Inventory Management in China: Evidence from Micro Data

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Inventory Management in China: Evidence from Micro Data

A Thesis

By

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Abstract

Inventory management has become a favorite topic in the literature. However, research focusing on inventory performance and management in China is quite limited. A good understanding of inventory control would provide valuable information about the mechanism through which a firm determines its target inventory level and adjusts the inventory volume. Moreover, this study also contributes to examine inventory management improvement and its implement in developing country. This research uses a large sample of firm-level panel data from China to study inventory management and performance from three aspects.

First, using a variant of error-correction model, we empirically study the adjustment pattern of inventory and the effects of certain determinants on firms' target inventory level with emphasis on industry heterogeneity over the period 2000-2009. We find strong evidence indicating a partial adjustment mechanism in short-run and the speeds of adjustment are various among different industries. From a long-run perspective, sales, ownership structure, political affiliation and managerial fixed cost are detected to be significant indicators of target inventory level.

Second, we employ an asymmetric error-correction model to study the adjustment mechanism of inventory in different macro business regimes. We find that an asymmetric adjustment mechanism could be commonly claimed in short-run: firms tend to be more sensitive when they confront negative demand shocks. However, the indicators of target inventory level work symmetrically regardless of external business environment.

Last, we test whether there is a link between innovation and inventory reduction. We find that total factor productivity (TFP) is a better indicator of innovation, and higher TFP contributes to a lower inventory volume. Moreover, when allowing the asymmetric adjustment mechanism, the impact of TPF is symmetric between the upswing and downswing of business cycle, which means the benefits of innovations are lasting and cannot be discharged by adverse economic environments.

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Chapter 1. Introduction

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1.1 Introduction and motivation

Inventory management, also known as inventory control, is the process of monitoring a firm's inflow and outflow of inventories and preventing inventory level from being too high or too low. A well-established inventory management system could help firms achieve effectiveness and cost efficiency.

One of the fundamental aspects of inventory management is estimating lead times, which usually includes how long it takes for an individual supplier to deal with an order and implement a material delivery and how long it will take for the material to transfer into finished goods and reach to customers.

Volume control is another part of inventory management: documenting raw materials and work-in-progress inventories as they go through the manufacturing procedure and adjusting the ordering amounts before they run out or overstock to an unfavourable level. Moreover, keeping accurate records of finished goods is important since it could efficiently provide the sales personnel information about what is available and ready for shipment at any given time. Besides, management of returned products is also a part of volume control that needs to be taken into consideration.

Furthermore, competent inventory management takes the costs associated with inventory into account, which include the total value of goods and tax burden generated by the cumulative value of inventory.

Inventories play a vital role in the provision of products and services at all levels of an economy and have been subject to numerous investigations. Existing studies in the field of inventory management and performance usually involve single-country studies, using either aggregate sector data or firm-level data, which generally from publicly-listed firms. However, a lot of existing literature is mainly focused on developed countries such as US and UK and little attention was paid to developing markets.

Certain amounts of studies provide details about the benefits of inventory possession and the reasons for inventory management (Chikán, 2007, Chikán, 2009 and Protopappa-Sieke and Seifert, 2010). Empirical research also focuses on the relationships between inventory management and firms' exogenous and endogenous factors (Guariglia, 1999, Guariglia, 2000, Kashyap et al., 1993, Sangalli, 2013, etc.). Moreover, the literature describes the trends of inventory control and discuss their influences on firms' performance. The research on the developments in inventory control process is rich in context (Kanet and Cannon, 2000). However, the adoption of these developments has been proved to be challenging in practice, and the impacts of inventory control on corporate performance are various (Pong and Mitchell, 2012).

This thesis is motivated by the fact that, although inventory management has become a popular topic in the literature, research focusing on inventory performance and management in China is still quite limited.

Over the last decades, Chinese economy provides an incredible setting for doing economic research, especially relating to the manufacturing sector. The Chinese economy has experienced tremendous reforms and restructuring. As the world's factory, the high level of international engagement makes China integrating rapidly into the global economy, and the pace of economic growth is so impressive that strengthen the impact of any changes or trends.

Despite the growth of Chinese economy in recent decades, little is known about inventory management in China. This thesis provides insight into the inventory management and performance in China, including a symmetric and an asymmetric analysis of short-run dynamic and long-run equilibrium relationships that determine the holding of inventories.

According to the Chinese accounting standards for Business Enterprises (ASBE) which was issued in 2006, inventories refer to "finished products or merchandise possessed by an enterprise for sale in the daily of business, or work-in-progress in the process of production, or materials and supplies to be consumed in the process of production or offering labour service".

Inventories are required to be measured according to their cost. The ASBE (MoF, 2006) states that the cost of inventory includes purchase costs, processing costs and other expenses. More specifically, the purchase costs of inventories consist of the purchase price, relevant taxes, transport fees, loading and unloading charges, insurance premiums and other expenses that are related to the purchase costs of inventories. Direct labour and production overheads are accounted as the processing costs. The production overheads refer to all indirect expenses happened in the process of manufacturing products and providing labour services by an enterprise. Other expenses that yielded "in bringing the inventories to their present location and condition" are considered regarding "other costs of inventories".

The MoF (2006) also claims that the direct materials, direct labour and production overheads that are abnormally consumed; the storage expenses and other expenses that cannot be included in the costs happened in bringing the inventories to their present location and condition should be recognized as current profits and losses rather than the cost of inventories.

China provides an ideal setting to examine various hypotheses, due to its hosting a wide variety of firms (in terms of industry, ownership and political affiliation) as well as its diverse economic conditions and geographies. Furthermore, growth in factors are considered to have the ability to influence inventory levels, such as technology acquisition (both soft and hard) and the demand for product variety and service, have been both pronounced and rapid in China.

The rest of this chapter is organized follows: in the next section, we provide the main objective and research questions; the contributions of the study will be listed in Section 3; then in Section 4, we introduce the NBS dataset that we used for our empirical study; last, Section 5 presents the structure of this thesis.

1.2 Objectives and research questions

The main objective of the thesis is to provide insight into the inventory management and performance in China. In line with this main objective, this research has the following goals and addresses the following related research questions:

Objective 1: To examine inventories' partial adjustment pattern in short-run dynamics and long-run target equilibrium over different Chinese manufacturing industries.

Research questions:

1.1 Does partial adjustment phenomenon exist in inventories' short-run dynamics?

1.2 Do variables such as sales, firm age, liquidity, ownership structures, political affiliation, export status, geographic location and research expense determine firm's long-run target level of inventory?

Objective 2: To examine asymmetric inventory adjustment mechanism in short-run dynamics and long-run equilibrium over different Chinese manufacturing industries.

Research questions:

2.1 In various macro business regimes, does firm adjust its inventories at different speeds in short-run dynamics?

2.2 In various macro business regimes, does firm adjust its inventories toward different targets in the long-run?

Objective 3: To examine the role of innovation in inventory management by taking total factor productivity (TFP) into consideration.

Research questions:

3.1 Can TFP explain the impact of innovation on inventory management in a symmetric inventory adjustment model?

3.2 Can TFP explain the impact of innovation on inventory management in an asymmetric inventory adjustment model?

In order to understand the partial adjustment pattern in inventories' short-run dynamics and determine the long-run relationships between inventory level and a set of factors, such as sale and firm age, a variant of Guariglia and Mateut (2006) error-correction model will be examined with emphasis on industry heterogeneity over the period 2000-2009.

Studies in the literature that consider the adjustment pattern of inventory assume a symmetric mechanism. It is supposed that firms adjust at the same rate toward desired inventory level regardless of external parameters that affect the macro business environment. In order to detect the asymmetric mechanism of inventory adjustment, we will employ an asymmetric error-correction model in order to study the adjustment mechanism of inventory in different macro business regimes. By doing this, we could detect both the asymmetric adjustment mechanism in the short-run and long-run perspectives.

In the last part of the research, TFP will be introduced as an indicator of innovation. We will test whether there is a link between TFP and inventory reduction. Moreover, when allowing the asymmetric adjustment mechanism, the inventory reduction impact of TPF will be compared between the upswing and downswing of business cycle, which means whether the benefits of innovations are substantial regardless of economic environment will be detected.

1.3 Contributions of the study

China's economy has experienced extraordinary growth in the past twenty years. Since its economic reform and opening in 1978, China has achieved an average of nearly double-digit growth rates in the last two decades, which helped it to overtake Japan as the world's second-biggest economy in 2011.

The reform initiated from 1978 has altered the Chinese economy from a planned economy to a mixed economy by gradually introducing market forces. This "gradualism approach" makes the economy experience a long-lasting expansion at a relatively high speed. However, after almost three decades transformation, the role of government in allocating critical resources is still dominating and cannot be replaced by market forces, which causes distortion in a number of key factor market such as financial markets (Allen et. al. 2005). Therefore, it is important to study how this kind of resource distortion affects firms' activities. We present the contributions to this field of study as followed:

First, we use a large panel data set to empirically investigate a firm-level inventory performances in China and take the industry heterogeneous into consideration. This is, as far as I know, the first study on the subject analysing inventories' long-run equilibrium and short-run dynamics over the different Chinese manufacturing industries. It has been claimed that a firm's inventories tend to be proportional to sales in the long-run, but the relation is violated in the short-run when trade-off between inventory investment and sales takes place. We are interested in the impact of industrial level heterogeneity on this issue, and the comprehensive large panel data provides us with the opportunity to consider industry variety.

Secondly, we analyse the impacts of business cycle on inventory accumulation by allowing an asymmetric partial adjust mechanism. So far as we know, we are the first to do this. An important limitation of current studies in inventory level determination is that symmetric adjustment is assumed. For instance, the speed of adjustment toward desired inventory level is constant regardless of the macro business environment. In other words, they do not allow for a possibility that firms employ various adjustment policy toward their optimal inventory structure following macro business cycle fluctuation. Therefore, another aim of this thesis is to fill this gap in the literature by developing a more comprehensive empirical approach, allowing for an asymmetric adjustment mechanism.

