portfolios, there is a large difference in the loadings with respect to the industrial production factor (0.334 versus -0.034), in the loadings with respect to the term premium factor (0.849 versus 0.459), and in the loadings with respect to the default premium factor (1.662 versus 1.358).

The average return spread between the low AG firms and the high AG and high q firms is 1.40% per month, whereas the implied expected returns difference across these two portfolios is 1.24%. Thus, consistent with both the q-theory and the real options model, the bulk (89%) of the average return spread between low AG firms and high AG and high q firms is accounted for by the spread in systematic risk. Moreover, the difference between the average return spread of these two portfolios and their expected returns spread is statistically insignificant, with a t-statistic of 0.83. The finding that the fraction of average return spread captured by the spread in expected returns is higher for high q firms than for all firms (89% for high q firms versus 60% for all firms) is consistent with the q-theory and the real options model predictions.

Overall the results in Table 3 are very consistent with the predictions of real options and the q-theory of investment: the average return spread between firms exercising valuable growth opportunities and low investment firms is largely accounted for by the spread in expected returns implied by the spread in their systematic risk. This evidence is accordant with the conjecture that behavioral biases do not account for the entire negative investment (asset growth)-future returns relationship.

3.3 Risk Dynamics and Investment

We now examine the dynamics of systematic risk around periods of high and low asset growth and investment. The q-theory predicts that discount rate shocks that lower a firm's cost of capital will trigger investment. The real options model predicts that risk falls during investment periods because investment constitutes the exercising of a risky growth option. Thus, both theories predict lower systematic risk following investment periods in comparison to the preceding period.

We focus on the dynamics of risk and note that comparing the average return dynamics (as opposed to risk dynamics) around investment periods to the dynamics of risk around such periods is not informative. The reason for this is that prior to the investment period firms typically experience a sequence of positive profitability shocks. Thus, their high average returns prior to investing stem not only from their potentially high risk but also from their positive shocks. Therefore, comparing the average return and expected return differences between the period prior to and following investment is not informative because much of the average return prior to investment is a consequence of profitability shocks that induce the investment.

As seen in Panel A of Table 4, the loadings with respect to all of the CRR factors decline during high IK years. The loading with respect to the industrial production factor falls substantially from 0.424 to 0.120. The loading on the default premium falls from 1.684 to 1.449, and the loading on the term premium factor falls from 0.690 to 0.616, which implies a large fall in expected returns given the large risk premium earned by the term premium factor. The overall fall in the loadings translates into a decline in expected returns of 0.57% per month (7.06% annualized) which is a sizeable decline.

Panel B examines risk dynamics for firms who undertake large investment when they have valuable growth opportunities as captured by a high Tobin's q (that is, their Tobin's q is in the top quintile at the time of the high investment). The rational-based theories, namely the q-theory and the real options models pertain mostly to those firms as they are investing when they have valuable investment opportunities. For example, finding that for high q and high investment firms systematic risk does not fall during investment periods would constitute evidence against the rational-based theories. Hence our focus on these firms. The post investment period portfolio loadings on the CRR factors are smaller than the pre-investment period loadings. The loading on the industrial production factor drops substantially from 0.399 to -0.070, a very substantial fall which reduces expected returns dramatically given the large premium earned by the industrial production factor. The loading on the change in expected inflation factor also falls sharply, but the premium on this factor is close to zero, so that the effect on expected returns is negligible. There is a large fall in the loading with respect to the term spread factor, from 0.706 to 0.486, which has a large impact on expected returns due to the large premium commanded by this factor (0.94 percent per month). Finally, the loading on the default spread factor falls from 1.460 to 1.357. The decline in the factor loadings implies that during high investment periods expected monthly returns fall by a remarkable 0.89%, or 11.22% in annual terms.

Panel C of Table 4 examines risk dynamics for firms who experience a high growth rate of assets. The post AG period portfolio loadings on the CRR factors are smaller than the pre-AG period loadings, with the exception of the loadings with respect to the unexpected inflation factor which rise slightly. The most noticeable change is the large fall in the loading with respect to the industrial production factor, which declines from 0.350 to 0.100. The fall in the loading with respect to the term spread factor is also substantial, from 0.641 to 0.534. The overall change in the loadings leads to a monthly decline in expected returns of 0.44% per month (5.41% annualized).

Panel D presents risk dynamics for firms who have a high growth rate of assets coupled with having valuable investment opportunities, as measured by a high q. As in the previous Panels, there is a sharp fall in the loading with respect to the industrial production factor, from 0.415 to -0.057. Expected returns also decline due to substantial falls in the loadings with respect to the term spread (from 0.686 to 0.448) and the default spread (from 1.525 to 1.424). Consistent with the case of the high IK and high q portfolios, the fall in implied expected returns is substantial and amounts to 0.89% per month (11.22% annualized).

In summary, Table 4 provides strong support for the predictions of the q-theory and the real options models. The fall in expected returns during periods of high investment and high asset growth is mainly due to a decline in portfolio loadings with respect to the industrial production and term spread factors, two factors that are tightly linked to the business cycle. These findings are particularly interesting regarding the debate about the causes of the investment (asset growth)-future returns relationship. While we have found substantial falls in expected returns that mirror the falls in average returns, the behavioral based explanations of the investment negative-return relationship do not have a clear prediction concerning changes in risk and expected return around investment, but only concerning average returns. In light of this, and coupled with our earlier findings regarding the spread in average and expected returns of the low and high investment portfolios, it would seem that behavioral based explanations do not solely account for the investment (asset growth)-future returns relationship.

3.4 Risk Dynamics and Disinvestment

The real options model and the q-theory described above pertain to the relationship between positive investment and risk. However, the intuition can be carried over to the relationship between disinvestment and risk in a straightforward manner. Shocks that increase a firm's discount rate will increase its cost of capital and, consequently, the NPV of some of its existing projects will become negative. In this case, the q-theory predicts that firms will disinvest. Therefore, following disinvestment periods there is an increase in systematic risk. Similarly, the real options theory predicts that risk increases during disinvestment because the option to disinvest is a real put option and disinvestment constitutes exercising this option.

We examine the dynamics of systematic risk during disinvestment as follows. We compare the loadings with respect to the five CRR factors of two portfolios. The first portfolio consists, in year t, of all firms who will disinvest (i.e. have negative capital growth or negative total asset growth) in either year $t+4$, $t+3$ or in year $t+2$ (or in any two of the three years or in all three years). This portfolio is termed the pre-disinvestment portfolio. The second portfolio consists in year t of all firms whose capital growth (asset growth) is negative in year $t-1$. This portfolio is termed the post-disinvestment portfolio.

Panel A of Table 5 shows the results when disinvestment is defined as negative capital growth, whereas in Panel B disinvestment is defined as negative asset growth. As seen in Panel A, all factor loadings rise during periods of negative capital growth. Particularly noticeable are the increases in the loadings with respect to the industrial production factor (from 0.268 to 0.442) and the default spread factor (from 1.365 to 1.538). Expected returns implied by the risk factor loadings rise by 0.39% per month (4.78% annualized).

