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Inventory investment and the cost of capital ☆

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ABSTRACT

We examine the relation between inventory investment and the cost of capital in the time series and the cross section. We find consistent evidence that risk premiums, rather than real interest rates, are strongly negatively related to future inventory growth at the aggregate, industry, and firm levels. The effect is stronger for firms in industries that produce durables rather than nondurables, exhibit greater cyclicality in sales, require longer lead times, and are subject to more technological innovation. We then construct a production-based asset pricing model with two types of capital, fixed capital and inventories, to explain these empirical findings. Convex adjustment costs and a countercyclical price of risk lead to negative time series and cross-sectional relations between expected returns and inventory growth.

1. Introduction

As a form of investment, a firm's optimal inventory stock should naturally be expected to vary with its cost of capital. At a macro level, we would expect aggregate inventory investment to vary with measures of the average cost of capital. One of the puzzling results from the empirical macroeconomic literature on inventories is the apparent lack of relation between the accumulation of inventories and the cost of capital, at least as proxied by short-term real interest rates. Maccini, Moore, and Schaller (2004) note that although there is a "perception of an inverse relationship between inventory investment and interest rates, … almost no evidence exists for such an effect." Given that inventory investment contributes more to fluctuations in the gross domestic product (GDP) than either consumption or fixed investment, the inability to relate inventory investment to the cost of capital is disconcerting. A limitation of prior work is that it generally focuses on the real interest rate as the cost of capital relevant for determining inventory investment decisions. If inventory investment is risky, however, then the real interest rate may be a poor proxy for the relevant cost of capital.

The primary goal of our paper is to investigate the relationship between risk premiums and inventory investment. We find strong empirical evidence that risk premiums predict inventory growth at the aggregate, industry, and firm levels. Specifically, a higher risk premium predicts lower aggregate inventory growth, particularly in industries where inventory investment is likely

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to be riskier. At the firm level, both time series and cross-sectional variation in the cost of equity capital drive inventory investment. We then ask whether a production-based asset pricing model with aggregate and idiosyncratic productivity shocks can explain these findings. In the model, which generates both the time series and cross section of firm investment behavior, we find a negative relationship between the cost of capital and inventory investment that is generally consistent with our empirical results.

We find that aggregate inventory investment is negatively related to both debt and equity cost of capital measures constructed from standard regressions of excess returns on predictive variables. We then investigate whether the forms of inventory investment with a greater exposure to systematic risk are more sensitive to these measures. While many types of inventories, like food or tobacco, would appear to carry little systematic risk, other types may be risky for a number of reasons. The value of commodity-like inventories, for instance, might fluctuate substantially with macroeconomic growth. Other goods, like automobiles, which are held in finished goods inventory for longer amounts of time, may face considerable demand risk over the period from when they are produced until when they are sold. This demand risk may be even more substantial for work in progress inventories of goods that require a substantial amount of time to produce.

We find that the relation between the risk premium and inventory investment is stronger for durable goods than it is for nondurables. As noted by Yogo (2006), expenditures are more strongly procyclical for durable goods than they are for nondurables. In our sample, the beta of a regression of durable expenditure growth on GDP growth is around 2.5 times as large as the corresponding beta for nondurables. This greater sensitivity to the business cycle should naturally make investment in durable inventories more risky and therefore more sensitive to aggregate risk premiums.

Our empirical work also separates input inventories (raw materials and work in progress) from output inventories (finished goods). It is well known that these two types are qualitatively different. Input inventories are larger and, at least in the case of durable goods, exhibit greater volatility and are more procyclical. Though we find some sensitivity to risk premiums in both input and output inventories, the effect is weaker for output inventories. This may be the result of output inventories, being finished goods that are ready to be sold, being less risky than input inventories, which take time to transform into final products. This would be consistent with the relative lack of cyclicality we observe in output inventories.

Our regressions also control for variation in the ex ante real interest rate. As in prior research, we find no relation between the real rate and inventory investment. A potential explanation is that, in contrast to risk premiums, volatility in real rates was quite low over much of the post-war sample period. With a data set covering 1953–1971, for instance, Fama (1975) fails to reject the hypothesis of constant ex ante real rates. While subsequent rates have proved significantly more volatile, it is likely that they still represent the least volatile component of the average firm's cost of capital. If inventories are sufficiently risky, then the variation in the real interest rate might be only weakly related to the appropriate cost of capital.

We further disaggregate the data by examining inventory growth patterns in 12 different manufacturing industries. Although we find that the relation between inventory growth and risk premiums is only significant for six or seven of them, the effect is stronger for those industries, like transportation equipment, whose sales covary most positively with aggregate GDP growth, than for other industries, like food, whose sales are relatively flat across the business cycle. The effect is also stronger in high-patent industries, where changing technologies may cause inventories to become obsolete more quickly. Finally, the effect is stronger in industries with longer lead times, which make inventories a longer-term and hence riskier commitment.

At the firm level, we examine the relation between the cost of capital and inventory investment using several different approaches. First, we find that the implied cost of equity capital constructed from projected firm earnings and current market prices is strongly related to future inventory growth. We obtain this result both in Fama-MacBeth regressions and in panel regressions with firm fixed effects, indicating that the cost of capital's effect on inventories has both time series and cross-sectional components. We find similar results whether we use a cost of capital constructed from analyst earnings forecasts (Gebhardt, Lee, and Swaminathan, 2001) or measures based on forecasts from statistical models (Hou, van Dijk, and Zhang, 2012; Wu and Zhang, 2011).

We also confirm earlier findings (e.g., Thomas and Zhang, 2002; Belo and Lin, 2012) that portfolios formed on the basis of inventory growth exhibit a substantial spread in future excess returns, with the returns of low inventory growth firms exceeding those of high growth firms by 5.73% per year. This, too, is consistent with a negative relationship between inventory growth and the cost of capital (e.g., Wu, Zhang, and Zhang, 2010). In a refinement to this result, we then decompose this return spread into industry and firm components. We find that roughly half of the spread between high and low inventory growth portfolios is firm-specific and half is industry-related. Furthermore, firms in the extreme quintile portfolios tend to come from industries that are significantly riskier than average. These results provide additional evidence that inventory growth at the industry level is related to the cost of capital, and that industry heterogeneity is an important feature of the data.

We then build a theoretical model to investigate the relation between inventory investment and risk premiums at the firm and aggregate levels. Our model economy is populated by many firms producing a homogeneous good using two types of capital, namely fixed capital and inventories, and labor. Our production function follows Kydland and Prescott (1982) and Christiano (1988), where production requires investment in both fixed capital and inventories. Like Kydland and Prescott, we introduce a friction into the adjustment of the capital stock, but we replace Kydland and Prescott's time-to-build constraint