Finally, TFP, as well as a research and development (R&D) variable and time trends, is used as a determinant of inventory management and control improvement and its relationship with inventory levels is analysed to examine the outcome of supply chain management development. It is generally accepted that inventory reduction is one of the obvious consequences of improvements technology and inventory control systems. We find that the R&D dummy, firm age, time trend and the location dummy seem not to be appropriate indicators since they could not capture all the new trends in inventory management development. Instead, we use TFP to describe how efficiently a firm transforms its innovations (such as R&D, Just in Time (JIT) and World Class Manufacturing (WCM)) into operation.

Moreover, given the unique institutional setting in China, where lending bias and regional disparities have important roles to play in firms' activities, for all three empirical studies in this thesis, we also consider whether there are any heterogeneous effects on firms' inventory levels across ownerships, political affiliations and regions.

1.4 Dataset

Our data are drawn from the annual accounting reports filed by industrial firms with the Chinese National Bureau of Statistics (NBS) over the period 2000-2009. With this boom in economic activity, the NBS dataset has become widely available to researchers. Officially referred to as the 'all state-owned' and 'all above-scale non-state owned industrial enterprise database' (with annual sales of five million yuan), the NBS dataset involves firms operate in the manufacturing and mining sectors and come from 31 province or province-equivalent municipal cities. Like other datasets that are collected by statistical agencies in other countries, the NBS dataset provides us unique information about the economic changes that relate to the transformation of Chinese manufacturing sector.

This dataset is particularly suitable for our study since it is one of the most representative firm-level datasets for China and would provide a superb picture of the firm behaviours in China. What's more, it contains both listed firms and unlisted firms. This is particularly important in the study of the effects of financial constraints and business environment on inventory fluctuations.

Observations with negative sales, negative ownership variables were dropped[1]. We also dropped firms that did not have complete records on our main regression variables. Our final dataset is an unbalanced panel, covers about 2.3 million firm- year observations. There is significant churning among firms during our sample period

[1] Negative sales and negative ownership variables cannot express meaningful information and are probably due to wrong record.

(Ding et al., 2014) and Brandt et al. (2012) regard the intense entry and exit of companies as the consequence of enterprise restructuring, which began earnestly in the mid-1990s.

The NBS dataset contains a continuous measure of firms' ownership, which is based on the fraction of paid-in-capital contributed by the following six different types of investors: the state; collective groups; legal entities or corporation investors; individuals; foreign investors and investors from Hong Kong, Macao, and Taiwan. We use this information to represent ownership, instead of ownership dummies that are usually utilized in the Chinese market studies, to capture dynamic nature of firm ownership changes.

Another feature of the NBS dataset is the inclusion of an index on firms' political affiliation. A political affiliation relationship is associated with government support and subsidies. However, it is argued that the aim of highly politically affiliated firms may not be profit maximization but to achieve objectives preferred by the government. We believe that both the ownership and political affiliation information are necessary when examining firm's inventory performance in the Chinese context because such institutional factors have a significant impact on firms' decision making and behaviour in China.

1.5 Structure of the thesis

In chapter 2, we provide a literature review on inventory management and performance. First, we present an overview of the relationship between inventory management and firms' overall performance. Followed by the description of the development in inventory management during recent decades. Last, we will provide a brief review of the inventory management in the Chinese context.

Chapter 3 is devoted to studying the partial inventory adjustment mechanism for each industry using a specification derived from an error-correction model. This allows us to capture the short-run fluctuation and long-run desired inventory level at the same time.

Chapter 4 analyses the asymmetric inventory adjustment using a dynamic panel threshold model. We further revise the specification used in the previous chapter and take the possibility of firm's asymmetric response to business cycle movement into consideration.

In Chapter 5, we focus on the impact of technological innovation and technical efficiency changes on inventory accumulation. TFP is used as a proxy for the innovation in order to examine this relationship.

Finally, Chapter 6 concludes the paper with a review of our empirical findings. Then a discussion of the results and relevant policy implications is provided. Last, we make some suggestions of how we can extend our research in the future.

Chapter 2. Inventory management and performance: A literature review

Chapter 2. Inventory management and performance: A literature review

2.1 Introduction

As mentioned in Chapter 1, inventories refer to "finished products or merchandise possessed by an enterprise for sale in the daily of business, or work in progress in the process of production, or materials and supplies to be consumed in the process of production or offering labour service" (MoF, 2006).

For the possession of inventory, the literature empirically investigates managers' perception of the role of inventories in today's business. In general, inventory is one of the valuable business asset and impacts directly on customer service. The possession of inventory provides the following: "Most importantly it acts as a demand and/or supply buffer facilitating prompt" (Pong and Mitchell, 2012), which may reduce operational costs. Such a buffer will provides significant benefits for firms that have difficulties to improve production speed and operational flexibility that are necessary to deal with lower level of inventory. When taking the business fluctuation into consideration, this buffer are even more vital for firms which have long manufacturing lead times or poor predictive capability. During the expansion, firms tend to establish their inventory control system based on economic order quantities, which suggests that optimal inventory investment will represent an economy of scale. The possession of inventory is beneficial since firms can save their cost by purchasing materials when the price is low. Besides, large volume of material purchase may lead to discounts from suppliers and long production runs could help firms apportion fixed cost. Therefore, economies of scale can be obtained and the accumulation of inventory is favourable (Pong and Mitchell, 2012).

On the other hand, the possession of inventory can also have disadvantages and inventory management which reduce the inventory level is needed. By establishing an inventory control system, firms can ease financial pressures and get more internal funds for other uses since working capital investment needs are diminished. Besides, inventory control can also limit the storage costs and reduce waste. Moreover, the traditional view has been that inventory is an investment, and it is treated as an asset on the balance sheets. This may have been true when product life cycles were long, and product updating were few. However, in recent decades, product life cycles are reducing so much, and the product designs are changing rapidly to satisfy customers' demands. Manufacturers now better understand the cost savings and efficiency gains that come from only stocking what is critical to have during the production and leveraging supplier partners to deliver all other items when they are needed (Bonney, 1994).

As a result of the fundamental changes in the economic and business environment, companies tend to focus on competitiveness and have a network (chain) view. These new characteristics of managing the business make inventories have strategic importance for companies as contributors to value creation, means of flexibility and means of control (Chikán, 2009).

This chapter is organised in the following way. The next section reviews the relationship between inventory management and firms' overall performance. Section 3 provides details about relevant developments in inventory management during recent decades. Section 4 gives a brief review of the inventory management in the Chinese context and finally section 5 provides a briet conclusion of the literature review.

2.2 Empirics on inventory performance

Empirical research on inventories generally involves single-country studies, using either aggregate sector data or firm-level data and generally from publicly-listed firms. Analysis often focuses on identifying relationships between inventory and firms' exogenous and endogenous variables.

2.2.1 Corporate performance

In recent years, empirical evidence on the value of inventory reduction in terms of its impact on corporate performance has been mixed. This is apparent, firstly, in a series of USA studies. Balakrishnan et al. (1996) discover that a superior performance in inventory management was not associated with the superior return on assets (ROA) and, similarly, Vastag and Clay Whybark (2005) find no relationship between inventory turnover and an index of reported corporate performance. Chen et al. (2005) reveal that exceptional inventory performers did not have exceptional share price performance, however, abnormally high inventory was associated with poor share price performance. Cannon (2008) concludes from his empirical study that "inventory performance did not measure up as a robust indicator of overall performance."

In contrast, Deloof (2003) find that lower inventories were associated with higher profits in Belgium and Ramachandran and Janakiraman (2009) confirm this finding in Indian companies.

When taking the development of modern inventory management into consideration, It is found that the adoption of JIT tends to associate with a higher inventory turnover and earnings per share than those not using JIT (Huson and Nanda,1995). For larger companies, Kinney and Wempe (2002) discover that JIT adopters experience a better profit margin performance relative to non-adopters. Sim and Killough (1998) suggest that firms gain benefits from adopting JIT when combined with total quality management (TQM) and performance goals.

Thus, prior studies show no clear consensus on the relationship between inventory control and corporate performance. This can be partially explained by the advantages and disadvantages that the possession of inventory brings. Moreover, the adoption of initiatives such as JIT and WCM usually associated with reduced inventory level and requires significant organisational effort and change. Therefore, not all companies may decide to pursue these initiatives and among those that do, there are likely to be failures since only a certain number of firms are capable of coping with the challenges of operating with tight inventory control.

2.2.2 Financial conditions

Financial constraints are common in developing countries, and becoming an important issue that firms suffered in those countries where financial capital is limited and financial institutions are underdeveloped. Smith and Hallward-Driemeier (2005) state that the cost and access to finance are considered to be one of the top 5 problems that firms face, according to the World Bank Investment Climate Surveys, covering more than 26,000 firms across 53 developing countries. The 2012 China Enterprise Survey (IFC, 2013), conducted by the World Bank and its partners, highlights that among fifteen areas of the business environment, firms in China tend to rate access to finance to be the biggest obstacle to their daily operations. More than 20% of firms rank access to finance as their first obstacle. The survey also claims that the share of Chinese firms using bank financing for their working capital or investment is very low, at 6% and 5% respectively. These percentages are lower than the average for all surveyed economies and considerably lower than the average for Upper-Middle-Income countries.

Since inventories can be converted into cash rapidly with a low adjustment cost, they are likely to be much more sensitive to financial variables when compared with fixed investment. A growing number of papers have studied inventory investment under imperfect capital markets. With the attempt of investigating what factors determine the short-run variability of inventories with respect to sales, several models have been formalised and tested the extent to which financial constraints affect firms' investment in inventories.

A flourishing literature has documented that inventories tend to be proportional to sales in the long-run, but the relation is violated in the short-run when a trade-off between inventory investment and sales takes place. Financial constraints faced by firms are found to be one of the primary determinants of downward corrections in inventories. The negative response of inventory investment to the presence of financial boundaries might provide evidence of a significant role played by the financial framework in conditioning the real side of the economy, especially during recession years, when liquidity problems arise.

