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 a spread in systematic risk, as measured by the loadings with respect to the Chen, Roll and Ross (1986) factors. The spread in systematic risk is particularly large for high q firms who have good investment opportunities and consequently are unlikely to be overinvesting. Asset growth and investment factors can both predict aggregate earnings growth and industrial production growth. Moreover, firms' risk and volatility fall sharply during large investment periods. Our evidence implies that much of negative investment (asset growth)-future returns relationship can be explained by rational pricing.

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1 Introduction

Recent empirical work finds a strong negative 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 to 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. Moreover, Xing finds that an investment factor, defined as the difference in returns between low investment stocks and high-investment stocks, contains information similar to the Fama and French (1993) value factor (HML), and can explain the value effect about as well as HML. 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". In view of these findings it is important to determine what drives the negative investment (asset growth) - future returns relationship. This issue is particularly noteworthy since the empirical findings are consistent with both theoretical explanations that rely on a rational optimizing agent theory, as well as with a behavioral model that assumes some form of mispricing.

In this paper we explore empirically whether risk plays a role in accounting for these empirical findings. First, 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 Liu and Zhang (2007) we measure systematic risk as the loadings with respect to 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 risk factors. Second, we test whether the profitability of the investment and asset growth factors can be linked to future earnings growth and industrial production. Thus, we tie the ability of these factors to capture the cross-section of portfolio returns, as documented by Xing (2006) and Lyandres, Sun and Zhang (2007), to the macroeconomy. Finally, we examine the dynamics of risk and volatility around real investment periods, for which risk-based explanations offer a clear prediction, and for which the behavioral explanations offer no prediction.

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. 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 (2007) show that the neoclassical 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, low discount rates will trigger firms' real investment since it entails more investment projects will have a positive NPV. 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 response by undertaking investment. Thus, a fall in risk in the period *just before* investment is consistent with the prediction of the q theory. These dynamics, in which the discount rate falls and subsequently (but not contemporaneously) investment is undertaken is proposed by Lamont (2000). Lamont finds support for Cochrane's (1991) hypothesis that investment orders and plans rise immediately upon receiving a discount rate shock but investment itself occurs with a lag. The implication is that there is a decline in firms' systematic risk preceding large capital investment.

Real options models (e.g. McDonald and Siegel (1986), Majd and Pindyck (1987), and Pindyck (1988)) also predicts that firms undertaking investment projects experience a fall in their systematic risk because undertaking real investment exercises a risky real option. A fall in risk before investment is also consistent with the real options models; risk should decline before actual investment is undertaken if investors learn that the firm has decided to invest and exercise its real option.

Behavioral based explanations for the negative investment-future returns relationship are based on investor overreaction, management overinvestment, and market timing. Titman Wei and Xie (2004) focus on the slow reaction of investors to firm overinvestment. The negative abnormal returns they uncover for firms that substantially increase investment are strongest for firms with high cash flows and low debt ratios, characteristics of firms that could be overinvesting. Consequently, they argue that investors are 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 firms might be timing the market and invest when their stocks are overpriced and hence the negative abnormal returns are a correction for the overpriced 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-future returns relationship and can be summarized as follows. First, we show that, particularly for firms investing when they have good investment opportunities as measured by Tobin's q, the negative investment (asset growth)-future returns relationship is largely accounted for by differences in loadings with respect to the Chen, Roll and Ross (1986) macroeconomic factors between high investing and low investing firms. Thus, mispricing is a potentially economically important explanation only for firms who invest when they have poor investment opportunities.

Second, we show that an investment (and asset growth) factor, defined as the return difference between firms with low investment and firms with both high investment and good growth opportunities (in the top quintile of Tobin's q), can predict both earnings growth and industrial production growth. This finding is important because recent studies find that the spreading on loading on an investment factor captures much of the cross-section of average returns and can explain several anomalies. For example, Xing (2006) shows that the investment factor can explain the value effect about as well as the HML factor. Lyandres, Sun and Zhang (2007) find that the post SEO underperformance substantially diminishes when an investment factor portfolio is added as a common risk factors. Chen and Zhang (2008) show that a three factor model, where the factors are the market portfolio, an investment portfolio and a productivity portfolio, explains much of the average return spreads across testing assets formed on momentum, financial distress, investment, profitability, net stock issues and valuation ratios. Our paper is complementary to these papers.

We find that when predicting earnings growth and industrial production growth, the coefficients on the investment and asset growth factors are positive, implying 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.

Third, we find that firms' loadings with respect to the CRR factors fall (increase) substantially in the year before the investment (disinvestment) is undertaken. Similarly, the loadings fall sharply in the year before high asset growth years (and rise before negative asset growth years). These finding are consistent with the predictions of both the q-theory and the real options model. While these risk based theories predict that the low (high) average returns after high (negative) investment is a result of a fall (increase) in systematic risk, behavioral explanations do not predict that systematic risk changes, in either direction, following investment or disinvestment. Therefore, our methodology allows us to distinguish between the various explanations for the negative investment-future returns relation and 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.

The finding that systematic risk falls in the year prior to investment can be interpreted as follows. Investment plans typically precede actual investment (see Lamont, 2000).

According to the q-theory, investment will be undertaken when the cost of capital is low, for example when the firm receives a discount rate shock (see Liu, Whited and Zhang (2007) or when an investment project with low systematic risk becomes available (see Berk, Green and Nail (1999) and Gomes, Kogan and Zhang (2003)). If investors observe that the cost of capital of a firm has become low, expected returns and risk will fall upon receiving the news in the year before actual investment is undertaken. Similar logic applies to disinvestment. That is, expected returns increase upon receiving a shock that increases the discount rate and entails disinvestment.

Our fourth finding concerns the volatility of stock returns around investment periods. The real options theory predicts that before investing firms' 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 remains unchanged.

We note that the both the real options theory and the q-theory pertain to firms optimally exercising valuable growth options and not to firms which may be overinvesting. We find that volatility drops during high asset growth and high investment periods. Moreover, firms which invest (i.e. have either high asset growth or high investment to capital ratio or both) when their Tobin's q is high (in the top quintile of firms) experience a much more drastic decline in stock return volatility upon investing. Specifically their annualized volatility falls by 16% (1600 basis points) during the investment period. This finding lends further support for the predictions of real options models and of the q-theory. This finding 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 fundaments (e.g. demand volatility) drops following investment.

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 factors, quantifies the effect of the loadings with respect to the factors in driving the investment (asset growth)-future returns relationship, and presents evidence that the asset growth and investment factors can predict real activity. Section 3 also explores the dynamics of systematic risk and return volatility around periods of high asset growth and high capital investment. 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 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 it is a strong determinant of average returns. Our second 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 data 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.

We now turn to the allocation of stocks into portfolios based on asset growth or capital investment. At the end of June of each 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 portfolios based on either asset growth or on the investment to capital ratio.