Panel B presents the results when disinvestment is defined as negative asset growth. As is the case for the IK portfolios, the loadings with respect to all of the five CRR factors rise after negative asset growth periods. The largest impact on expected returns dynamics is due to the large rise in the loadings with respect to the industrial production factor (from 0.223 to 0.364), the term premium factor (from 0.716 to 0.919) and the default spread factor (from 1.501 to 1.712). Expected returns rise by 0.46% per month (5.66% annualized) which is a substantial increase in expected returns due to the rise in systematic risk.

We conclude that the dynamics of risk around disinvestment periods are consistent with the predictions of rational-based models. These findings are in line with the earlier results regarding the changes in systematic risk around investment periods.

3.5 Volatility Dynamics

In this section, we examine the dynamics of volatility around high investment (asset growth) periods. The real options theory has clear predictions concerning volatility dynamics: the volatility of stock returns should decline following investment. The reason for this is that by investing the firm is exercising its real option whose value is highly volatile when its 'moneyness' is high prior to periods of investment. Grullon, Lyandres and Zhdanov (2008) show that the sensitivity of firm value to changes in proxies for underlying volatility (e.g. the volatility of demand) increases prior to the exercising of real options, and drops sharply following the exercising of real options. Volatility then starts rising again as firms start building up new real options. The rationale is that the value of a real option should increase with the volatility of the underlying profitability process, just like the value of a financial option increases with the volatility of the underlying asset.

The q-theory also predicts a fall in volatility during high investment and asset growth periods. The rationale is that discount rate shocks that reduce a firm's systematic risk will render more projects positive NPV investments and, thereby, induce new investment. At the same time a decline in systematic risk should reduce a firm's stock return volatility (assuming no increase in idiosyncratic volatility). Thus, both the real options theory and the q-theory predict a fall in volatility during high asset growth and investment periods. This effect is in addition to the sensitivity of firm value to the underlying volatility which Grullon, Lyandres and Zhdanov examine.

The real options theory and the q-theory both pertain to firms that optimally exercise valuable growth opportunities as reflected in high Tobin's q. Therefore, we also focus separately on the group of firms to which these theories apply the most by examining separately the volatility dynamics for all firms and for the group of firms exercising valuable growth option (i.e. investing when their Tobin's q is high). For example, finding that for high q and high investment firms volatility does not fall during investment periods would constitute evidence against the rational-based theories.

Panel A of Table 6 shows the results for the top decile investment-to-capital portfolios. The standard deviation of monthly returns is 9.02% (or 31.25% in annual terms) in the period before high investment years. In the year following the high investment years the volatility of monthly returns drops to 7.28%, a large fall of 1.74% (6.03% annualized). According to the results in Panel B, the volatility of monthly returns of the high investment and high q portfolio in the period before high investment years is 12.70% (44.31% annualized) which is very large relative to the volatility of a typical well-diversified portfolio such as the market portfolio. In the year following high investment years the volatility of monthly returns falls drastically to 8.37% (28.99% annualized). This translates to a very large decline of 15.32% in annualized returns which is highly consistent with the rational based theories.

Panels C and D provide results pertaining to asset growth portfolios. Panel C shows that during high asset growth years volatility of monthly returns drops substantially by 1.1%, which is 3.81% in annual terms. Panel D presents the results for firms with high q in the period of high asset growth. As in the case of the high investment-to-capital portfolio, volatility of monthly returns is very high (12.53%, which is 43.41% in annual terms) in the period before the high asset growth years. In the year following investment this volatility drops to 8.33%, implying a very large drop of 4.20% in the volatility of monthly returns (or 14.55% decline in annualized returns).[7]

Overall, our findings regarding the dynamics of stock return volatility are remarkably consistent with the real options models and with the q-theory. Volatility drops for all firms in the year prior to investment. However, it drops substantially more for firms investing when they have valuable growth opportunities. These large drops in volatility are consistent with the predictions of the rational based models and consistent with the findings reported earlier regarding changes in systematic risk around investment.

3.6 The Asset Growth and Investment Factors as Predictors of Real Activity

Several papers document that return factors based on low minus high investment portfolios can capture the cross-sectional variation of stock returns. Xing (2006) shows that these factors can subsume the HML factor in explaining the cross-sectional variation of portfolios based on investment and book-to-market. Lyandres, Sun and Zhang (2007) find that the long-term SEO underperformance largely vanishes upon the introduction of an investment portfolio. Chen and Zhang (2008) show that a three factor model, where the factors are the market portfolio, an investment based factor, and a productivity portfolio, explains

[7] In untabulated results we find that the volatility dynamics are very similar when using the top and bottom quintile (as opposed to decile) investment-to-capital and asset growth portfolios.

much of the average return spread across test assets formed on momentum, financial distress, investment, profitability, net stock issues and valuation ratios.

In view of these findings, it is important to examine whether the investment and asset growth factors are related to the macroeconomy. If these factors are indeed related to the macroeconomy then they can be interpreted as risk factors that investors require a premium for holding. In order to assess this, we form two zero investment portfolios and examine whether they can predict future real activity. The first factor is the return on the bottom decile investment-to-capital firms over the top decile investment-to-capital firms. The second factor is the return on the bottom decile investment-to-capital firms over the intersection of the top decile investment-to-capital firms and the top quintile Tobin's q firms. We also repeat the analysis using asset growth portfolios.

The results are presented in Table 7. Panel A shows that the investment-to-capital factor can predict next quarter's real industrial production growth. The coefficient is positive (0.12) and statistically significant (t-statistic 2.54). A positive coefficient implies that, just like the return on the market portfolio, the investment factor earns a low return before recessions.[8] Thus, the investment factor is cyclical and its premium is likely a risk premium. The second row also shows that the investment to capital factor that is also conditional on high q also predicts real industrial production growth. Panel B presents the results for the asset growth factor. As in the case of the investment-to-capital factor, the asset growth factor's coefficient is positive and (marginally) statistically significant when predicting real industrial production growth.

The findings in this section that the coefficients on the investment and asset growth factors are positive, imply that the factors, like the market portfolio, earn low returns just before recessions. This finding is consistent with the interpretation that these factors constitute risk factors that vary with the business cycle, and therefore on average earn a positive risk premium. We conclude that our evidence lends support to the notion that the investment and asset growth factors constitute risk factors and that investors will require a risk premium in order to hold stocks that load on to these factors.

[8] Liew and Vassalou (2000) find that the excess return on the market portfolio, HML and SMB can all predict future economic growth. The coefficients on all three factors are positive.