For the purpose of investigating the reason of short-run volatilities of inventories with respect to sales, several models have been established and analysed on both macro- and micro-data. Target adjustment models (Lovell, 1961, Blanchard, 1983), production smoothing models (Blinder and Maccini, 1991) and production-cost smoothing models (Blinder, 1984, Eichenbaum, 1990, West, 1991) have been formalised in earlier studies with the attempt to capture these patterns. More specifically, target adjustment models are set to explain an adjustment pattern of a firm's inventories towards a 'target level' because of the rising of adjustment costs when, for some reasons, the real inventories to sales ratio deviates from the optimal one. Production smoothing models, instead, state that inventories react negatively to demand shocks since firms tend to smooth production relative to fluctuations at the demand side in order to reduce adjustment costs and maximize profits.

Based on these models, recent papers analyse the sensitivity of firm inventories to liquidity shocks and constraints in order to provide an alternative explanation for their short-run dynamics. Firms who are financially constrained, in the sense of being in difficulty in catching more credit from the market, or are more likely to suffer from problems of informational asymmetry tend to utilize the inventory channel to generate internal liquidity as fast as possible while facing contingencies.

Evidence of binding financial constraints for inventory investment was found in a lot of studies focused on American data. The paper written by Kashyap et al. (1993) seems to be one of the earliest papers in this field of study. Using aggregate data from the US between 1964 and 1989, it is showed that financial factors, such as the prime commercial paper spread and the mix of bank loans and commercial paper, have a significant predictive power on inventory investment.

Following Kashyap et al. (1993), a flourishing literature has claimed the factors that may affect the inventory to financial variable sensitivity. Kashyap et al. (1994) take the firm heterogeneity into consideration. By employing a cross-section of firms rather than aggregate time-series data to analyse this problem, they conclude that the cash accumulation is a significant determinant of the inventory growth for firms without bond rating. Besides, the financial constraints appear to be much more important during recessionary episodes. The same view is supported by Carpenter et al. (1994): Using quarterly data for US manufacturing firms, their results strongly support the idea that financial factors have a significant impact on firms' inventory investment for both small and large firms and the effect is significantly stronger for small firms than for large firms in the recessionary periods of the early and late 1980s. They also obtain similar results when they separate the sample according to whether firms have bond rating or not, where they find firms without bond rating display higher cash flow sensitivities.

A panel data approach is also employed in selected works on the European manufacturing industry. Reference is made to Guariglia (1999) and Guariglia (2000), who focuses on the UK manufacturing, They find a link between financial variables and inventory investment, especially for the firms with low average interest cover ratio, high average ratio of short-term debt to sales or high average net leverage ratio, during periods of recession and tight monetary policy. This link is stronger for work-in-process and raw material inventories than that for total inventories.

Financial constraints were analysed, at this stage, in the context of fixed investment regressions, in levels, augmented with financial variables. Other studies make instead use of a more dynamic approach. Error-correction inventory investment equations augmented with a financial composition variable are exploited to capture both the influence of a long-run relationship between inventories and sales and the response of inventory investment to financial pressure in the short-run. More precisely, Guariglia and Mateut (2006) state that the use of trade credit has a positive impact on inventory investment to financial variable sensitivity. It is said that even in periods of tight monetary policy and recession, when bank loans are harder to obtain and/or more costly, financially constrained firms are not forced to reduce their investment too much as they can finance it with trade credit. This phenomenon is referred as the trade credit channel of monetary transmission. This paper extends the study of financial constraints and inventory investment by testing the existence of trade credit channel of monetary transmission in the UK over the period 1980 to 2000. They find that both credit and trade credit channels of transmission of monetary policy operate side by side in the

UK, and the use of trade credit could offset the liquidity constraints. Guariglia and Mateut (2010) explore for the first time the link between firms' global engagement and their financial health in the context of inventory investment regressions, using panel data for UK firms. They argue that firms that do not export and are not foreign owned exhibit higher sensitivities to inventory investment to financial constraints. However, global engagement substantially reduces the sensitivities for smaller, younger and more risky firms. It seems to be that participation in global engagement helps to shield firms from financial constraints.

In addition to the UK and the US markets, the factors that may influence the inventory investment to financial variable sensitivity has also been tested in other countries. For the market of Spain, Benito (2005) finds evidence that cash flow effects and liquidity effects are existing, but these effects are not as strong as in the UK. Benito (2005) suggests this is due to the fact that Spanish banks have good liquidity buffers that allow them to cope with the interest rate change without significant impact on the credit supply; and that the direct involvement of the Spanish banks in the governance of Spanish companies helps to reduce the information problems.

Focusing on the Netherlands, Bo et al. (2002) analyse inventory investment using a balanced panel of 82 Dutch firms. The empirical evidence provides support for the relevance of capital market imperfections in explaining Dutch inventory investment. More specifically, the inventory investment of the firms that are likely to be financially constrained respond much more sharply to cash flow shocks than firms that are likely to be financially unconstrained.

Contrary to most of the studies, Cunningham (2004) finds no cash flow effect for Canadian manufacturing firms over the period of 1992 to 1999. The author believes this is likely due to the fact that the Canadian economy did not suffer from any recession during the study period, which makes it hard to detect the effects of financial constraints.

Bagliano and Sembenelli (2004) make use of annual data on firms' balance sheets to study the effects of the early Nineties' recession on inventory investment in Italy, France and the United Kingdom. By means of proxies for financial pressure at a firm level, a higher sensitivity of inventory investment is detected for small and young manufacturing firms. As far as Italian firms are specifically concerned, an additional recessive effect is found, acting in the sense of amplifying inventory investment variability. This supports the view of a 'financial accelerator channel' emphasizing the transmission of monetary effects to the real side of the economy. In line with previous studies on the subject, Sangalli (2013) suggests that financial constraints affect the inventory investment behaviour negatively. Moreover, inventory investment was found to be more sensitive to financial binding in correspondence to small firms in Italy. Besides, by assigning a risk dummy to the estimation equation, a higher sensitivity of inventory investment to financial constraints for riskier firms is observed.

2.2.3 Others

Recent research has investigated the relationship between inventory performance and other exogenous and endogenous variables. Gaur et al. (2005) study several hundred publically-listed US retailers and identify gross margin, capital intensity, and “sales surprise” as drivers for inventory turns. They also show that inventories declined during recent decades. Rumyantsev and Netessine (2007a) consider the relationship between inventory performance and various environmental variables for 1992–2002 data from 722 listed US manufacturers and retailers, including the effect of demand and earnings uncertainty, and lead times. Employing a 2000–2005 panel data set of 556 Greek retailers, Kolias et al. (2011) find inventory turnover to be positively correlated with capital intensity but negatively correlated with gross margin.

The effects of both fixed costs (in purchasing, manufacturing, and distribution) along with risk-pooling (both geographic and product) suggest that firm inventories are a sublinear function of aggregate volume measured by cost of goods sold (Ballou, 2000). Indeed, the majority of studies find a concave relationship between inventory levels and volume. However, there are exceptions: Roumiantsev and Netessine (2007b), employing COMPUSTAT data from 1994 to 2004, find absolute inventories exhibit diseconomies of scale with cost of goods sold in 4 of the 9 countries (Germany, France, Canada, and Switzerland) studied. The paper concludes that this is due to countries exhibiting quite different fixed costs structures, which may arise from differences in flows of goods and geographic conditions. Robb et al. (2012) add that this phenomenon could also be accounted for large firms in such countries being relatively inventory-intensive, e.g., as a result of industry type, higher product variety and/or service levels.

Lai (2007) provides another of the few international studies, utilising COMPUSTAT data from 1994 to 2004 to examine the variance in inventory turnover (inventory/COGS) amongst listed manufacturers, and find country, industry, and firm effects comprised 12.7%, 28.5%, and 35.5%, respectively. The variance of inventory turnover among the 587 listed Chinese manufacturers was 0.112 which is the second highest among the 37 countries reported.

The impact of institutional ownership on inventory management has been examined in the literature (Tribo, 2007 and Ameer, 2010) through a control channel. It is said that institutional stockholders are more likely to monitor the business performance in a more active and effective method. Therefore, firms with institutional ownership can be prevented from being mismanaged and the appearance of excess inventory can be diminished to some extent. Consequently, the institutional ownership tends to associate with a better inventory management.

Barcos et. al. (2013) study the impact of implementing corporate social responsible (CSR) practices on firms' inventory policy and state an inverted U-shaped relationship between firms' CSR and their inventory levels. It is claimed that there is a conflict between customers and environmental activists for the interests regarding the outcome of inventory management: customers put pressure on firms to increase inventories so that they could satisfy the demand, and environmental activists force firms to reduce inventories in an environmentally friendly perspective. Therefore, the intensity of the implementation of social responsible policies becomes the essential element when determining the impact of stakeholders on inventory management: for low levels of CSR, customers are more relevant, and firms are in favour of increasing their inventory level; and for higher levels of CSR, the natural environment becomes importance, and firms tend to reduce their inventory.

2.2.4 Summary

As a conclusion, existing studies in the field of inventory management and performance usually involve single-country studies, using either aggregate sector data or firm-level data, which generally from publicly-listed firms. The relationship between inventory control and corporate performance various because of the different firms' ability of adopts innovations. The links between inventory management and several exogenous and endogenous factors have been widely discussed, however, the large amount of existing literature is mainly focused on developed countries such as US and UK.

2.3 Inventory management and its development

Since at least the early 1980s, great improvements of management (i.e. JIT, WCM, Supply Chain Management (SCM) and Enterprise Resource Planning Systems (ERPS)) have claimed that inventory control has positive impact on firms' performance and inventory reduction is achievable. These have been proved by the fact that inventory reduction is the primary target of JIT, or a by-product of other initiatives for SCM (Kanet and Cannon, 2000). However, although the application of these recent management innovations has widely spread, there no clear consensus on the outcomes of these improvements.

The reduction of inventory usually associated with pressure on internal operations to improve. When adopting modern inventory management systems, firms tend to perform without the convenient supply and/or demand buffer. Firms need to increase product quality, improve production flexibility and operational efficiency and enhance logistics. The inventory management improvement is favourable for firms' performance only if these enhancements can be carried out successfully (Pong and Mitchell, 2012).