In order to examine the dynamics of systematic risk around large investment periods it is important to carefully consider the timing of the investment process. We define the pre-investment period portfolio in year t as the equally-weighted portfolio of firms whose AG (IK) will be in the top quintile AG (IK) of all firms in year $t+3$ or year $t+2$ or both years. The investment period portfolio is an equally-weighted portfolio which consists of all firms whose AG (IK) is in the top quintile AG (IK) in year $t+1$ or year t or both years. The rationale for choosing this timing is that investment planning is likely to be time consuming. Therefore, a discount rate shock will culminate into actual investment after a period of time. We follow Lamont (2000) and assume investment planning spans over one year. Thus, the decline in systematic risk should occur in the year prior to investment. We choose the pre-investment period as two to three years prior to investment. This choice is robust to choosing either two years, three years or four years prior the actual investment and our timing choice is also robust to choosing year t or year $t+1$ as the investment period. We similarly choose the same timing for pre-disinvestment and disinvestment periods. Overall, we have a time-series of monthly returns for pre-investment (pre-disinvestment) and investment (disinvestment) portfolios from January 1963 through December 2004.

We obtain data on the five Chen, Roll and Ross factors from Laura Xiaolei Liu's website.[1] These variables, all given in monthly frequency from January 1960 to December 2004, include the monthly growth rate of industrial production index (MP), unexpected inflation (UI), the change in expected inflation (DEI), the term premium (UTS), defined

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

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.[2]

Panel A of Table 1 reports the average monthly returns of portfolios sorted by the investment-to-capital ratio. Average returns of low investment-to-capital firms are substantially higher than those of high investment-to-capital firms (the difference is 73 basis points 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.

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 the 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 I/K, implying that low investment-to-capital stocks are riskier than high investment-to-capital stocks and similarly, as seen in Panel B of the Table, low asset growth stocks are riskier than high asset growth firms.

As seen in Panel A, the loadings with respect to the industrial production factor generally decline with the investment-to-capital ratio, with the exception of the second decile portfolio which has a loading of 0.379 on that factor compared to a loading of 0.302 of the low investment-to-capital portfolio (decile 1). Notably, the loading of the high investment-to-capital ratio with respect to the industrial production factor is more than eight times smaller for the top investment-to-capital porftfolio than for the bottom investment-to-capital portfolio (0.036 versus 0.302).

The loadings with respect to the unexpected inflation factor (UI) decline, though non-monotonically, from -4.277 for the low investment-to-capital portfolio to -4.862 for the high investment-to-capital portfolio. The loadings with respect to the change in expected

[2] 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.

inflation initially fall from 10.451 for the low investment-to-capital portfolio to 5.265 for portfolio 5, before increasing again to approximately 8 for the top decile investment-to-capital portfolio.

The loadings on the term premium generally fall with I/K and, as seen in the last row of the Panel, the loadings with respect to the default premium also fall, albeit non-monotonically, with investment. The difference in the default premium loadings of low and high investment-to-capital portfolio is large (1.491 for the low I/K portfolio compared to 1.206 for the high I/K portfolio).

We conclude from Panel A of Table 1 that high investment-to-capital firms are riskier than low investment-to-capital firms as is reflected in their lower loadings with respect to each of the five Chen, Roll and Ross factors. Particularly notable are the differences between the loadings of the high and low I/K portfolios with respect to the industrial production factor and the default premium factor, two factors that are tightly related to the business cycle, suggesting that risk plays a role in the negative investment-future returns relationship.

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 bottom decile portfolio on the industrial production factor (0.483 versus 0.334). The loading of the top decile portfolio with respect to the industrial production factor are more than three times larger than the loading on that factor of the top decile asset growth portfolio (0.334 versus 0.100).

The loadings with respect to the unexpected inflation factor (UI) 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 -4.834 for the top decile asset growth portfolio. The loadings with respect to the change in expected inflation factor (DEI) fall monotonically from 11.131 for the bottom decile portfolio to portfolio 4.114 for portfolio 7, before increasing again to 7.153 for the high asset growth decile portfolio.

The loadings on the term premium factor fall sharply from 0.849 for the bottom decile portfolio to 0.536 for the top decile portfolio, and the loadings on the default premium factor fall, though non-monotonically from 1.662 for the low asset growth portfolio to 1.573 for the high asset growth portfolio.

Note that 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 premium factor.

3 Empirical Results

This section of the paper presents results on the spread of systematic risk and implied expected returns across asset growth and investment to capital portfolios based on the loadings and risk premia earned on the CRR factors. Specifically, 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 loadings of these portfolios with respect to the Chen, Roll and Ross factors and the CRR factors' estimated risk premiums.

In order to further link the spread in average returns on the low and high investment portfolios to economic fundamentals, we asses the ability of the low minus high investment and asset growth factors to forecast economic growth. Finally, to try and tie the average return dynamics of high and low investing firms to changes in systematic risk, we examine the dynamics of systematic risk during high investment and asset growth periods. This is an important step since one strand of the literature posists that the spread in average returns in caused by behavioral biases of either investor and/or managers. If this is the case, then we would not expect to see changes in systematic risk around investment, only changes in average returns. Conversely, a rational based argument for the average return dynamics predicts changes in systematic risk around investment.

Section 3.1 presents the estimated risk premiums associated with the five CRR factors. Section 3.2 presents evidence on the fraction of average return spread that is accounted for by a spread in systematic risk as measured by the loadings with respect to the five

CRR factors. Section 3.3 shows that return factors based on AG and IK can forecast real economic activity. The dynamics of risk during high investment periods is discussed in Section 3.4. Risk dynamics during disinvestment periods is presented in Section 3.6. Finally, Section 3.6 examines volatility dynamics.

3.1 Estimation of the CRR factors risk premium

We follow Liu and Zhang (2007) and estimate the risk premiums associated with the five CRR factors using a two-stage Fama and MacBeth cross-sectional regressions. Our test assets are portfolios of stock returns that display wide average return spreads. To this end we use 40 test assets including ten size, ten book-to-market, ten momentum portfolio (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. As Cooper, Gulen and Schill (2007) find that asset growth is the strongest determinant of average of stock returns, it seems appropriate to include asset growth portfolios as test assets.

Following Liu and Zhang (2007), we use 60-month rolling windows as well as extending windows in the first-stage regressions. The extending windows always start at January 1963 and end at month t, in which we perform the second-stage cross-sectional regressions of portfolio excess returns from t to $t+1$ on factor loadings estimated using information up to month t. As Liu and Zhang note, the advantage of using the extending windows over the rolling windows is that more sample observations are used to obtain more precise estimates of the factor loadings. We also use the full sample to estimate factor loadings, following Black, Jensen, and Scholes (1972), Fama and French (1992), Lettau and Ludvigson (2001) and Liu and Zhang (2007). If the true factor loadings are constant, the full-sample estimates should be the most precise.