3.7 Robustness Checks

In this section we conduct several robustness checks. First, we assess the robustness of our results concerning the fraction of average return spread explained by the spread in expected returns to using an extending window and a rolling window in the first stage of the Fama and MacBeth procedure. Second, we assess the robustness of our findings to the use of quintile rather than decile portfolios.[9]

Table 8 assesses the robustness of the results using different windows to estimate the factor loadings. Panels A and B present the results where the first-stage estimation employs an extending window. Panel A examines the fraction of average return spread between low investment stocks and high investment stocks that is accounted for by the spread in expected returns. Panel B similarly examines that fraction for asset growth portfolios. The results in Panel A are similar to the full sample results provided in Table 3. Panel A shows that as much as 90% of the average return spread between the low investment-to-capital and high investment-to-capital portfolios can be explained by the spread in expected returns implied by the risk factor loadings. When conditioning on high q firms, 95% of the spread in average returns between the low investment-to-capital portfolio and the high IK and high q portfolio are accounted for by the spread in expected returns. Thus, the tests based on an extending window also indicate that risk plays a central role in the negative investment-future returns relationship.

Panel B of Table 8 shows that when the factor risk premiums are estimated using the extending-window method, a smaller fraction of the average return difference between low asset growth firms and high asset growth firms (and high AG and high q firms) is accounted for by the spread in expected returns. The fraction of average return spread between low and high AG firms explained by the spread in expected return is 46% when using the extending windows method, although the fraction rises to 63% for high asset growth and high q firms.

Panels C and D show that when the first-stage estimation employs a rolling-window,

[9] In untabulated results we also find that the results are not sensitive to our choice of top quintile Tobin's q as a measure for valuable investment opportunities. That is, when using different percentiles of q, the results we obtain are very similar to those presented in the previous Tables.

a relatively smaller part of the average return spread is accounted for by a spread in the implied expected returns. This result is consistent with the result in Liu and Zhang (2007) who find that when using the full sample in the first-stage estimation 91% of momentum profits are explained by expected momentum profits implied by the loadings of winners and losers on the five Chen, Roll and Ross factors. In contrast, when using rolling-window estimation in the first-stage, expected momentum profits are only 18% of actual momentum profits (see Panel B of Table 6 in their paper).

The next set of robustness tests employs quintile rather than decile portfolios. Table 9 shows that the fraction of average return spread that are accounted for by the spread in expected return is large when considering bottom quintile and top quintile portfolios. Panel A presents the results for low and high investment-to-capital portfolios. The fraction of the average return spread between the low and high IK quintile portfolios that is explained by implied expected return spread is 108%. The difference between the average return spread and the expected return spread is statistically insignificant (t-ratio of -0.31). That is, the entire 'investment effect' can be explained by the spread in systematic risk. When considering firms with high IK when they have high Tobin's q, as seen in the third row, that fraction rises to 133%, and the difference between the observed average return spread and the expected return spread as implied by the risk factor loadings are again statistically indistinguishable from zero although it is marginally significant (t-statistic of -1.63)

Panel B presents the results for the asset growth portfolios. A large fraction (81%) of the average return spread between the bottom quintile AG and top quintile AG portfolios is accounted for by the expected return spread. Moreover, the difference between the average return spread and the expected return spread is now statistically insignificant with a t-ratio of 1.40 (as opposed to the case when using decile portfolios as in Panel B of Table 3, in which the difference is statistically significant). Thus, the bulk of the asset growth effect, that is the strongest determinant of the cross-section of average returns (as Cooper, Gulen and Schill (2007) document) stems from a spread in expected return. When considering firms with high AG when their Tobin's q is high this fraction rises to

102% (the t-statistic of the difference is -0.07). That is, all of the large average return spread (1.23% per month) is explained by the spread in systematic risk.

Table 10 examines risk dynamics using quintile IK and AG portfolios. The results are similar to those when using decile portfolios in Table 4. Panel A shows that expected returns implied by risk factor loadings fall by 0.34% per month during periods of high investment. As seen in Panel B, when investment occurs when q is high, the fall in implied expected returns is 0.81%, which is a very large drop (10.16% in annual terms).

Panels C and D show very similar dynamics when using quintile asset growth portfolios. For firms investing when they have valuable growth opportunities as reflected by high q, expected returns implied by risk factor loadings fall by 0.85% per month (10.69% in annual terms), a very large decline. Overall, our robustness checks in Tables 9 and 10 show that the results in the paper are not sensitive to our choice of decile portfolios. Our findings are entirely consistent with the rational-based explanations for the negative investment (asset growth)-future returns relationship.

4 Conclusion

Previous studies find a strong negative cross-sectional relation between real investment (and asset growth) and future stock returns. This finding is consistent with behavioral explanations that are based on either the slow reaction of investors to overinvestment, overreaction of the market to capital growth, or market timing on the part of managers. In addition, this finding is also consistent with rational-agent explanations based on the q-theory of investment and on real options models. This paper is a first attempt to try to relate the investment-future returns relationship to macroeconomic risk and, thereby, measure the extent to which the rational-based explanations account for the negative investment (asset growth)-future returns relationship.

We measure systematic risk as stock returns' loadings with respect to the mimicking portfolios of the five Chen, Roll and Ross (1986) factors. The advantage of using these factors, as opposed to using characteristic-related factors, is their strong association with the business cycle which implies they can be interpreted easily as risk factors. We document that the negative investment (asset growth)-future returns relationship cannot be attributed solely to stock mispricing. Rather, it is primarily accounted for by differences in systematic risk between high investment (asset growth) and low investment (asset growth) firms. Consistent with the q-theory and real options models, the fraction of average return spread between low investment (asset growth) and high investment (asset growth) firms that is accounted for by the spread in expected returns is particularly large for firms that invest when they have good investment opportunities as reflected by a high Tobin's q.

Consistent with rational-based explanations offered by the q-theory of investment and by real options models for the negative investment-future returns relationship, firms' systematic risk falls sharply during periods of high investment (asset growth). The fall in risk is particularly large for firms with a high Tobin's q which we interpret as exercising valuable investment opportunities. Also consistent with rational-based explanations is our finding that firms' systematic risk increases after they disinvest.

We also find that stock return volatility drops during periods of high investment (asset growth). The fall in volatility of returns is again particularly large for firms investing when their Tobin's q is high. This finding also supports the prediction of both the real options theory and the q-theory.

The paper also examines whether return factors, defined as the excess returns of low investment (asset growth) firms over high investment (asset growth) firms are related to the macroeconomy. Investment based factors have been shown to explain several asset pricing anomalies, such as the spread in average returns across book-to-market portfolios and the long-term SEO underperformance. Moreover, Chen and Zhang (2008) show that an investment factor, together with the market factor and a productivity factor explain much of the average return spread across test assets formed on momentum, financial distress, investment, profitability, net stock issues and valuation ratios. We find that these factors can predict future real activity. Specifically, the factor returns are positively related to future industrial production growth. This evidence suggests that these factors can indeed be interpreted as risk factors that investors demand a risk premium for holding.