2.3.1 Just in Time (JIT) and Supply Chain Management (SCM)

In the 1950s and 1960s, the Japanese JIT system was first established Taiichi Ohno for Toyota (Monden, 1983). Then, JIT became popular and widely spread across the West in the mid to late 1980s. JIT is an extensive managerial philosophy which takes the whole business process into consideration and its primary objective is to totally eliminating waste (Japan-Management-Association, 1989). The excessive inventory seems to be one of the most important source of waste recognised under the JIT philosophy (Harrison, 1992). Thus, inventory reducing becomes the main target for firms which adopting JIT. The demand-pull-system was designed in Japan to address this task specifically, by creating a ‘pull’ production control driven by customer needs (Monden, 1983, Vollmann et al., 1992).

In practice, the purchaser and supplier are constructed into mutually supportive supply chain groups to reduce cost from which they can both get benefits. This supply chain structure is commonly exist in Japanese manufacturing companies (Sakai, 2003). Although this type of structure has not been commonly established among Western manufacture industries, firms tend to set up a more co-operative relationship with their suppliers in order to enhance inventory control (Cooper and Slagmulder, 2004, Ellram, 1991).

Voss et al. (1987) summarize the advantages of adopting JIT using a series of case studies and claimed that inventory reduction is one of the most important achievement for JIT adopters. Huson and Nanda (1995) confirm the inventory management advantages of JIT when reporting on the inventory turnover increases obtained by a Western adopter: JIT firms in their sample increased their inventory turnover by almost

24% on average in the post-JIT period. The contrast between the fourth year after adoption and the pre-adoption period is far more stark, 35%. However, Huson and Nanda (1995) consider only total inventory not raw material, working-in-process (WIP), and finished goods. When taking these factors into consideration, findings indicate that the total inventory to sales ratio and the raw material inventory to sales ratio reduced substantially post-JIT adoption. However, the changes in the WIP inventory to sales ratio and finished goods inventory to sales ratio are not statistically significant. This means that firms reduced their total inventory primarily through reductions in raw material inventory and not through significant reductions in WIP and finished goods inventories (Biggart and Gargeya, 2002).

Although impacts of JIT on inventory management have been claimed in many kinds of literature, the common use of JIT is still under challenged. According to Jones and Riley (1985), significant investments in equipment and buildings are required in order for JIT to work. These investments usually include changes in the manufacturing process and layout and personnel practices. New working relationships must be developed, and a high level of understanding and support from top management is also required. Success in JIT implementation has certainly not been universal. The high level of change required to cope with JIT operation results in regular failures. Cannon

(2008) states that staff in Toyota took two decades to fully develop JIT and considered that "…others will require at least ten years to obtain satisfactory results by copying it". Many difficulties arise when companies do not undertake the necessary preparatory groundwork and, therefore, cannot adjust to the high operational standards necessary (Voss and Clutterbuck, 1989). Research has also identified a series of human costs which can detract significantly from the advantages offered by JIT. These include loss of individual and team autonomy through regimentation, increased workload, tighter controls, increased subordination and surveillance and lack of security. Thus, while many companies have been attracted to JIT, existing empirical research does suggest that by no means all of them succeed and reap the benefits (Voss and Clutterbuck, 1989, Klein, 1989).

2.3.2 World Class Manufacturing (WCM)

WCM, including lean production, continuous flow manufacture, the theory of constraints and streamlined administrative procedures, may be seen as "a Western response to Japanese managerial success" (Pong and Mitchell, 2012). Compared with JIT, firms adopting WCM pay more attention to their customers and improving customer satisfaction is their main target. Besides, inventory reduction seems to be a by-product of WCM system since it attempts to reduce firms' dependence on costly and unnecessary levels of buffer inventory. Moreover, WCM system has got great achievement in the simplification of manufacturing methods, improvement of product quality, cost reduction and management restructure. Thus, a success of adopting WCM could make firms increase their efficiency and flexibility(Voss and Blackmon, 1996) and therefore, enable firms to operate effectively with lower levels of inventory and better financial conditions.

In the 1980s and 1990s, WCM became popular among Western manufacturers. Large number of firms pay efforts to transform their management structure in order to adopt WCM system (Oldman and Tomkins, 1999). Governments also play a vital role in WCM application. For instance, the UK launched a series of official initiatives to support the WCM philosophy and encourage its application by introducing Training and Enterprise Council Programmes. The objectives of these programmes include providing instruction on WCM methods and motivate the development of "flexible machine centres, minimal set up times and little inventory leading to small warehouses and little work in progress areas" (Jazayeri and Hopper, 1999).

Similar to JIT, the attitudes towards the level of success of WCM implementation are controversial. Jazayeri and Hopper (1999) and Oldman and Tomkins (1999) support the idea that the adoption of WCM is beneficial and successful for UK companies. Also, Lind (2001) provides similar conclusion by conducting a study of Swedish implementation of WCM. However, according to Jazayeri and Hopper (1999), for the 55 UK companies that are engaged in WCM adoption, "around one-third succeeded fully; another one-third had partial success, and one-third failed". The WCM followers are disappointed by the fact that the benefits of adopting this system seems difficult to be achieved. Only 6% of WCM adopters claims that they have met the target of becoming international competitors (Voss and Blackmon, 1996).

2.3.3 Morden information technology (IT) and control system development

Increasingly number of retail outlets are adopting equipment that permits capture of demand data and updating of inventory records at the point of sale (Silver, 1981). Inventory management is more computer-based nowadays and is becoming part of increasingly integrated systems. "The ready availability of personal computers and appropriate software has meant that even relatively small organisations can use computer methods effectively for inventory planning and control. The software also exists for simulating proposed inventory systems. This means that the performance of proposed systems, when faced with typical demands, may be tested prior to implementation" (Bonney, 1994, p110). The smartphones and mobile business technology played an important role as well. Smart phones can be used as a handheld device or a bar-code scanner and a digital network can monitor products information efficiently.

The Inventory management has been literally reorganized by the new networked technologies and the practices they facilitate, which include e-procurement, e-logistics, collaborative commerce, real-time demand forecasting, true JIT production and web-based package tracking. The Internet as an enabling force for improved supply chain management offers efficiency and cost reduction to business processes across industries and nations. By allowing real-time communication among supply chain participants, networks can practice integrated forecasting, where it is possible to modify raw material orders to meet demand in real time, thus reducing the costs of stockout or other costs associated with holding inventory. It has been found that the Internet has given both downstream and upstream members of the supply chain the ability to offer technical support and alter raw material inputs in real time to enhance the performance of network products and services (Lancioni et al., 2003).

Cachon and Fisher (2000) conclude that implementing information technology to accelerate and smooth the physical flow of goods through a supply chain is more significant than expanding the flow of information. It is said that supply chain costs are 2.2% lower on average with the full information policy than with the traditional information policy, and the maximum difference is 12.1%. The advanced information technology also leads to shorter lead times and smaller batch sizes. In their analysis, cutting lead times nearly in half reduces costs by 21% on average, and cutting batches in half reduces costs by 22% on average.

Jones and Riley (1985) suggest that information systems will continue to play a major role in planning and controlling inventories along supply chains. It is said that an integrated approach to overall SCM is a proven method of obtaining competitive advantages. There is growth in the understanding of inventory systems through better mathematical modelling and simulation including control theory and industrial dynamics. These can take account of the effect of system dynamics and hierarchical planning in the complete logistics chain. “Processing and materials handling are being networked to management control systems to create computer controlled flexible manufacturing cells and integrated manufacturing systems. Flexible manufacturing methods also meet the need to be able to manufacture in variable quantities. The component classification technology methods that go in parallel with flexible manufacturing also reduce variety and ease set-up cost reduction" (Bonney, 1994, p110). Each of these developments offers opportunities to reduce inventory.

Also, the SCM software such as ERPS is employed as a complementation to make the adoption of JIT and WCM becomes easier (Davenport, 1998). These integrated software packages can be used as an overall monitor of the flows of material, labour, monetary and information, which enables firms to get a more comprehensive view of their performance (Granlund and Malmi, 2002). Nowadays, ERPS has been widely utilized by the real world and makes it easier for firms to adjust their resource requirements and internal operations according customer needs. Thus the commonly adoption of ERPS provides positive impact on firms to reduce waste and run their business more efficient and flexible with lower level of buffer inventory.

Pong and Mitchell (2012) state that the general reductions in inventory days have been apparent during the two decades (1986-2005) studied and this study period was notable for the emergence of software packages and the high profile promotion of management initiatives designed to improve inventory control. Information on the actual adoption of these packages and initiatives by the companies studied was not available for this analysis. Consequently, the results must be viewed as providing only circumstantial evidence on whether or not these factors were influential in inventory control practice in UK manufacturing. This circumstantial evidence is, in general, consistent with the initiatives encouraging overall improvement in inventory control during the period. The results do reveal that companies that have made higher capital investments (providing the ability to cope with the operational demands of inventory reduction) do have superior inventory control performance. To the extent that this factor, capital investment level, can be considered a proxy for the adoption of the initiatives and software packages, then a positive influence on inventory control can be ascribed to them.

Although ERPS helps firms to improve the efficiency of production and transaction processing and elimiates waste, One of the biggest challenges of adopting ERPS is that firms need to enhance their supporting abilities such as information control and decision making, in order to run business without a comfort inventory buffer (Dechow and Mouritsen, 2005). The primary target of ERPS seems to be establishing an effective and efficient routine operational management system rather than helping firms deal with the low inventory level (Scapens and Jazayeri, 2003). Grabski and Leech (2007) emphasize that, to make a successful ERPS implementation, how to handle the vast amount of information and make comprehensive decisions is a crucial task that firms need to undertake. Similarly, Hyvönen et al. (2008) concern that the integration of ERPS and the contemporary accounting innovation may bother new adopters and lead to a failure of implementation. Moreover, in a case study of SAP implementation in a manufacturing company, Kennerley and Neely (2001) state that an inadequate implementation control may result in a creation of excessive inventory, which is contrary to the expectations of inventory management improvements.