Table 2 presents the results. Using the full sample, the estimated industrial production premium is the largest at 1.23 percent per month.[3] It is highly statistically significant with a Shanken $t-$statisitic of 5.91. The unexpected inflation and yield spread between Baa and Aaa corporate bonds premiums are also highly statistically significant with Shanken t-

[3] The industrial production growth premuim that we estimate is similar to the one estimated by Liu and Zhang who estimate it as 1.47% using a somewhat longer time series, 1960-2004.

statistics of over five and three respectively. The estimates are also quite large (about 0.40 percent per month). The yield spread between long-term government bonds and treasury bills is relatively large (0.60 percent per month) although not statistically significant. The adjusted R^2 is 80% which is relatively large and comparable to other studies. For example, using 30 test assets and a sample from January 1960 through December 2004, Liu and Zhang (2007) find an R^2 of 66% when estimating the five CRR risk premiums.

When using the extending window the industrial production factor premium is still the largest. The magnitude of factor premiums declines relative to the full sample with the exception of the term premium factor, which now has a higher premium (0.71 percent per month) and is now statistically significant. The final row of the Table reports the results when using a rolling window in the first stage. In this case, the term premium factor premium becomes the largest estimate premium, whereas the other factor premiums decline.

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) portfolio, which are defined as the product of the factor loads 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

Rational-based models that tie firm investment to expected returns assume optimal investment behavior. Firms will invest optimally when their Tobin's q is high and subsequently investment will be followed by low systematic risk and low expected returns. The behavioral based explanations for the negative investment-future returns relationship does not link this relationship to investment opportunities. Thus, if the rational-based explanations account for some of the negative investment-future return relationship, then we expect that the fraction of the average return spread explained by the spread in systematic risk is larger when the spread is between firms with low investment and firms with both high investment and a high q, than when the spread is between low investment firms and high investment firms but which have a low q.

To test this conjecture, we examine whether the average return spread between low and high investment firms can be accounted for by differences in systematic risk as implied by the loadings with respect to the CRR factors. Implied expected returns are calculated as the product of the estimated factors risk premia and the portfolio loading with respect to the factors. 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

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

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

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

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

Moreover, we examine whether, for firms investing when their q is high, a larger fraction of the average return difference is explained by expected return spread implied by risk difference. We define a firm to have exercised valuable investment opportunities if the average of its Tobin's q in the year in which it invested and the previous year is in the top quintile Tobin's q in that period.

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 or high investment and high q portfolio. The eighth column presents the expected return spreads, where expected return on a portfolio is calculated as the product of the estimated loadings and the estimated factor risk premiums presented earlier in Table 2. Finally, the last column shows the ratio of expected return spread to average return spread. A ratio that is 1 implies that all of the average return spread is accounted for by systematic risk spread.

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 (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. Recalling that the industrial production factor's estimated risk premium is 1.23% per month, this loadings difference implies a large expected returns difference. The loadings with respect to the default premium factor is large as well. The average return difference between the low and high IK portfolios is 0.73 percent per month (9.12% in annual terms), whereas the implied expected return difference is 0.83 percent per month. Thus, the fraction of the average return spread that is accounted for by risk spread is 115%. This implies that all of the investment effect in stock returns can be explained by a spread in sensitivity to macroeconomic variable. 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.

The following row of the Table shows the result for firms with both high IK and high Tobin's q. These firms are unlikely to be overinvesting. Therefore we would expect that the predictions of both the q-theory and the real options model are more relevant for them. In contrast, firms investing when their Tobin's q is low are likely to be investing in spite of poor investment opportunities and the rational-based models do not predict a change in risk and expected returns following periods of high investment for them. Moreover, if the Titman, Wei and Xie (2004) argument that the negative abnormal returns following large investment periods are a consequence of slow investor reaction to overinvestment applies for these firms, then for low q firms we should see only a small fraction of the average return spread accounted for by risk spread.

As seen by comparing 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: 0.302 for the low investment portfolio versus -0.172 for the high investment and high q portfolio. There is also a large difference in the loadings with respect to the term premium and with respect to the default premium. Overall, the spread in expected returns between the low IK portfolio and the high IK and high q portfolio, as implied by the two factors' loadings with respect to the Chen, Roll and Ross factors, is 1.49% 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 retun spread is 1.41, implying that all of the average return spread is accounted for by risk spread for these firms.

Panel B of Table 3 presents the results for the asset growth portfolios. The high AG portfolio, which includes firms in the top quintile 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 in the loadings with respect to the industrial production factor and the term premium, 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 0.77 percent per month. Thus, the fraction of the average return spread that is accounted for by risk spread is 64%. This implies that the bulk of the asset growth effect in stock returns can be explained by a spread in sensitivity to macroeconomic variable. However, our finding suggests that there is still a potential role for mispricing as an explanation for part of the asset growth effect.

The following row of the Table shows the result for firms with both high AG and high Tobin's q. As these firms are supposedly optimally investing, we would expect that the predictions of both the q-theory and the real options model apply most for them. Comparing the first and the third rows of Panel B reveals that the loadings of the high AG and high q portfolio are substantially lower with respect to each of the five Chen, Roll and Ross factors 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 (0.849 versus 0.459) and in the loadings with respect to the default preium (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 across these two portfolios is 1.33%. Thus, consistent with both the q-theory and the real options model, 95% of the average return spread between low AG firms and high AG and high q firms are accounted for by risk spread.

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 options and low investment firms is largely accounted for by a spread in expected returns. This evidence is accordant with the conjecture that behavioral biases do not account for the entire negative investment (asset growth)-future returns relationship.

In Table 4, we assess the robustness of the results using different windows to estimate the factor loadings. Panels A and B present the results for which the first-stage risk premiums estimation is an extending window estimation. The results are similar to the results in Table 3, although a somewhat lower fraction of the average return spread is accounted for by risk factor loadings spread relative to the results in Table 3. Panel A shows that 79% of the average return spread between low investment-to-capital and high investment-to-capital portfolio can be explained by the expected returns spread implied by the risk factor loadings. 93% 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 risk loadings spread. Thus the tests based on extending window indicate that risk plays a central role in the negative investment-future returns relationship.

Panel B of Table 4 shows that a large fraction of the average returns between low asset growth firms and high asset growth firms (and high AG and high q firms) is accounted for by risk loadings spread, when the factor risk premiums are estimated using the extending-window method.

Panels C and D show that when the first-stage estimation of the factor premiums is through a rolling-window, a relatively small 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, whereas 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).

3.3 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 in explaining the cross-sectional variation of portfolios based on investment and on book-to-market. Lyandres, Sun and Zhang (2007) show 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 portfolio, and a productivity portfolio, 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 findings, it is important to examine whether an investment (and an asset growth) factor is related to the macroeconomy. If this factor is indeed related to the macroeconomy then it might represent a risk that investors require a premium for holding. In order to assess this, we form two factors and examine whether they can predict future real activity. The first factor is the excess return of the bottom quintile investment-to-capital firms over the intersection of the top quintile investment-to-captal firms and the top quintile Tobin's q firms. The second factor is the excess return of the bottom quintile asset growth firms over the intersection of the top quintile asset growth firms and the top quintile Tobin's q firms. We test whether quarterly returns on these factors can predict next quarter's real earnings growth and industrial production growth.