As our findings are highly consistent with rational-based explanations for the negative investment-future returns relationship, they lend strong support to the notion that risk plays an important role in the negative asset growth (investment)-future returns relationship.

References

[1] Anderson, Christopher W., and Luis Garcia-Feijoo, 2006, Empirical Evidence on Capital Investment, Growth Options, and Security Returns, *Journal of Finance*, 61, 171-194.

[2] Baker, Malcolm, Jeremy C. Stein and Jeffrey Wurgler, 2003, When Does the Stock Market Matter? Stock Prices and the Investment of Equity-Dependent Firms, *Quarterly Journal of Economics*, 118, 969-1006.

[3] Bansal, Ravi, Robert F. Dittmar, and Christian T. Lundblad, 2005, Consumption, Dividends, and the Cross Section of Equity Returns, *Journal of Finance* 60, 1639–1672.

[4] Berk, Jonathan B., Richard C. Green, and Vasant Naik, 1999, Optimal Investment, Growth Options, and Security Returns, *Journal of Finance*, 54, 1553-1607.

[5] Berk, Jonathan B., Richard C. Green, and Vasant Naik, 2004, Valuation and Return Dynamics of New Ventures, *Review of Financial Studies*, 17, 1-35.

[6] Black, Fischer, Michael C. Jensen, and Myron S. Scholes, 1972, The Capital Asset Pricing Model: Some Empirical Tests, in Studies in the Theory of Capital Markets, edited by Michael C. Jensen, Praeger, New York, 79–121.

[7] Breeden, Douglas T., Michael R. Gibbons and Robert H. Litzenberger, 1989, Empirical Tests of the Consumption-Oriented CAPM, *Journal of Finance*, 44, 231-262.

[8] Carhart, Mark, 1997, On Persistence in Mutual Fund Performance, *Journal of Finance*, 52, 57-82.

[9] Carlson, Murray, Adlai Fisher and Ron Giammarino, 2006, Corporate Investment and Asset Price Dynamics: Implications for SEO Event Studies and Long-Run Performance, *Journal of Finance*, 61, 1009-1034.

[10] Carlson, Murray, Adlai Fisher and Ron Giammarino, 2009, SEO Risk Dynamics, Working Paper, University of British Columbia.

[11] Chen, Nai-Fu, Richard Roll and Stephen A. Ross, 1986, Economic Forces and the Stock Market, *Journal of Business*, 59, 383-403.

[12] Chen, Long and Lu Zhang, 2008, Neoclassical Factors, Working Paper, Washington University, St. Louis and University of Michigan.

[13] Cochrane, John H., 1991, Production-Based Asset Pricing and the Link Between Stock Returns and Economic Fluctuations, *Journal of Finance*, 46, 209-237.

[14] Cochrane, John H., 2001, Asset Pricing, Princeton University Press.

[15] Cooper, Michael J., Huseyin Gulen, Michael J. Schill, 2007, What Best Explains the Cross-Section of Stock Returns? Exploring the Asset Growth Effect. *Journal of Finance*, forthcoming.

[16] Eckbo, Espen B., Ronald W. Masulis and Oyvind Norli, 2000, Seasoned Public Offerings: Resolution of the 'New Issues Puzzle', *Journal of Financial Economics*, 56, 251-291.

[17] Fama, Eugene F. and Kenneth R. French, 1992, The Cross-Section of Expected Stock Returns, *Journal of Finance*, 47, 427-465.

[18] Fama, Eugene F. and Kenneth R. French, 1993, Common Risk Factors in the Returns on Stocks and Bonds, *Journal of Financial Economics*, 33, 3-56.

[19] Fama, Eugene F. and Kenneth R. French, 2002, Testing Trade-off and Pecking Order Predictions about Dividends and Debt, *Review of Financial Studies*, 15, 1-37.

[20] Ferson, E. Wayne and Campbell R. Harvey, 1991, The Variation of Economic Risk Premiums, *Journal of Political Economy*, 99, 385-415.

[21] Ferson, E. Wayne and Campbell R. Harvey, 1993, The Risk and Predictability of International Equity Returns, *Review of Financial Studies*, 6, 527-566.

[22] Gomes, Joao F., Leonid Kogan and Lu Zhang, 2003, Equilibrium Cross-Section of Returns, *Journal of Political Economy*, 111, 693-732.

[23] Grullon, Gustavo, Evgeny Lyandres and Alexei Zhdanov, 2008, Real Options, Volatility and Stock Returns, Working Paper, Boston University, University of Lausanne and Rice University.

[24] Hackbarth, Dirk and Erwan Morellec, 2008, Stock Returns in Mergers and Acquisitions, *Journal of Finance*, 63, 1213-1252.

[25] Jagannathan, R. and Z. Wang, 1996, The Conditional CAPM and the Cross-Section of Expected Returns, *Journal of Finance* 51, 3-53.

[26] Kydland, Finn E. and Edward C. Prescott, 1982, Time to Build and Aggregate Fluctuations, *Econometrica*, 50, 1345-1370.

[27] Lamont, Owen, 2000, Investment Plans and Stock Returns, *Journal of Finance*, 55, 2719-2745.

[28] Lamont, Owen, 2001, Economic Tracking Portfolios, *Journal of Econometrics*, 105, 161-184.

[29] Lamont, Owen and Jeremy C. Stein, 2006, Investor Sentiment and Corporate Finance: Micro and Macro, *American Economic Review Papers and Proceedings*, 96, 147-151.

[30] Lettau, Martin and Sydney C. Ludvigson, 2001, Resurrecting the (C)CAPM: A Cross-Sectional Test when Risk Premia are Time-Varying, *Journal of Political Economy,* 109, 1238–1287.

[31] Li, Erica X.N., Livdan Dmitry and Lu Zhang, 2007, Anomalies, *Review of Financial Studies*, forthcoming.

[32] Liew, Jimmy and Maria Vassalou, 2000, Can Book-to-Market, Size and Momentum be Risk Factors that Predict Economic Growth?, *Journal of Financial Economics*, 57, 221-245.

[33] Liu, X. Laura and Lu Zhang, 2007, Momentum Profits, Factor Pricing and Macroeconomic Risk, *Review of Financial Studies*, forthcoming.

[34] Liu, Laura X., Toni M. Whited and Lu Zhang, 2008, Investment-Based Expected Stock Returns, Working Paper, Hong Kong University of Science and Technology, University of Wisconsin - Madison and University of Michigan.

[35] Lyandres, Evgeny, Le Sun and Lu Zhang, 2006, Investment-Based Underperformance Following Seasoned Equity Offerings, *Review of Financial Studies*, forthcoming.

[36] Majd, Saman and Robert Pindyck, 1987, Time to build, option value, and investment decisions, *Journal of Financial Economics*, 18, 7-27.

