Journal of Financial Economics 101 (2011) 182–205

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

# Real investment and risk dynamics ☆

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ARTICLE INFO

*Article history:*
Received 3 August 2009
Received in revised form
13 July 2010
Accepted 27 July 2010
Available online 2 March 2011

*JEL classification:*
G12
G31
E44

*Keywords:*
Real investment
Expected returns
Systematic risk
*q*-theory
Real options

ABSTRACT

We ask to what extent the negative relation between investment and average stock returns is driven by risk. We show that: (i) the average return spread between low and high asset growth and investment portfolios is largely accounted for by their spread in systematic risk, as measured by the loadings on the Chen, Roll, and Ross (1986) factors; (ii) as predicted by *q*-theory and real options models, systematic risk falls during large investment periods; (iii) the returns of factors formed on the investment-to-assets, asset growth, and investment growth all forecast aggregate economic activities. Our evidence suggests that risk plays an important role in explaining the investment-return relation.



## 1. Introduction

We provide evidence in support of a risk-based interpretation of the role of investment in driving the cross-section of average stock returns. This finding is important since recent empirical work documents 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.[1]

☆ We are grateful for comments from Azi Ben-Rephael, Jonathan Berk (AFA discussant), Long Chen, Engelbert Dockner (EFA discussant), Burton Hollifield (UBC summer conference discussant), Oyvind Norli, William Schwert (the Editor), Lu Zhang, as well as seminar participants at the AFA 2009 annual meeting, University of Amsterdam, Ben Gurion University, UBC 2009 Summer Finance Conference, University College Dublin, 2008 North American summer meeting of the Econometric Society, EFA 2009 annual meeting, IDC Herzliya 2010 summer conference, Instituto de Empresa Madrid, Manchester University, and Vienna Graduate School of Finance. An anonymous referee deserves special thanks for numerous helpful comments and suggestions.

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doi:10.1016/j.jfineco.2011.02.002

[1] For example, Xing (2008) finds that an investment factor contains information similar to the Fama and French (1993) value factor high minus low (HML), and can explain the value effect. Lyandres, Sun, and Zhang (2008) find that the post Seasoned Equity Offerings (SEO) underperformance substantially diminishes when a low minus high investment portfolio is added as a common risk factor. Chen, Novy-Marx, and Zhang (2010) show that a three-factor model, where the factors are the market portfolio, an investment factor, and a return on assets factor, explains much of the average return spreads across test assets formed on short-term prior returns, failure probability, *O*-score, earnings surprises, accruals, net stock issues, and stock valuation ratios. Wu, Zhang, and Zhang (2010) apply the *q*-theory to understand the accrual anomaly and provide evidence that adding an investment factor into standard factor regressions substantially reduces the magnitude of the accrual anomaly, often to insignificant levels. The motivation for the incorporation of the investment factor as a common risk factor is based in part on a set of empirical studies that show a strong negative cross-sectional relation between real investment (and asset growth) and future stock returns (see Anderson and Garcia-Feijoo, 2006; Xing, 2008; and Cooper, Gulen, and Schill, 2008).

Our central findings can be summarized as follows. First, low investment firms have substantially higher loadings with respect to the Chen, Roll, and Ross (1986) factors than high investment firms. The dispersion in the loadings between low and high investment firms is particularly large with respect to the growth rate of industrial production, which is a prominent and highly procyclical macroeconomic variable, and the term spread factor, which has substantial forecasting power for macroeconomic activity.[2] These findings hold regardless of whether investment is measured as investment-to-assets, asset growth, or the growth of capital expenditures.

Second, industrial production growth and the term spread are priced risk factors, and coupled with the spread in the loadings with respect to these factors across low and high investment portfolios, the implied expected returns spread can account for much of the spread in average return across these portfolios. Third, the dynamics of systematic risk around both large investment periods and around disinvestment periods are consistent with the predictions of both the *q*-theory of investment and of real option models. We find that systematic risk falls during high investment periods and rises in disinvestment periods.