2.3.4 Summary

In summary, the literature describes the trends of inventory control and discuss their influences on firms' performance. The research on the developments in inventory control process is rich in context. However, the adoption of these developments has been proved to be challenging in practice, and the impacts of inventory control on corporate performance are various.

2.4 Inventory performance and management in China

Generally speaking, published studies, focusing on inventory performance and management in China, are quite limited. Based on UN national accounts statistics from

88 countries over the period 1970 to 1989, Chikán and Horváth (1999) claim a remarkable change of inventory to GDP ratio in China. However, this macroeconomic level analysis does not report absolute levels of inventory.

Instead of using aggregated country level data, recent researches have been conducted at the firm level because of the capability of getting access to more comprehensive microeconomic level datasets. One of the commonly acceptable conclusions of these studies is that the inventory levels are relatively high for Chinese manufacturers when compared to their counterparts in other countries. For instance, Robb et al. (2008) document a study carried out in 2001. 72 Chinese furniture manufacturers in 12 Chinese provinces are involved in this study and it is mentioned that the sales-weighted average of self-reported raw materials, work-in-process, and finished goods inventories turnovers to be 44, 13, and 13 days in 2001, respectively, which are substantially higher than industry average of the US furniture manufacturing figures in 2000 (25, 10, and 8) reported in Rajagopalan and Malhotra (2001). This result could be due to the lag in the adoption of IT and modern inventory control methods (Irvine, 2003) as well as the highly fragmented and decentralised distribution networks in China (Feuling, 2010).

One recent study (Hu et al., 2010) employs World Bank data from 2003 for 530 manufacturers from 5 industries in 8 Chinese cities and takes the firms' ownership structure into consideration. They found private firms to have a higher raw material and finished goods inventory days than do foreign and joint venture firms. The study also considered the association between inventory turnovers and firms' performances, finding the turnover of finished goods inventories to have a slightly more positive impact on return on sales compared to the raw materials.

By analysing a panel data set of 1531 listed firms, Lai et al. (2010) test the effect of firm location on inventory turnover. It concludes that one-fourth of the variance in inventory turnover could be explained by city and province effects jointly. The study also considered the association between inventory and financial performance, finding the turnover of finished goods inventories to have a slightly more positive impact than does raw materials on return on sales.

Robb et al. (2012) contribute to this field of study by merging unlisted manufacturers into the analysis. First, it is asserted that the overall inventory as a percentage of GDP in China has been declining since the 1990s. Second, it provides evidence for apparent diseconomies of scale for large unlisted firms and publicly listed manufacturers' significantly higher inventories compared to unlisted firms. Third, it also analyses the relationship between an enterprise's inventory and its location and industry: regional inventory intensities do differ, and the government monopoly industries have higher inventory ratio since working capital may be relatively accessible and cheap.

When focusing on the inventory investment and financial constraints, according to the previous literature review, most of the articles focus on the developed market, such as the UK, US or other European countries and it can be claimed that a common weakness of this literature is that the firms' behaviour in the developing economy, especially in the Chinese market, has not been emphasised. Only a few studies have attempted to study the impacts of financial constraints in the context of China (Chow and Fung, 1998, Chow and Fung, 2000, Guariglia et al., 2011, Héricourt and Poncet, 2009). Xu and Yao (2008), based on 1998–2004 data from listed firms, suggest that the relationship between financial performance and inventory turnover can be characterised as having an inverted-U shape. Evidence on the role of ownership structure and regional differences is a useful contribution to the literature since little exists regarding the association between them and firms' inventory investment behaviours. It is necessary to further develop this field of study not only because China has experienced an extraordinary growth in the past twenty years but also because it has variety types of firms' ownership structure and huge regional differences which provide us a unique data set to analyse the firms' heterogeneity. One of the objectives of this paper is analysing the sensitivity of the inventory investment to financial variables using the data from the Chinese market and testing the effects of ownership structures and regional characteristics on this sensitivity.

2.5 Conclusions

As a conclusion, in this chapter, we provide a general background showing the benefit of inventory possession and reason for inventory management. The possession of inventory works as a demand and/or supply buffer to reduce operation costs, and inventory management leads to cost saving and efficiency gains. Moreover, empirical research also focuses on the relationships between inventory management and firms' exogenous and endogenous factors, financial conditions and business environment for instances. We also describe the trends of inventory control and discuss their influences on firm performance in detail. The developments in management have been widely used in inventory control process. However, the adoption of these developments has been proved to be challenging in practice, and the impacts of inventory control on corporate performance are various. Last but not least, we reviewed relevant literature focusing on the Chinese market. A delay in adopting modern inventory control methods has been found, and the role of ownership structure and regional differences is vital when we examine firms' inventory performance in China.

Chapter 3. Inventory management in the Chinese manufacturing industry: A partial adjustment approach

Chapter 3. Inventory management in the Chinese manufacturing industry: A partial adjustment approach

3.1 Introduction

Inventory represents one of the most important and difficult assets to be managed at firm level as well as at macro economy level. Conventionally, academics and practitioners argued that inventories have a triple role in modern organizations: as contributors to value creation, as means of flexibility and as means of control (Chikán, 2009).

Inventory movements proved to be strongly related to output fluctuations during the past. It is widely accepted that they are useful indicators of business activities. A flourishing literature has documented that firm inventories tend to be proportional to sales in the long-run, but the relation is violated in the short-run, given the trade-off between inventory investment and sales. Financial constraints faced by firms are found to be one of the main determinants of downward corrections in inventories. However, knowledge of how other factors determine the target inventory level, and whether the inventory dynamics vary among industries is limited by a lack of research. The present chapter addresses this issue by exploiting a large unbalanced panels of Chinese manufacturing firms observed over the period 2000–2009, which involve all state-owned firms and above-scale non-state firms. This is, as far as I know, the first study on the subject analysing inventories' long-run equilibrium and short-run dynamics over the different Chinese manufacturing industries. A dynamic approach is adopted to shed light on peculiarities of the phenomenon that may rely on intrinsic characters of firms.

The remainder of this chapter is organized as follows. The next section describes the empirical specification of the model, both the baseline specification and the related variants. Section 3 provides some relevant descriptive statistics. Section 4 is devoted to empirical econometric results and further discussions. The main conclusions are summarized in Section 5.

3.2 Empirical model specification and estimation methodology

3.2.1 Dynamic inventory adjustment model

The underlying foundation of Lovell (1961)'s basic stock-adjustment model of inventory accumulation is that, despite unanticipated changes in sales, the stock of inventories changes since firms partially close the gap between current desired inventories and the previous level of the inventory. More specifically,

$$I_t - I_{t-1} = \delta(I_t^* - I_{t-1}) + \varphi(S_t^e - S_t) \quad (3.1)$$

where I_t and I_t^* are actual and desired inventories of finished goods, respectively, at the end of quarter t, and S_t and S_t^e are actual and expected sales, respectively.

If desired inventories depend linearly on current sales,

$$I^* = \alpha_0 + \alpha_1 S_t \quad (3.2)$$

and if sales expectations are based on the simplest "naive expectations" assumption that the current level of sales will continue into the next quarter $S_t^e = S_{t-1}$, then

$$I_t - I_{t-1} = \delta\alpha_0 + \delta\alpha_1 S_t - \delta I_{t-1} + \varphi(S_{t-1} - S_t) \qquad (3.3)$$

As we have discussed in the literature review, Target adjustment models (Lovell, 1961, Blanchard, 1983), production smoothing models (Blinder and Maccini, 1991) and production-cost smoothing models (Blinder, 1984, Eichenbaum, 1990, West, 1991) have been established in the attempt to capture the short-run volatility of inventories with respect to sales and cost shocks. Following this development, the Error-correction inventory investment equations augmented with a financial composition variable is formalised by Guariglia and Mateut (2006), which intend to capture both the influence of a long-run relationship between inventories and sales and the response of inventory investment to financial pressure in the short-run.

The model employed in our empirical testing is a variant of the Guariglia and Mateut (2006)'s Error-correction model. This model based on the hypotheses that (a) each firm has a desired target level of inventories in the long-run and (b) when firm's actual level of inventories is different from its target level, it attempts adjustment towards the target level within any time period. However, due to the adjustment cost, firms could only make a partial adjustment in the short-run (Blinder, 1986, Lovell, 1961). For example, it may be desirable for a firm to cut down on its output, but doing this will create adjustment costs such as redundancy payments and lower staff morale. On reflection of its adjustment costs, it may be more desirable to keep producing at a sub-optimum level. Similarly, a rapid expansion in output may create problems such as difficulties in negotiating a bigger place to rent and the difficulties in hiring more workers.

Denoting the logarithm of the actual and target level of inventories of firm i at time t with I_{it} and $I_{it}*$, respectively. The partial adjustment process can be written as:

$$\Delta I_{it} = I_{it} - I_{i,t-1} = \delta\left(I_{it}^{*} - I_{i,t-1}\right) + v_{it} \qquad (3.4)$$

δ indicates the speed of adjustment that measures how fast firms move towards their target inventory level. This coefficient is expected to lie between 0 and 1, with a higher value indicating a faster speed of adjustment.

We then considered the target inventory level ($I_{it}*$) is related to a set of firms' characteristics:

$$I_{it}^{*} = \beta' X_{it} \qquad (3.5)$$

where the variables are expressed in logarithms and X_{it} denotes the $k \times 1$ vector of variables that determining target level of inventory with β being the structural parameters. We take firm characteristics such as sales, age, liquidity, ownership structures, political affiliation, export status and geographic location into consideration and moreover, a time trend is also involved in order to measure the change of equivalent level of inventory over time. The determinant variables are listed in Table 3.1, and the reason for why these variables are included in our model will be discussed in next section.

The one-stage procedure (Ozkan, 2001, Flannery and Rangan, 2006) will be involved in order to estimate Eq.(3.4) and Eq.(3.5).