[37] McDonald, Robert and Daniel Siegel, 1986, The value of waiting to invest, *Quarterly Journal of Economics*, 101, 707-727.

[38] Panageas, Stavros, 2005, The Neoclassical Theory of Investment in Speculative Markets, Working Paper, The Wharton School.

[39] Pindyck, Robert, 1988, Irreversible investment, capacity choice, and the value of the firm, *American Economic Review*, 78, 969-985.

[40] Stein, C. Jeremy, 1996, Rational Capital Budgeting in an Irrational World, *Journal of Business*, 69, 429-455.

[41] Titman, Sheridan, K.C. John Wei, and Feixue Xie, 2004, Capital Investment and Stock Returns, *Journal of Financial and Quantitative Analysis*, 39, 677-700.

[42] Xing, Yuhang, 2006, Interpreting the Value Effect through the Q-Theory: An Empirical Investigation, forthcoming, *Review of Financial Studies*.

[43] Zhang, Lu, 2005, The Value Premium, *Journal of Finance*, 60. 67-103.

Table 1
Summary Statistics for Portfolio Returns

Panel A presents average portfolio returns and loadings with respect to mimicking portfolios of the five Chen, Roll and Ross (1986) factors for 10 equally-weighted portfolios formed on the investment to capital ratio, IK. The loadings are estimated from monthly regressions of portfolio returns on the five mimicking portfolios for the CRR factors. MP is the growth rate of industrial production, UI is unexpected inflation, DEI is the change in expected inflation, UTS is the term premium and UPR is the default premium. $\bar{r}$ denotes average portfolio returns. The 3rd to the 7th rows are the loadings with respect to the five factors. Panel B presents average returns and loadings with respect to the five mimicking portfolios for the Chen, Roll and Ross factors for 10 equally-weighted portfolios based on asset growth. The sample is monthly from January 1963 to December 2004. t-statistics are in parentheses.

Panel A - Investment to Capital Portfolios

Decile	Low	2	3	4	5	6	7	8	9	High
$\bar{r}$	1.76	1.61	1.49	1.52	1.43	1.41	1.32	1.25	1.27	1.03
MP	0.395	0.293	0.243	0.198	0.181	0.172	0.158	0.121	0.129	0.120
	(3.27)	(2.91)	(2.59)	(2.15)	(1.94)	(1.82)	(1.59)	(1.14)	(1.11)	(0.86)
UI	−4.233	−4.214	−4.062	−4.042	−4.074	−3.995	−4.142	−4.407	−4.686	−4.847
	(−8.84)	(−10.56)	(−10.94)	(−11.13)	(−11.03)	(−10.69)	(−10.53)	(−10.48)	(−10.16)	(−8.82)
DEI	10.338	7.332	5.959	5.704	5.559	5.007	5.373	6.322	6.785	8.107
	(7.47)	(6.36)	(5.56)	(5.43)	(5.21)	(4.64)	(4.73)	(5.20)	(5.09)	(5.11)
UTS	0.750	0.676	0.644	0.591	0.563	0.571	0.586	0.592	0.622	0.616
	(11.08)	(11.98)	(12.27)	(11.51)	(10.80)	(10.81)	(10.54)	(9.96)	(9.55)	(7.93)
UPR	1.546	1.558	1.557	1.542	1.595	1.529	1.587	1.539	1.560	1.449
	(8.08)	(9.77)	(10.49)	(10.62)	(10.82)	(10.24)	(10.10)	(9.15)	(8.46)	(6.604)

Panel B - Asset Growth Portfolios

Decile	Low	2	3	4	5	6	7	8	9	High
$\bar{r}$	1.91	1.78	1.67	1.48	1.45	1.34	1.36	1.29	1.08	0.70
MP	0.334	0.484	0.184	0.215	0.168	0.133	0.126	0.133	0.136	0.096
	(2.22)	(4.37)	(1.88)	(2.49)	(1.88)	(1.56)	(1.34)	(1.35)	(1.18)	(0.71)
UI	−4.521	−4.253	−4.030	−4.231	−3.939	−3.988	−3.729	−4.433	−4.758	−4.823
	(−7.58)	(−9.69)	(−10.42)	(−12.37)	(−11.13)	(−11.81)	(−10.01)	(−11.33)	(−10.38)	(−9.02)
DEI	11.131	8.958	7.551	6.283	5.761	4.935	4.114	5.022	5.816	7.126
	(6.46)	(7.06)	(6.76)	(6.36)	(5.64)	(5.06)	(3.82)	(4.45)	(4.39)	(4.61)
UTS	0.849	0.746	0.716	0.609	0.562	0.581	0.526	0.572	0.549	0.534
	(10.08)	(12.03)	(13.09)	(12.59)	(11.23)	(12.17)	(9.98)	(10.36)	(8.47)	(7.06)
UPR	1.662	1.490	1.405	1.623	1.462	1.629	1.663	1.484	1.485	1.572
	(6.97)	(8.49)	(9.09)	(11.88)	(10.34)	(12.07)	(11.17)	(9.49)	(8.10)	(7.36)

Table 2

Risk Premium Estimates

We estimate the risk premiums for the mimicking portfolios for the five Chen, Roll, and Ross (1986) factors, including industrial production (MP), unexpected inflation (UI), change in expected inflation (DEI), term premium (UTS), and default premium (UPR) using the two-stage Fama-MacBeth (1973) cross-sectional regression methodology. In the first stage, we estimate factor loadings using 60-month rolling-window regressions, extending-window regressions, and full-sample regressions. The extending windows always start at January 1963 and end in month t. We perform the second-step cross-sectional regressions of portfolio returns from t to $t+1$ on factor loadings estimated using information up to month t. In the extending windows and rolling windows estimations we start the second-stage regressions in January 1968 to ensure that we always have 60 monthly observations in the first-stage rolling window and extending window regressions. We use 40 testing portfolios: ten size, ten book-to-market, ten momentum, and ten asset growth portfolios. We report results from the second-stage cross-sectional regressions including the intercepts ($\widehat{\gamma}_0$), risk premiums ($\widehat{\gamma}$) and average second-step cross-sectional regression $\overline{R}^2 s$. The intercepts and the risk premiums are in percentage per month. The uncorrected Fama-MacBeth t-statistics are reported in the top parentheses, and the Shanken (1992)-corrected t-statistics are reported in the bottom parentheses.