The results are presented in Table 5. Panel A shows that the investment-to-capital factor can predict next quarter's real earnings. The coefficient is positive (0.44) and statistically significant (t-statistic 2.62). A positive coefficient implies that, just like the return on the market portfolio, the factor earns low return before recessions.[4] Thus, the asset growth factor is cyclical and its premium is likely a risk premium. The coefficient on the factor is still positive when predicting industrial production growth although it is only marginally statistically significant.

Panel B presents the results for the asset growth factor. As the investment-to-capital factor, the asset growth factor's coefficient is positive (0.472) and statistically significant (t-statistic 2.67) when predicting real earnings growth and is of a similar magnitude to that in Panel A. The asset growth factor is also marginally significant when predicting industrial production.

We conclude that our evidence lends support to the notion that the investment and asset growth factors constitute risk factors which investors care about and require a risk premium in order to hold stocks that load on to these factors.

3.4 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 an exercising of a risky growth option.

If there are lags in investment (due to time-to-build and investment planning), then investment will not rise immediately after the discount rate shock and the firm's decision to undertake investment. Instead, we would expect to see investment a period later than the discount rate shock. In this case, we should observe a decline in systematic risk *before* investment relative to the period before the investment shock. Lamont (2000) finds evidence that investment plans (but not investment) can predict future stock returns. His findings support the notion of existence of lags in the investment process (see also Kydland and Prescott (1982) for evidence regarding time to build).

[4] 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.

In Panel A of Table 6, we examine the loadings with respect to risk factors of two portfolios. The first consists, in year t, of all firms whose IK will be in the top decile IK in year $t+3$ or in year $t+2$ or both. This is termed the pre-investment portfolio. The second consists of all firms in year t whose IK will be in the top decile among all firms' IK in year $t+1$ or year t or both. We call this the investment period portfolio. We have a time series of 504 months (January 1963 through December 2004) for each of the portfolios. We form similar AG portfolios which we term the pre-AG period and the AG period portfolios, respectively.

As seen in Panel A of Table 6, the loadings with respect to the CRR factors mostly decline in the year prior to high asset growth years, with the exception of the loadings on MP which slightly rise. The loadings with respect to the default premium (which changes from 1.609 to 1.129) and term premium (which changes from 1.173 to 0.717) fall the most. The fall in the loadings translates into a fall in expected returns of 0.65% per month which is a sizeable decline (8.08% annualized).

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, Tobin's q is in the top quintile at the time of the high investment). The ivestment period portfolio loadings on the CRR factors are smaller than the pre-investment period loadings, with the exception of the loadings on the MP factor which very slightly rise. The fall in the loadings on the default premium and term premium factors is particularly sharp: the pre-investment period loading on the term premium (1.290) are more than twice as large as the investment period loadings (0.634), and the default premium loadings in the period prior to the investment period (1.716) are substantially larger than the investment period loading with respect to that factor (0.696). In the year prior to high investment years expected monthly returns fall by a remarkable 1.17%, or 14.98% in annual terms. This constitutes strong evidence in favor of the q-theory and the real options model.

Panel C of Table 6 examines risk dynamics for firms who experience high growth rate of assets. The AG period portfolio loadings on the CRR are smaller than the pre-AG period loadings, with the exception of the loading with respect to the change in expected inflation factor which rise somewhat. The declines in the loading on the default premium (from 1.710 to 1.147) and the term premium (from 0.921 to 0.743) are the largest. The change in the risk factor loadings leads to a 0.79% decline in expected returns per month (9.90% annualized). This is a substantial fall in expected returns, lending further support to the q-theory and the real options model.

Panel D presents risk dynamics for firms who have high growth rate of assets when they have valuable investment opportunities, as measured by high q. The loadings with respect to the five factors drop at the AG period relative to the pre-AG period, with the exception of the loadings with respect to the industrial factor which slightly rise. As in the previous Panels, the fall in the loadings with respect to the term premium (from 1.283 to 0.696) and the default premium (from 1.675 to 0.841) are particularly large. The fall in implied expected returns is very large and amounts to 1.33% per month (17.18% annualized). This dramatic fall in expected returns that lends strong support to the rational-based explanations for the negative asset growth-future returns relationship.

In summary, Table 6 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 decline in portfolio loadings with respect to the term premium and default premium factors, two factors that are tightly linked to the business cycle. We also note that the behavioral based explanations of the investment negative-return relationship predicts no change in risk and expected return around investment.

3.5 Risk Dynamics and Disinvestment

The real options model and the q-theory described above pertain to the relation 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 therefore some of its project will become negative NPV projects. Therefore, the q-theory predicts that this firm will disinvest. Considering that disinvestment occurs with a lag we expect to observe a decline in systematic risk before periods of disinvestment. Similarly the real options theory predicts that risk increases after disinvestment because the option to disinvest is a real put option and disinvestment constitutes exercising this option. If investment occurs with a lag and if investors are aware that the firm has decided to exercise the real option we should see an increase in systematic risk before the disinvestment occurs.

We examine the dynamics of systematic risk before 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 (have a negative capital or total asset growth) in year $t+3$ or in year $t+2$ or in both years. This portfolio is the pre-disinvestment portfolio. The second portfolio consists in year t of all firms whose capital (asset growth) is negative in year $t+1$ or in year t or in both years. This portfolio is termed the disinvestment period portfolio.

Panel A of Table 7 shows the results for which disinvestment is defined as negative capital growth, whereas in Panel B disinvestment is defined as negative asset growth. As seen in Panel A, with the exception of the loadings with respect to the industrial production factor, risk factor loadings rise following periods of negative capital growth. Expected returns implied by the risk factor loadings increase by 0.33% per month (4.03% annualized). This finding is again consistent with both the q-theory and the real options model.

Panel B shows that when disinvestment is defined as negative asset growth, the loadings with respect to unexpected inflation, change in expected inflation, the term premium and default premium all rise in the disinvestment period relative to the previous period. The only exception is, again, the loading on the indusrtrial production, which fall from 0.371 to 0.172. Expected returns rise by 0.20 per month (2.43% annulized).

We conclude that the dynamics of risk around disinvestment periods, as well as investment periods, is consistent with the predictions of rational-based models.

3.6 Volatility Dynamics

The real options theory has clear predictions concerning volatility dynamics: volatility of stock returns should decline following investment, because 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, it drops sharply following the exercising of real options, and then it starts rising again as firms start building up new real options. The rationale is that just like the value of a financial option increases with the volatility of the underlying asset, the value of a real option should increase with the volatility of the underlying profitability process.