This yields:

$$\Delta I_{it} = \delta\left(\beta' X_{it} - I_{i,t-1}\right) + v_{it} = \delta\beta' X_{it} - \delta I_{i,t-1} + v_{it}$$

$$I_{it} = (1 - \delta) I_{i,t-1} + \delta\beta' X_{it} + v_{it}$$

$$I_{it} = \varphi I_{i,t-1} + \pi' X_{it} + v_{it} \qquad (3.6)$$

Where $\varphi = 1 - \delta$ and $\pi = \delta\beta$.

This dynamic inventory adjustment model applied to panel data is set to account for both a long-term relation between inventories and the determinant variables of the target inventory level and the effects of short-run factors in boosting a deviation of inventories from their long-run path. In other words, firms tend to keep inventories stable in the long-run (target level of inventories) and to adjust inventories relative to such a 'desired stock' in the short-run. As discussed in Lovell (1961) and Blinder (1986), the partial adjustment towards the target level, which takes place in the short-run, could be due to the fact that there are costs involved in changing the level of inventories. Moreover, there could be problems related to the heterogeneous nature of inventories and/or the infrequent intervals at which certain goods are ordered. In fact, we also include lag 2 of inventory level into this model to make the target adjustment process more comprehensive[2].

The error term v_{it} in the equations could be divided into three parts: a firm-specific component μ_i, a time-specific component μ_i, which accounts for business-cycle effects and an error term u_{it}.

[2] The estimation is based on the equation: $I_{it} = \varphi_1 I_{i,t-1} + \varphi_2 I_{i,t-2} + \pi' X_{it} + v_{it}$, therefore, the speed of adjustment would be calculated as: $\delta = 1 - \varphi_1 - \varphi_2$.

3.2.2 Determinants of the target inventory level

In this section, we examine a number of variables that could determine firm’s target level of inventory. When adjusting ‘desired stock’, firms tend to take the following factors into consideration:

Sales

The long-run inventories-sales relationship has been documented by a large number of studies (e.g. Pong and Mitchell (2012) and Robb et al. (2012)). It is claimed that inventories play a crucial role in satisfying the demand of firm’s production. Therefore, the first variable that needs to be included in the model would be the expected demand which is measured by the value of final sales of goods. Firms anticipating an increase in future demand would likely hold more inventories, in order to maintain a stable inventory-to-sales ratio (Chacra and Kichian, 2004). Inventories and sales would be expected to be positively correlated in the long run and since the inventory-to-sales ratio various across industries, the coefficient tends to be vary among different industry subgroups.

Inventory to sales ratio can be seen as a measure of inventory management efficiency (Tribo, 2009). Therefore, inventory to sales ratio shows whether the firm is able to keep inventory level low with regard to its current sales figures. Since increasing this ratio from one period to another can be a sign of poor management of inventory, the reciprocal of this ratio is used to indicate that the larger the value, the better the inventory management (Elsayed and Wahba, 2013).

Ownership structure

Ownership represents the control and directional power of an organization, that is the person who, or entity that, owns the organization. There are several reasons why a firm's ownership structure impacts its strategy and performance (Beaumont et al., 2002, Delios et al., 2008, Douma et al., 2006). First, differences among owners, especially on identity, concentration, and resource endowments put power sharing, incentives management and manager control in various directions. Second, divergent goals of owners will create different influences on organizational decisions and action policies. Third, firms with different ownership types have different organizational structures, cultures, and business processes.

Thus, the influence of ownership on manufacturing strategy and performance can be explained from the viewpoints of three separate theories: agency theory, resource-based theory (Douma et al., 2006) and organization theory. In our analyses, we examine five variables that are related to firm's ownership structure: the percentage owned by the state, collective firms, corporations or legal entities, individuals and foreigners. The proportion of capital owned by Hong Kong, Macao and Taiwan is set to be a benchmark in this analysis.

Political affiliation

Despite more than two decades of reform and development, Chinese economy's transition to market economy is still largely incomplete. The central government continues to play a significant role in the allocation of resources, in particular in the credit allocation in the banking sectors.

Based on data in city level between 1989 and 1991, Wei and Wang (1997) find evidence that state-owned commercial banks favour firms with high political affiliation over other types of firms. Allen et al. (2005) show that firms with less political affiliation are typically being discriminated against for access to external finance compare to their less profitable counterparts with significant political affiliation. Besides, Wu et. al. (2012) find that private firms with politically connected managers have higher value and obtain more government subsidies than those without connected managers, whereas local state-owned enterprises with connected managers have a lower value and employ more surplus labour than those without connected managers. The results indicate that the effect of political ties is subject to firm ownership. We consequently expect that enterprises with no political affiliation will be significantly financially constrained and have a lower level of inventories.

Liquidity

An intense debate has been taking place in recent years about whether there is a statistically significant relationship between investment and firm's financial condition (Fazzari et al., 1988, Kaplan and Zingales, 1997) and the capital market imperfection is one of the most important theoretical backgrounds.

Capital market imperfection

Modigliani and Miller (1958) propose that, with several strict assumptions such as the perfect capital market assumption, the market value of an enterprise is independent from its capital structure. This proposition implies that only the expected rate of return on the projects, not the financing methods, could affect firms' investment decision. Under the Modigliani and Miller theory, firm's internal funds can be perfectly substituted for external funds and thus, firm's investment decisions are independent of financing decisions.

However, the perfect capital market assumption is challenged by the real market and factors such as transaction costs, bankruptcy costs and taxation are all contribution to the imperfect capital market. Empirical studies that in favour of the imperfect capital market pay much attention to the problems of adverse selection and moral hazard. Myers and Majluf (1984) present a model of equity finance and introduce the problem of information asymmetry and adverse selection in an imperfect capital market. It claims that outsiders (investors) tend to request a premium when acquiring firm’s shares so that they can get compensation for taking the risk of overestimating the firm’s value. Jensen and Meckling (1976) explain how the moral hazard could challenge the perfect capital market assumption. It is argued that the lender will demand a premium for the loan so that they can compensate the risk of borrowers’ investing in excessively risky projects.

The perfect capital market assumption is problematic, and, therefore, external funds cannot be used as a perfect substitution for internal funds. The cost of external funds deviates from the cost of internal funds, and the deviation is positively related to the level of information asymmetries. Firms with a high level of asymmetric information need to pay a higher level of premium to gain external funds than firms with a low level of asymmetric information.

Under the imperfect capital markets assumption, firms with asymmetric information can only get access to financial resources on less favourable terms in the capital markets. As a result, these firms' investments may be financially constrained in "hierarchy of finance" or "pecking order" models, in which internal funds have a cost advantage over external funds, equity and debt for instance.

The "hierarchy of finance" or "pecking order" refers to the fact that enterprises usually finance their investment by a preference order with respect to different kinds of financial resources (Myers and Majluf, 1984). When it is necessary to gain external funds, firms tend to issue the safest debt first then move on to riskier debt and finally use equity as a last resort. Under these circumstances, firms' investment decisions are closely related to the method of financing. The accumulation of internal funds have a positive impact on firm's financial condition, and as the cheapest financial resource, the level of internal funds becomes an important empirical determinant of investment.

Liquidity and inventory management

The relationship between inventory management and financial condition has been widely discussed in the literature. The different conclusions reached by different groups of authors can be explained by the different ways in which they measured financial conditions (Guariglia, 2008). Payout ratio (Fazzari et al., 1988, Agung, 2000), interest coverage (Whited, 1992, Schiantarelli, 1996, Cleary, 2006) and leverage ratio (Guariglia, 2000) are widely used as proxies of financial constraints when analysing the relation between financial condition and fixed investment.

Since we are focusing on the inventory investment, a firm is defined to be financially constrained if it cannot fund all desired inventory investment. This inability might be due to credit constraints or inability to borrow, failure to issue equity, dependence on bank loans, or illiquidity of assets (Lamont et al., 2001). One of the empirical challenges in the literature has been to identify financially constrained firms. Many studies unsatisfactorily use endogenous firm characteristics such as size, outward orientation, or dividend payment as proxies to categorize affected firms. However, when talking about inventory investment, internal finance seems to be the primary component of financial requirements (Chan, 2008). Zakrajsek (1997) concludes that "the observed volatility in aggregate retail inventory… is due to fluctuations in internal funds", and according to a report from the Federal Reserve Bank of New York, for firms with limited access to capital markets, the internal fund is a significant predictor of inventory investment.

Yang and Birge (2011) introduce an inventory financing pattern similar to the pecking order theory (Myers, 1984) in corporate finance. It is said that the retailer first will use internal cash to finance inventory. When the internal resource is insufficient, the retailer starts to use external financing, that is, operates with leverage. When moderately levered, the retailer will be offered cheap trade credit, which becomes the primary external source of inventory financing. With increasing leverage, the retailer will face more expensive trade credit, thereby diversifying external financing between trade credit and other short-term debts. Therefore, when constructing the index of inventory related financial constraints, we are mainly looking at a portfolio that may consist of proxies of internal funds, trade credit and short-term debts.

Internal financial resources

In the theory of capital structure, internal financing means a firm use its profits as a source of capital for new investment rather than rely on other investors or obtain capital elsewhere (Hubbard et al., 1995). Internal financing is generally thought to be less expensive for the firm than external financing because the firm does not have to incur transaction cost to obtain it, nor does it have to pay the taxes associated with paying dividends.

Cash flow is one of the components of a firm's internal funds. The pecking order theory implies that any firm obliged to access the external capital market may be financially constrained, since external funds can only be obtained by paying a premium, and sometimes this premium will be viewed as unacceptable. It is said that if the firm's internally generated cash flow is very high, the firm will be fully liquid as internally generated revenue is fully sufficient to cover its operation cost without ever having to raise external fund (Bolton et al., 2013). Taking into account the fact that firms with low levels of internal funds will be forced to attempt to obtain external funds, low cash flow levels will indicate that the firm is facing financial constraints.

Cash holdings can be valuable when other sources of funds, including cash flows, are insufficient to satisfy firms' demand for capital (Denis and Sibilkov, 2009). That is, firms facing external financing constraints can use available cash holdings to fund the necessary expenditures. Consistent with this view, several studies report that firms with greater difficulties in obtaining external capital accumulate more cash. In other words, firms tend to relieve their external financial distress by taking advantage of cash reserves (Almeida et al., 2004, Faulkender and Wang, 2006).