	$\widehat{\gamma}_0$	$\widehat{\gamma}_{MP}$	$\widehat{\gamma}_{UI}$	$\widehat{\gamma}_{DEI}$	$\widehat{\gamma}_{UTS}$	$\widehat{\gamma}_{UPR}$	$\overline{R}^2$
Full sample in first stage	0.784	1.425	0.271	−0.005	0.940	0.312	0.48
	(3.47)	(6.63)	(3.17)	(−0.31)	(2.77)	(2.33)	
	(2.60)	(5.33)	(2.45)	(−0.26)	(2.76)	(2.19)	
Extending window in first stage	1.113	1.235	0.167	−0.006	0.618	−0.033	0.48
	(3.84)	(5.55)	(2.04)	(−0.09)	(1.57)	(−0.28)	
	(2.97)	(4.16)	(1.84)	(−0.07)	(1.43)	(−0.45)	
Rolling window in first stage	0.845	0.677	0.147	0.015	0.641	0.256	0.48
	(3.56)	(4.05)	(2.43)	(0.87)	(2.04)	(2.35)	
	(3.26)	(2.83)	(1.46)	(0.82)	(1.77)	(1.73)	

Table 3

Spreads in Systematic Risk and Average Return Spreads

This Table reports loadings (based on regressions using monthly data) with respect to the mimicking portfolios of the five Chen, Roll and Ross (1986) factors for the bottom investment to capital (asset growth) equally-weighted decile portfolio, the top investment to capital (asset growth) equally-weighted decile portfolio and the equally-weighted portfolio of firms in the intersection of the top investment to capital (asset growth) decile portfolio with the portfolio of the top quintile Tobin's q firms. The Table reports average return spreads and implied expected return spreads between the low and high investment to capital (asset growth) portfolios, as well as the fraction of average return spread that can be explained by implied expected return spreads. Implied expected returns are calculated as the product of the loadings from regressing the monthly returns of a portfolio on the mimicking portfolios for the five Chen, Roll and Ross factors, and the average monthly factor premiums estimated based on the full sample in the first stage. $E(\overline{r})$ is the expected monthly return, $\bar{r}$ is the average portfolio monthly return. Asset growth is the annual growth rate of COMPUSTAT item 6 (total assets). Investment to capital is the ratio of COMPUSTAT item 128 (capital expenditures) to COMPUSTAT item 8 (property, plant and equipment). Tobin's q is the ratio of the book value of assets minus the book value of equity minus deferred taxes, plus the market value of equity to the book value of assets. The column $t\,(dif)$ reports the t-statistics testing the null that the differences between the observed average return spread and expected return spread is on average zero. The sample period is January 1963 through December 2004. t-statistics are in parentheses.

Panel A: Full Sample, Investment to Capital Portfolios

IK	MP	UI	DEI	UTS	UPR	$\overline{r}_L-\overline{r}$	$E(\overline{r}_L)-E(\overline{r})$	$\frac{E(\overline{r}_L)-E(\overline{r})}{\overline{r}_L-\overline{r}}$	$t\,(dif)$
Low	0.395	−4.233	10.338	0.750	1.546				
	(3.27)	(−8.84)	(7.47)	(11.08)	(8.08)				
High	0.120	−4.847	8.107	0.616	1.449	0.73	0.70	0.96	0.17
	(0.86)	(−8.82)	(5.11)	(7.93)	(6.604)				
High q	−0.070	−5.456	8.989	0.486	1.357	1.06	1.29	1.21	-1.15
	(0.44)	(−8.74)	(4.98)	(5.51)	(5.44)				

Panel B: Full Sample, Asset Growth Portfolios

IK	MP	UI	DEI	UTS	UPR	$\overline{r}_L-\overline{r}$	$E(\overline{r}_L)-E(\overline{r})$	$\frac{E(\overline{r}_L)-E(\overline{r})}{\overline{r}_L-\overline{r}}$	$t\,(dif)$
Low	0.334	−4.521	11.131	0.849	1.662				
	(2.22)	(−7.58)	(6.46)	(10.08)	(6.97)				
High	0.097	−4.821	7.132	0.533	1.569	1.21	0.73	0.60	2.84
	(0.72)	(−9.02)	(4.62)	(7.06)	(7.35)				
High q	−0.057	−5.427	9.105	0.447	1.454	1.40	1.24	0.89	0.83
	(−0.36)	(−8.63)	(5.01)	(5.03)	(5.79)				

Table 4
Risk Dynamics Around Investment

This table reports results from regressing monthly returns of an equally-weighted portfolio of firms whose investment to capital ratio (asset growth) is in the top decile of all firms' investment to capital ratios (asset growth) in any of years $t+4$, $t+3$ or year $t+2$ (the pre investment (pre AG period) portfolio) on the mimicking portfolios of the five Chen Roll and Ross factors and the monthly returns of an equally-weighted portfolio of firms whose investment to capital ratio (asset growth) is in the top decile asset growth in year $t-1$ (the Post investment period or Post AG portfolio) on the five CRR factors. The Table also presents regression results from regressing the return during the pre investment (pre asset growth) period and the post-investment (post-asset growth) period, of an equally-weighted portfolio of firms whose average Tobin's q (averaged over the year prior to the investment and the year of the investment) is in the top quintile among all firms' averaged q over these years, on the mimicking portfolios for the five CRR factors. $E(r)$ is the investment (asset growth) period portfolio expected return as calculated by the product of the loadings with respect to the mimicking portfolios for the five CRR factors with the corresponding estimated risk premiums (based on the full sample in the first stage estimation). Similarly $E(r_{pre})$ is the implied expected returns for the pre-investment portfolio. The sample period is January 1963 through December 2004. t-statistics are in parentheses.

Panel A: Highest investment to capital portfolio

	MP	UI	DEI	UTS	UPR	$E(r)-E(r_{pre})$
Pre investment	0.424	−4.803	10.470	0.690	1.684	
	(2.39)	(−6.83)	(5.10)	(6.87)	(6.02)	
Post investment	0.120	−4.847	8.107	0.616	1.449	-0.57
	(0.86)	(−8.82)	(5.11)	(7.93)	(6.60)	

Panel B: Highest and top 20% q, investment to capital portfolio

	MP	UI	DEI	UTS	UPR	$E(r)-E(r_{pre})$
Pre investment	0.399	−5.403	13.921	0.706	1.460	
	(1.51)	(−5.16)	(4.56)	(4.72)	(3.50)	
Post investment	−0.070	−5.456	8.989	0.486	1.357	-0.89
	(−0.44)	(−8.74)	(4.98)	(5.51)	(5.44)	

Panel C: Highest asset growth portfolio

	MP	UI	DEI	UTS	UPR	$E(r)-E(r_{pre})$
Pre AG period	0.350	−4.986	10.183	0.641	1.598	
	(2.19)	(−7.88)	(5.52)	(7.09)	(6.35)	
Post AG period	0.100	−4.952	7.312	0.534	1.584	-0.44
	(0.73)	(−9.06)	(4.59)	(6.84)	(7.29)	

Panel D: Highest asset growth and top 20% q portfolio

	MP	UI	DEI	UTS	UPR	$E(r)-E(r_{pre})$
Pre AG period	0.415	−5.456	13.806	0.686	1.525	
	(1.60)	(−5.33)	(4.62)	(4.69)	(3.74)	
Post AG period	−0.057	−5.427	9.105	0.447	1.454	-0.89
	(−0.36)	(−8.63)	(5.01)	(5.03)	(5.79)	

Table 5

Risk Dynamics Around Disinvestment

This table reports results from regressing the monthly returns on an equally-weighted portfolio of all firms whose capital growth (asset growth) is negative in any of the years $t+4$, $t+3$ or year $t+2$ (the Pre disinvestment portfolio) on the mimicking portfolios for the five Chen Roll and Ross (CRR) factors. Also reported are results from regressing the monthly returns of an equally-weighted portfolio of firms whose capital growth (asset growth) is negative in year $t-1$ (the Post disinvestment portfolio) on the mimicking portfolios for the five CRR factors. $E(r)$ is the portfolio expected return as calculated by the product of the loadings with respect to the mimicking portfolios for the five CRR factors with the corresponding estimated risk premiums (based on the full sample in the first stage estimation of the factor risk premiums). Similarly $E(r_{pre})$ is the implied expected returns for the pre-investment portfolio. The sample period is January 1963 through December 2004. t-statistics are in parentheses.