Fourth, the investment factors contain information about future real industrial production growth, future real gross domestic product (GDP) growth, future real corporate earnings growth, and future real aggregate investment growth. Like the market portfolio, the investment factors earn low returns just before recessions. This evidence lends support to the interpretation of these factors as common risk factors that investors require a premium for holding.[3]

In addition to the empirical work that relates investment to the cross-section of returns, an investment factor arises as a result of the *q*-theory of investment (Cochrane, 1991; Li, Livdan, and Zhang, 2009; and Liu, Whited, and Zhang, 2009). However, the stream of recent papers that shows the first-order importance of investment for the cross-section of average returns stays away from the risk interpretation of the investment effect because of the *q*-theory's partial equilibrium nature. For example, Liu, Whited, and Zhang (2009) note that "… because we do not parameterize the stochastic discount factor, our work is silent about why average return spreads across characteristics-sorted portfolios are not matched with spreads in covariances empirically." Lyandres, Sun, and Zhang (2008) and Chen, Novy-Marx, and Zhang (2010) also note that they do not interpret the investment factor as a risk factor. Li and Zhang (2010) also try to disentangle the risk, and non-risk, based theories of the investment-return relation. In particular, Li and Zhang derive from *q*-theory that investment frictions should steepen the investment-return relation. However, the evidence is not supportive. In fact, limits-to-arbitrage proxies often dominate investment frictions proxies in explaining the magnitude of the investment-to-assets and asset growth effects in cross-sectional returns. By providing evidence for the role of risk in the investment effect in stock returns, our paper fills an important gap in the literature.

The rest of the paper is organized as follows. Section 2 reviews the risk-based and behavioral explanations for the investment-return relation and presents testable hypotheses concerning the role of risk in this relation. Section 3 describes the data and variable construction. Section 4 shows that the loadings with respect to the Chen, Roll, and Ross (1986) factors vary with investment, provides evidence that the Chen, Roll, and Ross (1986) factors are priced risk factors, and quantifies the effect of the loadings with respect to the factors in driving the investment-return relation. Section 5 explores the dynamics of systematic risk around periods of high investment and around periods of disinvestment. In Section 6, we present our results on the relation between the investment factors and future economic activity. Section 7 concludes.

## 2. Hypothesis development

The investment-return relation is consistent with both risk-based explanations and behavioral explanations. Our paper sheds some light on the contribution of these rival explanations by presenting evidence that the bulk of the investment-return relation can be explained by differential exposure to macroeconomic risk factors. However, even though we find that risk plays an important role in explaining the investment-return relation, completely disentangling these two schools of thought is difficult, if not impossible. In Section 2.1, we review the prominent risk-based and behavioral explanations offered for the investment-return relation, and in Section 2.2, we present testable hypotheses.

### *2.1. Explanations for the investment-return relation*

Several models provide risk-based explanations for the negative investment-return relation. Berk, Green, and Naik (1999) present a model 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.

Zhang (2005) presents a neoclassical industry equilibrium model with rational expectations and shows that costly reversibility of capital investment and a countercyclical price of risk lead to assets in place being harder to reduce. This mechanism renders firms with assets in place riskier than firms with growth options, especially in bad times. This theoretical prediction can be linked directly to the investment-return relation as follows. Due to costly reversibility, low investment firms are likely to be burdened with unproductive capital, finding it difficult to reduce their capital stocks, especially in bad times. Hence, in times of economic downturns when the price of risk is high, their dividends and returns covary with economic downturns more than the

[2] See, for example, Stock and Watson (1989), Chen (1991), Estrella and Hardouvelis (1991), Lettau and Ludvigson (2002), and Estrella (2005).

[3] Relatedly, Fama (1981) finds that the return on the market portfolio predicts GDP growth and Liew and Vassalou (2000) find similar evidence regarding the ability of the HML and small minus big (SMB) factors to predict GDP growth.