The interest coverage is another variable which is frequently used as a measure of the financial constraints (Whited, 1992, Hu and Schiantarelli, 1998 and Cleary, 2006).

Since the extent to which the interest covered by the firm's earnings may proxy for the firm's profitability, this variable may help us distinguish between financially constrained and unconstrained firms.

Trade credit

The needs of financing inventory arise from the difference in the timing of when costs are incurred and when revenue is received. Guariglia and Mateut (2006) state that the use of trade credit could offset the pressure of financial constraints and has a positive impact on inventory investment. It is said that even in periods of tight monetary policy and recession, when bank loans are harder to obtain and/or more costly, financially constrained firms are not forced to reduce their investment too much as they can finance it with trade credit. This phenomenon is referred as the trade credit channel of monetary transmission. Trade credit transfers some of the distress costs from the retailer to the supplier (Yang and Birge, 2011). The trade credit encourages the supplier to offer trade credit to further boost sales. However, the supplier could also limit the amount of trade credit by adjusting its price. These two effects not only explain why the supplier lends to the retailer but also rationalize why the price of trade credit is dispersed.

Short-term debts

One of the major disadvantages of internal financing is that it is not tax deductible (Petersen and Carpenter, 2002). The inclusion of short-term financing has important economic implications, since if firms ignore such financing opportunities and solely rely on their own capital, they may lose potential profits and development opportunities (Gong et al., 2014). Reference is made to Guariglia (1999, 2000, 2010), who concludes that the ratio of short-term debt to sales could explain the inventory investment fluctuation to some extends, especially during periods of recession and tight monetary policy and the results are even for work-in-process and raw material inventories than that for total inventories.

In this study, we consider the working capital net of inventory to be the major source of finance (Yang and Birge, 2011). Working capital is defined as current assets minus current liabilities.

$$Working\ capital = current\ assets - current\ liabilities$$

It measures the firm´s net position in liquid assets; it may be seen as the firm's store of funds. When cash flow levels decrease, ceteris paribus, working capital may be used as a source of funds. The existence of working capital can be thought of as relaxing firms´short-run financing constraints (Fazzari and Petersen, 1993). Therefore, we define our liquidity variable as the ratio of working capital (net of inventory) to total assets.

Liquidity = (working capital – inventory) / total assets

Since the ratio could be negative and the variables in the model are expressed in logarithms, we add 1 to this ratio and also include a dummy variable, neg_liquid (equals one if the liquidity ratio is negative and equals zero otherwise) in order to distinguish firms who have zero or negative liquidity ratio[3].

Export

The inclusion of export dummy into the model is motivated by Guariglia and Mateut (2010), which explore the link between firms' global engagement and their financial health in the context of inventory investment regressions. It is argued that firms that

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[3] Since the estimation results can be sensitive to the constant added before taking the logarithm, alternative ways of doing the transformations of the liquidity measure are considered. The log-modulus transformation (John and Draper, 1980) and Bos and Koetter (2009) supply alternatives for handling ln(x) when some of x are zero or negative. However they refer to the situation when it is the dependent variable that has zero or negative values, not the explanatory variable.

do not export and are not foreign owned exhibit higher sensitivities of inventory investment to financial constraints relationship.

However, the long-run direct impact of global engagement on inventory level has not been analysed and in this chapter, we will fill this gap. The export dummy, no_exporter, equals one if the firm does not undertake any exporting activities and equals zero otherwise. Since exporters get access to foreign markets, which could help firms overcome the impact of domestic market fluctuations, the export dummy (no_exporter) and inventories are expected to be negatively correlated in the long run.

Managerial fixed cost

In recent years, manufacturers and retailers are increasing their focus on logistics systems, looking for ways to reduce distribution costs and improve customer responsiveness (providing the desired product where and when the customer wants it). The goal of distribution cost reduction provides motivation for centralization of inventories (Chang and Lin, 1991).

On the other hand, the goal of customer responsiveness provides motivation for having goods as near to the final consumer as possible. Thus, there is a basic conflict between these objectives, and locating distribution centres (DCs) is a critical decision in finding an effective balance between them. Location decisions for DCs also affect transportation costs (Nozick and Turnquist, 2001). We take the cost of selling and distribution spending into consideration to examine the location-inventory relationship. Besides, the dummy of location, city200 (equals one if firm located in top200 cities based on population size), is also included as an alternative variable to measure this relationship.

Technology improvements

In order to capture firms' target inventory level movement due to the managerial development, three variables are included in our model: a dummy related to research and development spending (equals one if firms undertook any spending on R&D, equals zero otherwise), firm age, time trend.

3.2.3 Estimation methodology

The system Generalized Methods of Moments (system GMM) approach (Blundell and Bond, 1998) is employed when estimating the model. We choose this estimator since it is designed for situations with

1) "small *T*, large *N*" panels, meaning few time periods and many individuals;

2) a linear functional relationship;

3) dependent variable, lr_stocks, is dynamic, depending on its own past realizations: the presence of the lagged inventory variables (L.lr_stocks and L2.lr_stocks) into the model biases all the standard estimators for panel data because of the violation of the assumption of strict exogeneity between the error term and the regressors;

4) independent variables that are not strictly exogenous, meaning they are correlated with the past and possibly current realizations of the error: it is worth considering lr_sales as predetermined (i.e. potentially influenced by current and past shocks);

5) fixed individual effects;

6) heteroskedasticity and autocorrelation within individuals but not across them.

Arellano and Bover (1995)'s estimation, which is called difference GMM, starts by transforming all regressors, usually by differencing, and uses the generalized method of moments (GMM) (Hansen, 1982). The Blundell and Bond (1998)'s estimator augments Arellano and Bover (1995) by making an additional assumption that first differences of instrument variables are uncorrelated with the fixed effects. This allows the introduction of more instruments and can dramatically improve efficiency. It builds a system of two equations, the original equation and the transformed one, and is known as system GMM.

In this paper, we make use of lagged values of inventories and sales as instruments to deal with the problems of endogeneity which is mentioned above. Other factors in the model are considered exogenous and thus are treated as instrumental variables. Hansen statistics is used as a test of the validity of the instruments and since instrument proliferation weakens the power of the Hansen test to detect invalidity of the system GMM instruments, we also "collapse" instruments to limit instrument proliferation (Roodman, 2009). Moreover, In terms of the test of autocorrelation, the AR(2) test on the residuals in first differences is used to detect AR(1) in the underlying levels variables.

3.3 Descriptive statistics

The Chinese National Bureau of Statistics (NBS) database is involved in this chapter so that we can analyse the parameters that impact inventory management. We allow the firms enter or quit freely during the research period in order to avoid survivorship bias. By doing this, we could concentrate on firms that survive throughout the entire research period as well as those that did not survive in this empirical analysis.

The research period is from 2000 to 2009, and it covers 10 calendar years. The replacement of firms is dramatic during the research period as the consequence of enterprise restructuring, which began in earnest in the mid-1990s. The fluctuation of business and economic environment during the search period is another reason.

Table 3.1 presents the survival period of the firms in the dataset. The total number of companies that survived over the period 2000-2009 is 22,655. Our research sample covers 38,772 firms that were established in 2000. 38,047 of them survived until 2001, and 37,453 survived until 2002. This gives us survival ratios of 98.13% and 96.60% respectively. 22,655 of them existed by 2009, which gives a 58.43% survival rate through the research period of 10 years. Similarly, 42,774 films entered the dataset in 2001 and 41,698 of them survived until 2002 and 40,355 until 2003.

In addition to our survival statistics supplied in Table 3.1, Figure 3.1 present the average survival rates of firms for the period 2000-2009. On average, 89.74% of firms survive more than one year, and 82.08% survive more than two years. The average of those firms surviving more than eight years is 65.69%.

The average survival rates for each calendar year is introduced in Figure 3.2. it shows that the average survival rates declined severely from 2008 onwards. This is consistent with the fact that a significant business recession is observed after the global financial crisis and a large number of firms become insolvent during the period 2008-2009.

Figure 3.3 focus on the survival statistics in 2009. 58.43% of firms that were established in 2000 still survived in 2009. However, this number drops to 34.54% for firms that started in 2007. Moreover, 74.46% of firms that established in 2008 survived during 2009, which is lower than the average rate for firms survive more than one year (89.74% in Figure 3.1). This states that the global financial crisis impacts young firms more severely.

Table 3.1: Survival statistics (2000-2009)

Year	<2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
<2000	318958										
2000		38772	38047	37453	36310	36371	37210	37191	36215	29233	22655
			725	1319	2462	2401	1562	1581	2557	9539	16117
			98.13%	*96.60%*	*93.65%*	*93.81%*	*95.97%*	*95.92%*	*93.41%*	*75.40%*	*58.43%*
			1.87%	*3.40%*	*6.35%*	*6.19%*	*4.03%*	*4.08%*	*6.59%*	*24.60%*	*41.57%*
2001			42774	41698	40355	40024	40958	41050	39770	31973	23943
				1076	2419	2750	1816	1724	3004	10801	18831
				97.48%	*94.34%*	*93.57%*	*95.75%*	*95.97%*	*92.98%*	*74.75%*	*55.98%*
				2.52%	*5.66%*	*6.43%*	*4.25%*	*4.03%*	*7.02%*	*25.25%*	*44.02%*
2002				46303	44370	43386	44469	44433	42975	33587	24964
					1933	2917	1834	1870	3328	12716	21339
					95.83%	*93.70%*	*96.04%*	*95.96%*	*92.81%*	*72.54%*	*53.91%*
					4.17%	*6.30%*	*3.96%*	*4.04%*	*7.19%*	*27.46%*	*46.09%*
2003					50881	48157	48971	48801	46925	35626	26863
						2724	1910	2080	3956	15255	24018
						94.65%	*96.25%*	*95.91%*	*92.22%*	*70.02%*	*52.80%*
						5.35%	*3.75%*	*4.09%*	*7.78%*	*29.98%*	*47.20%*
2004						43737	42372	42097	40354	28535	22872
							1365	1640	3383	15202	20865
							96.88%	*96.25%*	*92.27%*	*65.24%*	*52.29%*
							3.12%	*3.75%*	*7.73%*	*34.76%*	*47.71%*
2005							38241	36908	35020	22689	20686
								1333	3221	15552	17555
								96.51%	*91.58%*	*59.33%*	*54.09%*
								3.49%	*8.42%*	*40.67%*	*45.91%*
2006								30305	28152	16190	16784
									2153	14115	13521
									92.90%	*53.42%*	*55.38%*
									7.10%	*46.58%*	*44.62%*
2007									23528	9187	15402
										14341	8126
										60.95%	*34.54%*
										39.05%	*65.46%*
2008										14531	10805
											3726
											74.36%
											25.64%