Panel A: Investment to Capital Portfolios

	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre disinvestment	0.268	−4.328	8.338	0.735	1.365	
	(2.10)	(−8.60)	(5.71)	(10.21)	(6.83)	
Post disinvestment	0.443	−4.159	10.559	0.781	1.538	0.39
	(3.29)	(−7.82)	(6.80)	(10.28)	(7.27)	

Panel B: asset growth portfolios

	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre disinvestment	0.223	−5.145	9.411	0.716	1.501	
	(1.41)	(−8.28)	(5.22)	(8.06)	(6.09)	
Post disinvestment	0.364	−5.038	13.302	0.919	1.712	0.46
	(2.11)	(−7.39)	(6.69)	(9.44)	(6.31)	

Table 6

Volatility Dynamics

This table reports standard deviations of monthly returns of an equally-weighted portfolio of firms whose investment to capital ratio (asset growth) is in the top decile of all firms' investment to capital ratios (asset growth) in any of the years $t+4$, $t+3$ or year $t+2$ (the pre investment (AG) portfolio), and the standard deviation of monthly returns of an equally-weighted portfolio of firms whose asset growth is in the top decile asset growth in year $t-1$ (the Post investment (AG) period portfolios). The Table also presents the standard deviations of monthly equally-weighted returns of the pre investment (asset growth) portfolio and post investment (asset growth) portfolio of all firms whose investment (asset growth) is in the top decile and their investment (asset growth) period (i.e. averaged over years t and $t-1$) Tobin's q is in the top quintile. The sample period is January 1963 through December 2004.

Panel A: Highest 10% investment to capital portfolios

	Pre investment	Post investment	Difference
Return volatility	9.02	7.28	-1.74

Panel B: Highest 10% investment to capital and top quintile q portfolios

	Pre investment	Post investment	Difference
Return volatility	12.79	8.37	-4.42

Panel C: Highest 10% asset growth portfolios

	Pre AG	Post AG	Difference
Return volatility	8.21	7.11	-1.10

Panel D: Highest 10% asset growth and top quintile q portfolios

	Pre AG	Post AG	Difference
Return volatility	12.53	8.33	-4.20

Table 7

The Asset Growth and Investment Factors as Predictors of Economic Growth

This Table presents results from regressing quarterly real industrial production growth on the previous quarter's return of factor portfolios. The factor IK is the return on a portfolio that is long on the equally-weighted bottom decile of investment to capital stocks and short on the equally-weighted top decile of investment to capital stocks. The factor AG is the return on a portfolio that is long on the equally-weighted bottom decile asset growth stocks and short on the equally-weighted top decile asset growth stocks. The factor IKQ is the return on a portfolio that is long on the equally-weighted bottom decile investment to capital stocks and short on the equally-weighted top decile investment to capital stocks intersected with the top Tobin's q quintile portfolio. The factor AGQ is the return on a portfolio that is long on the equally-weighted bottom decile asset growth stocks and short on the equally-weighted top decile asset growth portfolio intersected with the top Tobin's q quintile portfolio. MP is the growth rate of real industrial production. Data are sampled quarterly from 1963:02 To 2005:04. Newey West t-statistics are in parentheses. $\overline{R}^2$ is the adjusted R^2.

Panel A - Investment to capital factors

	Constant	IK_{t-1}	$\overline{R}^2$
MP	-0.004 (2.57)	0.120 (2.54)	1.5
	Constant	IKQ_{t-1}	$\overline{R}^2$
MP	-0.004 (2.44)	0.055 (2.08)	1.0

Panel B - Asset growth factors

	Constant	AG_{t-1}	$\overline{R}^2$
MP	-0.004 (2.31)	0.067 (1.65)	0.5
	Constant	AGQ_{t-1}	
MP	-0.004 (2.39)	0.046 (1.80)	0.8

Table 8

Spreads in Systematic Risk and Average Return Spreads: Robustness

This table reports loadings (based on regressions using monthly data) with respect to the mimicking portfolios for the five Chen, Roll and Ross (1986) factors for the bottom investment to capital (asset growth) decile equally-weighted portfolio, the top investment to capital (asset growth) decile equally-weighted portfolio, and the equally weighted return of a portfolio of the firms in the intersection of the top investment to capital (asset growth) decile portfolio with the portfolio of the top quintile Tobin's q firms. The table reports average return spreads and implied expected return spreads between the low and high investment to capital (asset growth) portfolios, as well as the fraction of average return spread that can be explained by implied expected return spread. Implied expected returns are calculated as the product of the loadings from regressing the monthly returns of a portfolio on the mimicking portfolios for the five Chen, Roll and Ross factors, and the average monthly factor premiums based on either an extending window or rolling regression estimation. $E(\overline{r})$ is the expected monthly return, $\overline{r}$ is the average portfolio monthly return. Asset growth is the annual growth rate of COMPUSTAT item 6 (total assets). Investment to capital is the ratio of COMPUSTAT item 128 (capital expenditures) to COMPUSTAT item 8 (property, plant and equipment). Tobin's q as the ratio of the book value of assets minus the book value of equity minus deferred taxes, plus the market value of equity to the book value of assets. The sample period is January 1963 through December 2004.

