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Inventories, sales uncertainty, and financial strength

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ABSTRACT

We investigate the empirical linkages between sales uncertainty and firms' inventory investment behavior while controlling for firms' financial strength. Using large panels of manufacturing firms from several European countries we find that higher sales uncertainty leads to larger stocks of inventories. We also identify an indirect effect of sales uncertainty on inventory accumulation through the financial strength of firms. Our results provide evidence that financial strength mitigates the adverse effects of uncertainty.

1. Introduction

It has long been recognized that we can better understand the behavior of the firm and the cyclical fluctuations in output by studying the changes in inventory investment.[3] Over the business cycle, inventories constitute the most volatile component of GDP as they are the first in line to absorb shocks. This is due to inventory investment having a low adjustment cost (for instance compared to that of fixed capital investment). Following Metzler (1941), researchers proposed several inventory investment behavior models based on microeconomic principles including production smoothing, stock-out avoidance, accelerator motive, (S,s) inventory models among others, to explain the inventory holding behavior of firms.[4] Generally speaking, in these models the marginal cost and benefit of holding inventories determine the inventory investment behavior of firms. More recently, several researchers focusing on the presence of asymmetric information, including Carpenter et al. (1994), Kashyap et al. (1994), Guariglia (1999), Benito (2005), and Guariglia and Mateut (2006), show that inventories are determined by the availability of internal funds.

However, we know very little about how inventories are affected as a firm experiences periods of heightened uncertainty. A careful review of the literature yields only two studies where the linkages between uncertainty and inventory investment are empirically examined. Lee and Koray (1994), using aggregate macro level data, investigate the association between sales uncertainty and inventory behavior for the US wholesale and retail trade sector and show that the variance in sales does not affect inventory behavior in either sector. Bo (2001), in contrast, focuses on firm level data and uses a small panel of Dutch companies (770 observations) to investigate the impact of demand uncertainty. She finds that demand uncertainty (measured by the volatility of sales) has a positive and significant impact on inventory investment. Surprisingly, there are no other studies in the literature that investigate the effects of volatility on firms' inventory investment.[5]

In contrast to the empirical research on the inventory accumulation problem, the literature on the fixed investment behavior of the firm has extensively considered the effects of uncertainty. In particular, recent research has demonstrated that uncertainty may exert indirect effects on the fixed capital investment of a firm through firm's leverage, cash holdings or cash flows in addition to

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[3] See Metzler (1941), Abramovitz (1950), and Blinder and Maccini (1991).

[4] See for instance Blinder and Maccini (1991) and West (1995) for a summary of theoretical and empirical studies on inventory investment accumulation.

[5] Note that neither Lee and Koray (1994) nor Bo (2001) considers the role of financial market frictions in their investigations.

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its direct impact.[6] This observation is meaningful for potential lenders would limit the firm's ability to raise external funds by raising the risk premium they require since they cannot accurately evaluate the firm's creditworthiness in an environment with heightened uncertainty. Hence, as uncertainty varies over time, the importance of the variables that capture the financial state of the firm weakens or strengthens affecting the manager's course of action in an environment where asymmetric information makes it hard or impossible to raise external funds. Nevertheless, available research on the inventory accumulation problem of a firm has not considered the direct and the indirect effects of uncertainty.

In this paper, we use firm level data from several countries aiming to provide comprehensive empirical evidence on the effects of firm specific uncertainty on the inventory behavior of a firm. Our investigation concentrates on the impact of sales uncertainty and implements a dynamic inventory investment model to scrutinize the direct and indirect effects of sales uncertainty on inventory accumulation while we control for firms' financial strength. The empirical model employs panels of manufacturing firms from several continental European countries - including Belgium, Finland, France, Italy, Portugal, and Spain.[7] In our investigation, we use the same model across all countries rather than competing models so that we can stress those commonalities across countries. Our data cover the period 1999-2007 and are obtained from the Amadeus database.

Our results can be summarized as follows. We find that sales uncertainty has a positive impact on inventories indicating that firms facing high demand uncertainty build up inventories to avoid stock-out. However, we also find that the inventory build-up declines as firms hold more liquid assets or extend more trade credit relative to what they receive from their suppliers. This finding suggests that financially unconstrained firms do not increase their stocks to demand shocks. This observation, which is significant for almost all countries in our data set, can be attributed to the ability of a less constrained firm to adapt to changes in demand more easily than a constrained firm which cannot alter its production pattern due to constraints. In particular, one can argue that a less constrained firm has the means to purchase an extra unit of capital, hire labor quickly or outsource production over the business cycle.

The rest of the paper is constructed as follows. Section 2 presents the modeling framework and discusses the methodology we employ in our investigation. It also lays out the approach we implement to generate firm specific uncertainty. Section 3 documents the data. Section 4 presents our empirical findings and Section 5 concludes the paper.