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 firms' systematic risk will render more projects positive NPV projects and thereby induce investment, and at the same time a decline in systematic risk should reduce firms' 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.

In this section, we examine the dynamics of volatility around high investment (asset growth) periods. According to the real options theory, volatility itself should drop following periods of high growth in assets (high investment). 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 who optimally exercise valuable growth opportunities and not to overinvesting firms (for which volatility might actually rise following investment if the additional capital entails higher operating leverage). We therefore examine 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). Our findings are remarkably consistent with the real options model and with the q-theory. Volatility drops for all firms in the year prior to investment. However it drops substantially more for firms exercising valuable growth opportunities.

Panel A of Table 8 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) two years before high investment years. In the year prior to the high investment year the volatility of monthly returns drops to 7.28%, a large fall of 1.74% (6.03% annualized). This fall in volatility is consistent with real options models and with the q-theory of investment.

Recalling that real options theory and the q-theory pertain to firms which optimally exercise valuable growth options and not to firms which invest in spite of poor growth opportunities, Panel B examines volatility dynamics for firms with high Tobin's q in the years prior to high asset investment years. These firms are likely to hold valuable growth options and upon the decision to exercise the options in the year before high investment years, the theory predicts a fall in their stock return volatility. The q-theory also predicts a large fall in volatility for these firms because shocks that reduce a firm's cost of capital and thereby trigger investment, also increase its market value and therefore its Tobin's q rises. As seen in Panel B, the volatility of monthly portfolio returns two years before high investment years is 12.70% (44.31% annualized) which is very large for a well-diversified portfolio. In the year prior to 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. This evidence lends strong support for the predictions of the real options theory and the q-theory. The behavioral-based models, on the other hand, do not predict a change in volatility, in either direction, following investment.

Panels C and D pertain to asset growth portfolios. Panel C shows that between two years and one year before high asset growth years volatility of monthly returns drops substantially by 110 basis points, which is 3.81% in annual terms. Panel D presents the results for firms with high q in the year before years with 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) two years before the high asset growth years. In the year before 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).

In untabulated results we show that volatility dynamics is very similar when using top and bottom quintile investment-to-capital and asset growth portfolios.

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 exercising valuable growth options. These large drops in volatility are consistent with the predictions of the rational based models.

3.7 Robustness Checks

In this Section we conduct several robustness checks that show that our previous results for decile portfolios hold for quintile portfolios as well. Thus our findings in the paper are not sensitive to our choice of percentile of investment-to-capital or asset growth. 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 Tables.

Tables 9 shows that the fractions of average returns that are accounted for by spreads in the risk factor loadings, 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 returns spread between the low and high IK portfolios that is explained by implied expected returns spread is 112%. That is, the entire 'investment effect' can be explained by risk spreads. When considering firms with high IK when they have high Tobin's q, as seen in the third row, that fraction rises to 142%. Thus, for these firms the spread in average returns is in fact smaller than the spread in implied expected returns.

Panel B presents the results for the asset growth portfolios. A large fraction (85%) of the average return spread between the bottom quintile AG and top quintile AG portfolios are accounted for by risk loadings spread. 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 document) stems from spreads in systematic risk. When considering firms investing when their Tobin's q is high this fraction rises to 142%. That is, all of the large average return spread (1.23% per month) is explained by risk.

Overall, our results in Table 9 provide strong evidence that risk plays a central role in the negative investment (asset growth)-future returns relationship.

Table 10 examines risk dynamics for top quintile IK and AG portfolios. The results are similar to those when using decile portfolios in Table 6. Panel A shows that expected returns implied by risk factor loadings fall by 0.39 during periods of high investment. As seen in Panel B, when investment occurs when q is high, the fall in implied expected returns is 0.80%, which is a very large drop (10.03% in annual terms). This dynamics is very consistent with the q-theory and with real options models.

Panels C and D show very similar dynamics for the top quintile asset growth portfolios. For firms investing when they have valuable growth opportunities, expected returns implied by risk factor loadings fall by a whole 1% per month, a very large decline.

Overall, our robustness checks show that our results in the paper are not sensitive to our choice of decile portfolios. Our finidngs are remarkably consistent with the rational-based explanations for the negative investment (asset growth)-future returns relationship.

4 Conclusion

Previous studies find a strong negative relation between real investment (and asset growth) and subsequent stock returns. This finding is consistent with behavioral explanations that are based on either 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-based explanations based on the q-theory of investment and on real options models. This paper is a first attempt to try and distinguish between these two competing explanations and to measure the extent to which each of the two explanations account for the negative investment (asset growth) relationship.

We measure systematic risk as stock returns' loadings with respect to the five Chen, Roll and Ross (1986) factors. The advantage of usung 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 asset growth (investment) and high asset growth (investment) that is accounted for by risk spread is particularly large for firms that invest when they have good investment opportunities.

The paper also examines whether return factors, defined as the excess return of low asset growth (investment) firms over high asset growth (investment) firms who have invested when their Tobin's q was high, are related to the macroeconomy. Similar 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. We find that these factors can predict future real activity. Specifically, the return on the factors is positively related to future real earnings growth and 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.

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 high Tobin's q which we interpret as exercising valuable investment opportunities. Also consistent with rational-based explanations is our finding that firms' risk increases substantially after they disinvest.

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

While our findings are consistent with rational-based explanations for the negative investment-future returns relationship, behavioral explanations are silent as to risk and volatility dynamics and their link to investment opportunities. In light of this, our findings lend strong support to the notion that risk plays an important role in the negative asset growth (investment)-future returns relationship.

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Table 1
Summary Statistics for Portfolio Returns

Panel A presents average portfolio returns and loadings with respect to the five Chen, Roll and Ross (1986) factors for 10 portfolios formed based on the growth rate of total assets. The loadings estimates are from monthly regressions of portfolio excess returns on the five. 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 Chen, Roll and Ross factors for 10 portfolios based on the investment to capital ratio. The sample is monthly from January 1963 to December 2004. T-statistics are in parentheses.