Panel A: Extending Window, Investment to Capital Portfolios

	$\overline{r}_L - \overline{r}$	$E(\overline{r}_L) - E(\overline{r})$	$\frac{E(\overline{r}_L)-E(\overline{r})}{\overline{r}_L-\overline{r}}$
High IK	0.73	0.66	0.90
High IK and high q	1.06	1.01	0.95

Panel B: Extending Window, Asset Growth Portfolios

	$\overline{r}_L - \overline{r}$	$E(\overline{r}_L) - E(\overline{r})$	$\frac{E(\overline{r}_L)-E(\overline{r})}{\overline{r}_L-\overline{r}}$
High AG	1.21	0.56	0.46
High AG and high q	1.40	0.88	0.63

Panel C: Rolling Window, Investment to Capital Portfolios

	$\overline{r}_L - \overline{r}$	$E(\overline{r}_L) - E(\overline{r})$	$\frac{E(\overline{r}_L)-E(\overline{r})}{\overline{r}_L-\overline{r}}$
High IK	0.73	0.39	0.53
High IK and high q	1.06	0.67	0.63

Panel D: Rolling Window, Asset Growth Portfolios

	$\overline{r}_L - \overline{r}$	$E(\overline{r}_L) - E(\overline{r})$	$\frac{E(\overline{r}_L)-E(\overline{r})}{\overline{r}_L-\overline{r}}$
High AG	1.21	0.46	0.38
High AG and high q	1.40	0.66	0.47

Table 9

Spreads in Systematic Risk and Average Return Spreads: Using Quintile Portfolios

This Table reports loadings (based on regressions using monthly data) with respect to the mimicking portfolios for the five Chen, Roll and Ross (1986) factors for the bottom investment to capital (asset growth) quintile equally-weighted portfolio, the top investment to capital (asset growth) quintile equally-weighted portfolio, and the equally-weighted return on a portfolio of firms in the intersection of the top investment to capital (asset growth) quintile portfolio with the portfolio of the top quintile Tobin's q firms. The Table reports average return spreads and implied expected return spreads between the low and high investment to capital (asset growth) portfolios, as well as the fraction of average return spread that can be explained by implied expected return spreads. Implied expected returns are calculated as the product of the loadings from regressing the monthly excess returns of a portfolio on the mimicking portfolios for the five Chen, Roll and Ross factors, and the average monthly factor premiums based on the full sample. $E(\bar{r})$ is the expected monthly return, $\bar{r}$ is the average portfolio monthly return. Asset growth is the annual growth rate of COMPUSTAT item 6 (total assets). Investment to capital is the ratio of COMPUSTAT item 128 (capital expenditures) to COMPUSTAT item 8 (property, plant and equipment). Tobin's q as the ratio of the book value of assets minus the book value of equity minus deferred taxes, plus the market value of equity to the book value of assets. The column $t\,(dif)$ reports the t-statistics testing the null that the differences between the observed average return spread and expected return spread is on average zero. The sample period is January 1963 through December 2004. t-statistics are in parentheses.

Panel A: Full Sample, Investment to Capital Portfolios

IK	MP	UI	DEI	UTS	UPR	$\bar{r}_L - \bar{r}$	$E(\bar{r}_L) - E(\bar{r})$	$\frac{E(\bar{r}_L)-E(\bar{r})}{\bar{r}_L-\bar{r}}$	$t\,(dif)$
Low	0.344	−4.222	8.771	0.711	1.552				
	(3.17)	(−9.82)	(7.06)	(11.71)	(9.04)				
High	0.124	−4.775	7.482	0.619	1.508	0.51	0.55	1.08	-0.31
	(0.99)	(−9.56)	(5.19)	(8.77)	(7.56)				
High q	−0.066	−5.293	8.087	0.505	1.353	0.84	1.12	1.33	-1.63
	(0.45)	(−9.20)	(4.86)	(6.21)	(5.89)				

Panel B: Full Sample, Asset Growth Portfolios

AG	MP	UI	DEI	UTS	UPR	$\bar{r}_L - \bar{r}$	$E(\bar{r}_L) - E(\bar{r})$	$\frac{E(\bar{r}_L)-E(\bar{r})}{\bar{r}_L-\bar{r}}$	$t\,(dif)$
Low	0.413	−4.379	10.005	0.795	1.571				
	(3.23)	(−8.63)	(6.82)	(11.09)	(7.75)				
High	0.116	−4.791	6.455	0.541	1.528	0.95	0.77	0.81	1.40
	(0.93)	(−9.74)	(4.54)	(7.79)	(7.79)				
High q	−0.068	−5.463	7.420	0.488	1.407	1.23	1.25	1.02	-0.07
	(0.14)	(−2.59)	(1.32)	(2.09)	(1.79)				

Table 10
Risk Dynamics Around Investment, Quintile Portfolios

This table reports results from regressing monthly returns of an equally-weighted portfolio of firms whose investment to capital (asset growth) is in the top quintile of all firms' investment to capital ratios (asset growth) in any of the years $t+4$, $t+3$ or year $t+2$ (the pre investment (asset growth) portfolio) on the mimicking portfolios for the five Chen Roll and Ross (CRR) factors and the monthly excess returns of an equally-weighted portfolio of firms whose asset growth is in the top quintile asset growth in year $t-1$ (the post-investment or post-asset growth period portfolios) on the mimicking portfolios for the five CRR factors. The table also presents results from regressing the return during the pre investment (asset growth) period and the post-investment (post-asset growth) period, of an equally-weighted portfolio of firms whose average (averaged over the year prior to the investment and the year of the investment) Tobin's q is in the top quintile among all firms' averaged q over these years, on the mimicking portfolios for the five CRR factors. $E(r)$ is the investment (asset growth) period portfolio expected return as calculated by the product of the loadings with respect to the mimicking portfolios for the five CRR factors with the corresponding estimated risk premiums (based on the full sample in the first stage estimation). Similarly $E(r_{pre})$ is the implied expected returns for the pre-investment portfolio. The sample period is January 1963 through December 2004. t-statistics are in parentheses.

Panel A: Highest 20% investment to capital portfolios

	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre investment	0.265	−4.610	8.444	0.641	1.669	
	(1.83)	(−8.02)	(5.03)	(7.80)	(7.29)	
Post investment	0.127	−4.909	7.648	0.620	1.525	-0.34
	(0.99)	(−9.64)	(5.15)	(8.52)	(7.52)	

Panel B: Highest 20% and top q, investment to capital portfolios

	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre investment	0.393	−5.323	12.373	0.648	1.422	
	(1.54)	(−5.29)	(4.21)	(4.50)	(3.55)	
Post investment	−0.061	−5.444	8.185	0.502	1.371	-0.81
	(−0.41)	(−9.26)	(4.77)	(5.98)	(5.86)	

Panel C: Highest 20% asset growth portfolios

	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre *AG* period	0.286	−4.838	8.669	0.632	1.570	
	(2.16)	(−9.22)	(5.66)	(8.44)	(7.52)	
Post *AG* period	0.122	−4.927	6.685	0.545	1.544	-0.34
	(0.96)	(−9.81)	(4.56)	(7.59)	(7.73)	

Panel D: Highest 20% asset growth portfolios and top 20% q

	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre *AG* period	0.399	−5.295	12.338	0.661	1.486	
	(1.59)	(−5.35)	(4.27)	(4.68)	(3.77)	
Post *AG* period	−0.011	−5.474	8.022	0.448	1.371	-0.85
	(−0.07)	(−9.43)	(4.73)	(5.40)	(5.94)	