2. The model

We implement a variant of the stock adjustment model proposed by Lovell (1961), which performs well at explaining movements in aggregate inventory data. Using a similar approach, recent research in the literature has examined the inter-linkages between inventory investment and firms' financial health (see Benito, 2005; Guariglia and Mateut, 2006). This model relates the target stock of inventories to the level of sales and allows for slow adjustment of inventories to the desired level. In our case, while controlling for firms' financial strength, we augment the model with sales uncertainty to test for the impact of demand uncertainty on firms' inventory accumulation decision. Denoting I as the logarithm of inventories and S as the logarithm of sales, we model the growth in inventories as follows:

$$\Delta I_{it} = \alpha_i + \beta_0 \Delta I_{it-1} + \beta_1 \Delta S_{it} + \beta_2 \Delta S_{it-1} + \beta_3 (I_{it-1} - S_{it-1}) + \boldsymbol{\beta_4} Fin_{it} + \gamma_1 \sigma_{it} + v_i + v_t + v_{jt} + \varepsilon_{it} \quad (1)$$

where subscript i indexes firms, j industries and t time. The first difference lag of inventories is included in the model to capture the short-run dynamics. The parenthesized term, $(I_{it-1} - S_{it-1})$, is the error correction term which reflects the movement in inventories towards their long-run target. This term portrays the idea that inventories are not adjusted instantaneously due to the presence of adjustment costs. As usual, the idiosyncratic error is depicted by ε_{it} and the remaining terms (v_z) capture firm, time, and industry specific effects.

Eq. (1) is an error correction model. Due to the adjustment process of inventories, we expect the coefficient of the error correction term, β_3, as well as that of the lagged dependent variable, β_0, to have a negative sign. The coefficients associated with sales and lagged sales (β_1 and β_2) are expected to have a positive sign as a firm would increase (decrease) its inventories when it experiences increased (decreased) sales. The impact of firm specific uncertainty that emanates from sales is captured by σ_{it}. We expect that sales volatility will have a positive impact ($\gamma_1 > 0$) on the change in inventories.

2.1. The role of financial variables

To measure the impact of the financial strength of the firm on changes in inventories, we add variables that correspond to the firm's access to both internal and external resources.[8] In particular, in Eq. (1), Fin_{it} is a matrix that contains three financial variables: $Liquid_{it}$, NTC_{it} and $Debt_{it}$. While liquidity and leverage effects on inventory investment have been long established in the literature (see, for instance, Kashyap et al., 1994; Guariglia, 1999; Benito, 2005), we also incorporate the impact of net trade credit (NTC) following the recent research which considers the link between inventories and funding received from business partners in the form of trade credit.[9] Guariglia and Mateut (2006) show that the availability of finance from business partners in the form of trade credit positively influences the accumulation of inventories by UK manufacturing firms. Furthermore, two recent theoretical papers, Bougheas et al. (2009) and Daripa and Nilsen (2011), predict a negative relationship between the volume of trade credit extended and stocks of inventories as firms attempt to minimize inventory storage costs. We use net trade credit, defined as trade credit extended minus trade credit received, to capture both of these effects.

Firms' inventory investment is therefore expected to be correlated with access to internal resources and to short term external finance either from banks ($Debt_{it}$) or from their business partners (NTC_{it}). We measure firms' internal sources of finance ($Liquid_{it}$) as the ratio of liquid assets (cash, bank deposits and equivalent) to total assets. $Debt_{it}$ represents loans with short term maturity and NTC_{it} denotes net trade credit (trade credit extended minus trade credit received). All financial variables are scaled by total assets.

Briefly, we would expect to find a negative coefficient associated with liquid assets ($Liquid$); as firms increase their liquidity, firms are expected to reduce their stocks of inventories. We would also expect to find a negative correlation between net trade credit (NTC) and inventory investment. The reasoning can be explained as follows. On the one hand, there is a positive correlation between purchases

[6] See for instance Bloom et al. (2007) and Baum et al. (2010a,b).

[7] Potential accounting differences across countries, although the data are obtained from the same source, limit cross country comparisons.

[8] In a similar approach, Brown et al. (2009) and Brown and Petersen (2009) explore the role of financial constraints on R&D and fixed capital investment by adding variables that correspond to the firm's access to both internal and external equity. Thus, they control for firm's gross cash flow, net new funds from stock issues and net new long-term debt. Our choice of short term financial variables, i.e. liquid assets, net funding from business partners and short term bank debt, matches the higher frequency of inventory investment. Our choice of financial variables also reflects the fact that most firms in our data set are not quoted on the stock exchange.

[9] Benito (2005) uses the liquidity ratio and the borrowing ratio defined as debt interest payments to cash flow to measure the financial strength of firms.