Panel A - Investment to Capital Portfolios

Decile	1 (low)	2	3	4	5	6	7	8	9	10 (high)
$\bar{r}$	1.76	1.61	1.49	1.52	1.43	1.41	1.32	1.25	1.27	1.03
MP	0.302	0.379	0.289	0.192	0.199	0.149	0.149	0.205	0.179	0.036
	(0.70)	(1.01)	(0.82)	(0.57)	(0.58)	(0.43)	(0.41)	(0.54)	(0.44)	(0.08)
UI	−4.277	−4.404	−4.367	−4.149	−3.836	−4.037	−4.456	−4.063	−4.649	−4.862
	(−2.23)	(−2.64)	(−2.80)	(−2.75)	(−2.52)	(−2.63)	(−2.77)	(−2.42)	(−2.55)	(−2.34)
DEI	10.451	7.206	6.658	5.831	5.750	5.265	6.625	5.693	6.460	7.999
	(2.04)	(1.62)	(1.60)	(1.45)	(1.42)	(1.28)	(1.55)	(1.27)	(1.33)	(1.44)
UTS	0.759	0.587	0.623	0.736	0.536	0.592	0.594	0.612	0.689	0.635
	(3.58)	(3.18)	(3.61)	(4.42)	(3.19)	(3.49)	(3.35)	(3.29)	(3.42)	(2.76)
UPR	1.491	1.567	1.551	1.132	1.577	1.589	1.620	1.697	1.510	1.206
	(2.09)	(2.53)	(2.67)	(2.02)	(2.79)	(2.78)	(2.72)	(1.99)	(2.23)	(1.56)

Panel B - Asset Growth Portfolios

Decile	1 (low)	2	3	4	5	6	7	8	9	10 (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	0.483	0.184	0.216	0.168	0.131	0.126	0.133	0.136	0.100
	(0.64)	(1.19)	(0.51)	(0.65)	(0.51)	(0.40)	(0.36)	(0.37)	(0.34)	(0.22)
UI	−4.521	−4.270	−4.030	−4.237	−3.939	−3.985	−3.729	−4.435	−4.758	−4.834
	(−1.96)	(−2.37)	(−2.51)	(−2.87)	(−2.69)	(−2.74)	(−2.44)	(−2.77)	(−2.65)	(−2.39)
DEI	11.131	8.988	7.551	6.277	5.761	4.934	4.114	5.045	5.816	7.153
	(1.80)	(1.87)	(1.79)	(1.59)	(1.47)	(1.27)	(1.01)	(1.18)	(1.21)	(1.32)
UTS	0.849	0.749	0.716	0.608	0.562	0.580	0.526	0.572	0.549	0.536
	(3.32)	(3.76)	(4.03)	(3.72)	(3.47)	(3.61)	(3.11)	(3.23)	(2.76)	(2.40)
UPR	1.662	1.490	1.405	1.625	1.462	1.632	1.663	1.482	1.485	1.573
	(1.93)	(2.23)	(2.35)	(2.96)	(2.69)	(3.02)	(2.92)	(2.49)	(2.22)	(2.09)

Table 3
Risk Premium Estimates

We estimate risk premiums of 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) from two-stage Fama-MacBeth (1973) cross-sectional regressions. 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 at the month t, in which we perform the second-stage cross-sectional regressions of portfolio excess returns from t to $t+1$ on factor loadings estimated using information up to month t. 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 including the ten size, ten book-to-market, ten momentum portfolios and ten asset growth portfolios. We report the second-stage cross-sectional regressions including the intercepts ($\hat{\gamma}_0$), risk premiums ($\hat{\gamma}$) and average cross-sectional $\bar{R}^2$s. The intercepts and the risk premiums are in percentage per month. The Fama-MacBeth t-statistics calculated from the Shanken (1992) method are reported in parentheses.

	$\hat{\gamma}_0$	$\hat{\gamma}_{MP}$	$\hat{\gamma}_{UI}$	$\hat{\gamma}_{DEI}$	$\hat{\gamma}_{UTS}$	$\hat{\gamma}_{UPR}$	$\bar{R}^2$
Full sample in first stage	1.164	1.229	0.399	0.028	0.602	0.439	0.80
	(4.66)	(5.91)	(5.26)	(1.72)	(1.57)	(3.74)	
Extending window in first stage	0.739	1.090	0.179	0.019	0.714	0.163	0.48
	(2.51)	(4.47)	(2.35)	(1.15)	(2.15)	(1.66)	
Rolling window in first stage	0.692	0.288	0.000	−0.015	0.381	0.054	0.44
	(2.88)	(3.09)	(0.20)	(−1.78)	(2.70)	(1.35)	

Table 3
Spreads in Systematic Risk and Average Return Spreads

This Table reports loadings (based on regressions using monthly data) with respect to the five Chen, Roll and Ross (1986) factors for the bottom asset growth (investment to capital) decile portfolio, the top asset growth (investment to capital) decile portfolio and the intersection of the top asset growth (investment to capital) decile portfolio with the portfolio of the top quintile Tobin's q firms in averaged over the calendar year in which the asset growth (investment) is measured and the previous year. The Table reports average return spreads and implied expected return spreads between the low and high asset growth (investment to capital) 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 five Chen, Roll and Ross factors, and the average monthly factor premiums based on either full sample, extending window or rolling regression estimation. $E(r)$ 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 sample period is January 1963 through December 2004.

Panel A: Full Sample, Investment to Capital Portfolios

	MP	UI	DEI	UTS	UPR	$\bar{r}_L - \bar{r}$	$E\left(\bar{r}_L\right) - E\left(\bar{r}\right)$	$\frac{E\left(\bar{r}_L\right) - E\left(\bar{r}\right)}{\bar{r}_L - \bar{r}}$
Low IK	0.302	−4.277	10.451	0.759	1.491			
	(0.72)	(−2.23)	(2.04)	(3.58)	(2.09)			
High IK	0.036	−4.862	7.999	0.635	1.206	0.73	0.83	1.15
	(0.08)	(−2.34)	(1.44)	(2.76)	(1.56)			
High IK and high q	−0.172	−5.03	8.525	0.579	0.941	1.06	1.49	1.41
	(0.33)	(−2.40)	(1.39)	(2.28)	(1.10)			

Panel B: Full Sample, Asset Growth Portfolios

	MP	UI	DEI	UTS	UPR	$\bar{r}_L - \bar{r}$	$E\left(\bar{r}_L\right) - E\left(\bar{r}\right)$	$\frac{E\left(\bar{r}_L\right) - E\left(\bar{r}\right)}{\bar{r}_L - \bar{r}}$
Low AG	0.334	−4.521	11.131	0.849	1.662			
	(0.64)	(−1.96)	(1.80)	(3.32)	(1.93)			
High AG	0.100	−4.834	7.153	0.536	1.573	1.21	0.77	0.64
	(0.22)	(−2.39)	(1.32)	(2.40)	(2.09)			
High AG and high q	−0.034	−5.318	8.459	0.459	1.358	1.40	1.33	0.95
	(−0.07)	(−2.30)	(1.37)	(1.80)	(1.58)			

Table 4
Spreads in Systematic Risk and Average Return Spreads: Robustness

This Table reports results (based on regressions using monthly data) with respect to the five Chen, Roll and Ross (1986) factors for the bottom asset growth (investment to capital) decile portfolio, the top asset growth (investment to capital) decile portfolio and the intersection of the top asset growth (investment to capital) decile portfolio with the portfolio of the top quintile Tobin's q firms in averaged over the calendar year in which the asset growth (investment) is measured and the previous year. The Table reports average return spreads and implied expected return spreads between the low and high asset growth (investment to capital) 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 five Chen, Roll and Ross factors, and the average monthly factor premiums based on either an extending window or rolling regression estimation. $E(r)$ 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 sample period is January 1963 through December 2004.

Panel A: Extending Window, Investment to Capital Portfolios

	$\bar{r}_L - \bar{r}$	$E\left(\bar{r}_L\right) - E\left(\bar{r}\right)$	$\frac{E\left(\bar{r}_L\right) - E\left(\bar{r}\right)}{\bar{r}_L - \bar{r}}$
High IK	0.73	0.58	0.79
High IK and high q	1.06	0.99	0.93

Panel B: Extending Window, Asset Growth Portfolios

	$\bar{r}_L - \bar{r}$	$E\left(\bar{r}_L\right) - E\left(\bar{r}\right)$	$\frac{E\left(\bar{r}_L\right) - E\left(\bar{r}\right)}{\bar{r}_L - \bar{r}}$
High AG	1.21	0.62	0.51
High AG and high q	1.40	0.92	0.66

Panel C: Rolling Window, Investment to Capital Portfolios

	$\bar{r}_L - \bar{r}$	$E\left(\bar{r}_L\right) - E\left(\bar{r}\right)$	$\frac{E\left(\bar{r}_L\right) - E\left(\bar{r}\right)}{\bar{r}_L - \bar{r}}$
High IK	0.73	0.11	0.15
High IK and high q	1.06	0.22	0.21

Panel D: Rolling Window, Asset Growth Portfolios

	$\bar{r}_L - \bar{r}$	$E\left(\bar{r}_L\right) - E\left(\bar{r}\right)$	$\frac{E\left(\bar{r}_L\right) - E\left(\bar{r}\right)}{\bar{r}_L - \bar{r}}$
High AG	1.21	0.13	0.11
High AG and high q	1.40	0.24	0.17

Table 5
The Asset Growth and Investment Factors as Predictors of Economic Growth

The table presents results from regressing quarterly real earnings growth and the growth rate of industrial production on quarterly return factor portfolios. The factor AGQ is the return on a portfolio that is long on the bottom decile asset growth stocks and short on the top decile asset growth portfolio intersected with the top Tobin's q quintile portfolio. The factor IKQ is the return on a portfolio that is long on the bottom decile investment to capital stocks and short on the top decile investment to capital portfolio intersected with the top Tobin's q quintile portfolio. Δre is the growth rate of real earnings, MP is the growth rate of real industrial production. Data are sampled quarterly from 1963:02 To 2005:04. t-statistics are in the parentheses.

Panel A - Investment to capital and high q

	Constant	IKQ_{t-1}	$\overline{R}^2$
Δre	−0.003	0.440	2.4
	(0.49)	(2.62)	
MP	0.380	2.959	1.1
	(6.22)	(1.91)	

Panel B - Asset growth and high q

	Constant	AGQ_{t-1}	$\overline{R}^2$
Δre	−0.008	0.472	3.5
	(0.95)	(2.67)	
MP	0.435	2.516	1.0
	(5.68)	(1.65)	

Table 6
Risk Dynamics Around Investment

This table reports results from regressing monthly excess returns of a portfolio of firms whose asset growth (investment to capital ratio) is in the top decile of all firms' asset growth (investment to capital ratio) in year $t+3$ or year $t+2$ or both (the pre asset growth (investment) portfolio) on the five Chen Roll and Ross (CRR) factors and the monthly excess returns of a portfolio of firms whose asset growth is in the top decile asset growth in year $t+1$ or year t or both (the AG or investment period portfolios) on the five CRR factors. The Table also presents regression results from regressing the return during the pre asset growth (pre investment) period and the asset growth (investment) period, of a portfolio of firms whose asset growth (investment to capital ratio) is in the top decile asset growth (investment to capital ratio) in year $t+1$ or t and whose Tobin's q is in the top quintile in year $t+1$ or t on the five CRR factors. $E(r)$ is the asset growth (investment) period portfolio expected return as calculated by the product of the loadings with respect to the five CRR factors with the corresponding estimated risk premiums (based on the full sample estimation). Similarly $E(r_{pre})$ is the implied expected returns for the pre-investment portfolio. The sample period is January 1963 through December 2004.

Panel A: Highest investment to capital portfolio

	Constant	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre investment	−0.001	−0.026	−5.238	11.788	1.173	1.609	
	(−0.12)	(−0.04)	(−2.02)	(1.73)	(3.94)	(1.69)	
Investment period	0.009	0.006	−5.617	10.927	0.717	1.129	-0.65
	(1.06)	(0.01)	(−2.68)	(1.98)	(2.97)	(1.46)	

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

	Constant	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre investment	0.006	−0.191	−5.954	15.144	1.290	1.716	
	(0.39)	(0.23)	(−1.61)	(1.55)	(3.03)	(1.26)	
Investment period	0.024	−0.182	−6.527	12.435	0.634	0.696	-1.17
	(2.34)	(−0.34)	(−2.69)	(1.95)	(2.27)	(0.78)	

Panel C: Highest asset growth portfolio

	Constant	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre AG period	-0.003	-0.001	-4.762	9.362	0.921	1.710	
	(0.26)	(0.00)	(-2.02)	(1.51)	(3.39)	(1.97)	
AG period	0.013	-0.025	-5.819	10.132	0.743	1.147	-0.79
	(1.56)	(-0.06)	(-2.85)	(1.88)	(3.16)	(1.53)	

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

	Constant	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre AG period	0.004	-0.181	-5.564	14.569	1.283	1.675	
	(0.28)	(0.22)	(-1.53)	(1.53)	(3.07)	(1.26)	
AG period	0.026	-0.164	-6.900	12.337	0.696	0.841	-1.33
	(2.53)	(-0.30)	(-2.86)	(1.95)	(2.51)	(0.95)	

Table 7
Risk Dynamics Around Disinvestment

This table reports results from regressing monthly excess returns of a portfolio of all firms whose capital growth (asset growth) is negative in year $t+3$ or year $t+2$ or both (the pre disinvestment portfolio) on the five Chen Roll and Ross (CRR) factors and the monthly excess returns of a portfolio of firms whose capital growth (asset growth) is negative in year $t+1$ or year t or both (the Disinvestment period portfolio) on the five CRR factors. $E(r)$ is the capital growth (asset growth) period portfolio expected return as calculated by the product of the loadings with respect to the five CRR factors with the corresponding estimated risk premiums (based on the full sample 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.

Panel A: Investment to Capital Portfolios

	$Constant$	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre disinvestment	−0.009	0.391	−5.393	6.802	0.510	1.249	
	(−1.02)	(0.87)	(−2.67)	(1.28)	(2.20)	(1.68)	
Disinvestment period	−0.014	0.210	−4.774	8.654	0.734	1.504	0.33
	(−1.77)	(0.51)	(−2.59)	(1.78)	(3.46)	(2.22)	

Panel B: asset growth portfolios

	Constant	MP	UI	DEI	UTS	UPR	$E(r) - E(r_{pre})$
Pre disinvestment	−0.009	0.371	−5.472	7.236	0.529	1.309	
	(−1.09)	(0.81)	(−2.65)	(1.33)	(2.23)	(1.72)	
Disinvestment period	−0.014	0.172	−4.831	8.583	0.673	1.427	0.20
	(−1.94)	(0.41)	(−2.57)	(1.74)	(3.11)	(2.07)	

Table 8
Volatility Dynamics

This table reports standard deviations of monthly returns of a portfolio of firms whose asset growth (investment to capital ratio) is in the top quintile of all firms' asset growth (investment to capital ratio) in year $t+3$ or year $t+2$ or both (the pre asset growth (investment) portfolio), and the standard deviation of monthly returns of a portfolio of firms whose asset growth is in the top quintile asset growth in year $t+1$ or year t or both (the AG or investment period portfolios). The Table also presents the standard deviations of monthly returns of the pre asset growth (pre investment) period portfolio and asset growth (investment) period portfolio of all firms whose asset growth (investment) period Tobin's q is in the top quintile. The sample period is January 1963 through December 2004.

Panel A: Highest 20% investment to capital portfolios

	Pre Investment	Investment period	Difference
Return volatility	9.02	7.28	-1.74

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

	Pre Investment	Investment period	Difference
Return volatility	12.79	8.37	-4.42

Panel C: Highest 20% asset growth portfolios

	Pre *AG*	*AG* period	Difference
Return volatility	8.21	7.11	-1.10

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

	Pre *AG*	*AG* period	Difference
Return volatility	12.53	8.33	-4.20

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 five Chen, Roll and Ross (1986) factors for the bottom asset growth (investment to capital) quintile portfolio, the top asset growth (investment to capital) quintile portfolio and the intersection of the top asset growth (investment to capital) quintile portfolio with the portfolio of the top quintile Tobin's q firms in averaged over the calendar year in which the asset growth (investment) is measured and the previous year. The Table reports average return spreads and implied expected return spreads between the low and high asset growth (investment to capital) 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 five Chen, Roll and Ross factors, and the average monthly factor premiums based on either full sample, extending window or rolling regression estimation. $E(r)$ 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 sample period is January 1963 through December 2004.

Panel A: Full Sample, Investment to Capital Portfolios

	MP	UI	DEI	UTS	UPR	$\bar{r}_L - \bar{r}$	$E(\bar{r}_L) - E(\bar{r})$	$\frac{E(\bar{r}_L)-E(\bar{r})}{\bar{r}_L-\bar{r}}$
Low IK	0.330	−4.354	8.746	0.676	1.538			
	(0.83)	(−2.48)	(1.86)	(3.48)	(2.35)			
High IK	0.109	−4.765	7.240	0.662	1.357	0.51	0.57	1.12
	(0.25)	(−2.47)	(1.40)	(3.10)	(1.89)			
High IK	−0.172	−4.979	7.004	0.580	1.057	0.84	1.19	1.42
and high q	(0.36)	(−2.32)	(1.22)	(2.45)	(1.33)			

Panel B: Full Sample, Asset Growth Portfolios

	MP	UI	DEI	UTS	UPR	$\bar{r}_L - \bar{r}$	$E(\bar{r}_L) - E(\bar{r})$	$\frac{E(\bar{r}_L)-E(\bar{r})}{\bar{r}_L-\bar{r}}$
Low IK	0.412	−4.367	10.007	0.793	1.578			
	(0.90)	(−2.16)	(1.85)	(3.55)	(2.10)			
High IK	0.121	−4.783	6.436	0.539	1.531	0.95	0.81	0.85
	(0.28)	(−2.52)	(1.27)	(2.57)	(2.17)			
High IK	−0.068	−5.463	7.420	0.488	1.407	1.23	1.37	1.42
and high q	(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 excess returns of a portfolio of firms whose asset growth (investment to capital ratio) is in the top quintile of all firms' asset growth (investment to capital ratio) in year $t+3$ or year $t+2$ or both (the pre asset growth (investment) portfolio) on the five Chen Roll and Ross (CRR) factors and the monthly excess returns of a portfolio of firms whose asset growth is in the top quintile asset growth in year $t+1$ or year t or both (the AG or investment period portfolios) on the five CRR factors. The Table also presents regression results from regressing the return during the pre asset growth (pre investment) period and the asset growth (investment) period, of a portfolio of firms whose asset growth (investment to capital ratio) is in the top quintile asset growth (investment to capital ratio) in year $t+1$ or t and whose Tobin's q is in the top quintile in year $t+1$ or t on the five CRR factors. $E(r)$ is the asset growth (investment) period portfolio expected return as calculated by the product of the loadings with respect to the five CRR factors with the corresponding estimated risk premiums (based on the full sample estimation). Similarly $E(r_{pre})$ is the implied expected returns for the pre-investment portfolio. The sample period is January 1963 through December 2004.

Panel A: Highest 20% investment to capital portfolios

	Constant	MP	UI	DEI	UTS	UPR	$E(r)-E(r_{pre})$
Pre investment	−0.002	−0.052	−5.134	10.045	1.046	1.573	
	(−0.18)	(−0.11)	(−2.37)	(1.76)	(4.20)	(1.97)	
Investment period	0.005	0.045	−5.337	8.949	0.664	1.233	-0.39
	(0.57)	(0.10)	(−2.74)	(1.75)	(2.96)	(1.72)	

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

	Constant	MP	UI	DEI	UTS	UPR	$E(r)-E(r_{pre})$
Pre investment	0.006	−0.098	−6.136	12.540	1.223	1.614	
	(0.38)	(0.12)	(−1.73)	(1.34)	(2.99)	(1.23)	
Investment period	0.017	−0.134	−6.147	10.948	0.578	0.976	-0.80
	(1.83)	(−0.28)	(−2.81)	(1.90)	(2.29)	(1.21)	

Panel C: Highest 20% asset growth portfolios

	Constant	MP	UI	DEI	UTS	UPR	$E(r)-E(r_{pre})$
Pre AG period	-0.002	0.022	-5.008	8.750	0.881	1.613	
	(0.27)	(0.05)	(−2.48)	(1.65)	(3.79)	(2.17)	
AG period	0.007	0.027	-5.423	8.690	0.687	1.292	-0.43
	(0.93)	(0.07)	(−2.89)	(1.76)	(3.18)	(1.87)	

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

	Constant	MP	UI	DEI	UTS	UPR	$E(r)-E(r_{pre})$
Pre AG period	0.003	-0.158	-6.079	13.224	1.239	1.690	
	(0.23)	(0.20)	(−1.74)	(1.44)	(3.08)	(1.31)	
AG period	0.004	-0.174	-6.426	10.578	0.629	0.863	-1.00
	(0.55)	(0.36)	(−2.98)	(1.87)	(2.54)	(1.09)	