Figure 3.1 Average survival rates by firm age

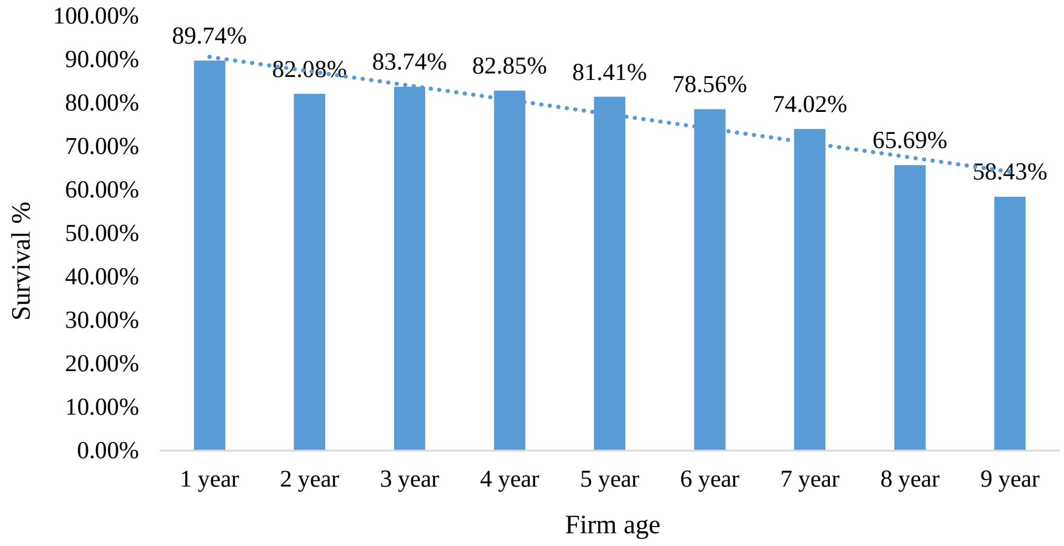

Figure 3.2 Average survival rates by year

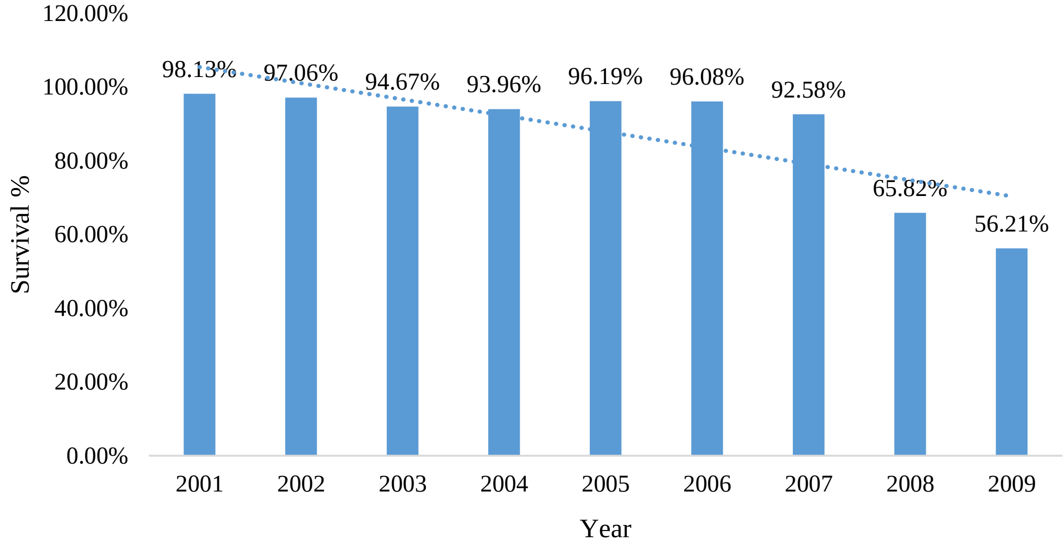

Figure 3.3 Survival rates in 2009

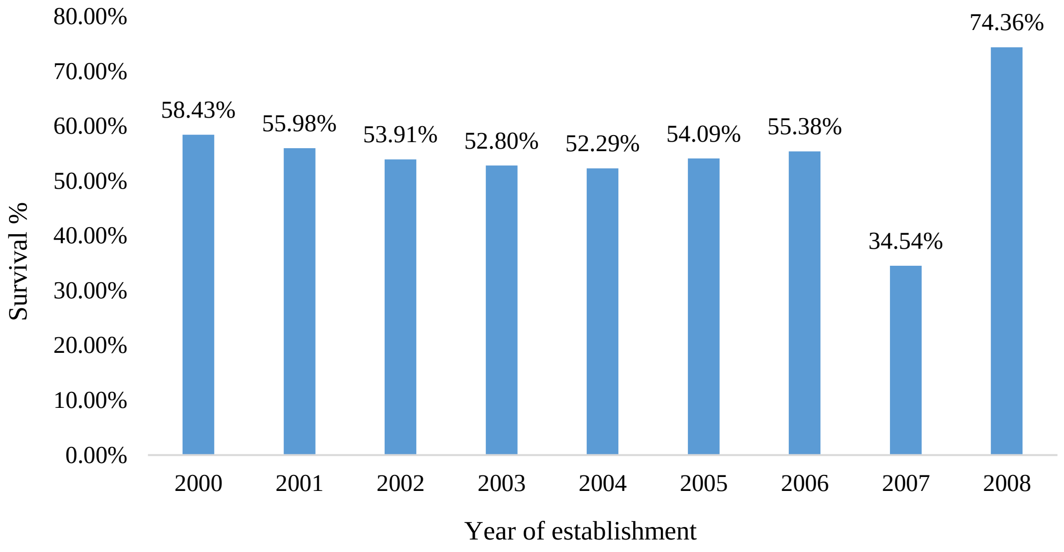

Table 3.2 presents the summary statistics of variables used in Equation (3.3). It is interesting to see that the majority of firms in the sample (63.8%) have no political affiliations with any level of government, and the ratio of unaffiliated firms dramatically increases from 13.7% in 2000 to 84.4% in 2009. This could be due to the China's marketization reform starting from the late 1970s.

In terms of ownership, our sample is dominated by private ownership, the individual investors and corporation entities investors occupy 46.5% and 21.2% respectively over the period of 2000-2009. There is a dramatic decline in the proportion of state ownership in our sample, from 22.5% in 2000 to 3.1% in 2009. A similar pattern holds for collective firms, whose share drops from 22.9% to 4%. In contrast, the share of individual investors increases from 21.9% to 77.3%.

Last but not least, 74.5% of firms do not export over the sample period, which dominates out data. This ratio remains stable in the ten years. Moreover, most firms in our sample (89.3%) do not engage in R&D.

Table 3.2: Descriptive statistics (2000-2009)

Variables	Definition	2000-2009		2000		2009	
		Mean	SD	Mean	SD	Mean	SD
lr_stocks	ln inventories (billion RMB 2002 prices)	-6.367	1.861	-6.282	1.841	-6.466	1.802
lr_sales	ln sales (billion RMB 2002 prices)	-3.874	1.385	-4.393	1.575	-3.531	1.237
p_capstate	Proportion of capital owned by the State	0.086	0.270	0.255	0.418	0.031	0.174
p_capcoll	Proportion of capital owned by collective firms	0.085	0.263	0.229	0.390	0.040	0.196
p_capcorporate	Proportion of capital owned by corporations/legal entities	0.212	0.382	0.171	0.339	0.000	0.000
p_capindividual	Proportion of capital owned by individuals	0.465	0.480	0.219	0.382	0.773	0.419
p_capforeign	Proportion of capital owned by foreigners	0.074	0.245	0.056	0.204	0.079	0.269
no_politics	No political affiliations	0.638	0.481	0.137	0.343	0.844	0.363
high_politics	High political affiliations with central or provincial governments	0.044	0.205	0.085	0.279	0.015	0.123
no_exporter	A dummy variable for non-exporters	0.745	0.436	0.759	0.428	0.777	0.416
lage	ln firm age (based on year-of-birth)	2.157	0.874	2.443	0.928	2.243	0.646
lliquid	ln [1+ratio of (current assets-current liabilities- inventories) to total assets]	0.116	0.154	0.108	0.146	0.146	0.165
neg_liquid	Dummy =1 if ratio of (current assets-current liabilities- inventories) to total assets ≤ 0	0.459	0.498	0.458	0.498	0.357	0.479
lfc	ln selling and distribution spending	1.052	0.859	1.205	0.941	0.933	0.774
rd_dum	Dummy variable=1 if firm undertook any spending on R&D	0.107	0.310	0.119	0.324	0.073	0.260
city200	Dummy=1 for firms located in top 200 cities based on population size	0.870	0.336	0.800	0.400	0.885	0.319
t_trend	Time trend (start from 2000)						
N	Number of observations	2,290,530		149,851		155,903	
firm_id	Number of firms	648,030					

Table 3.3: Descriptive statistics of inventories to total assets ratio

Variable	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
inventories/total assets	0.194	0.196	0.193	0.180	0.182	0.173	0.171	0.165	0.158	0.153
N	149851	156267	168143	183054	259966	253932	281086	309569	372759	155903

Figure 3.4 Inventories to total assets ratio

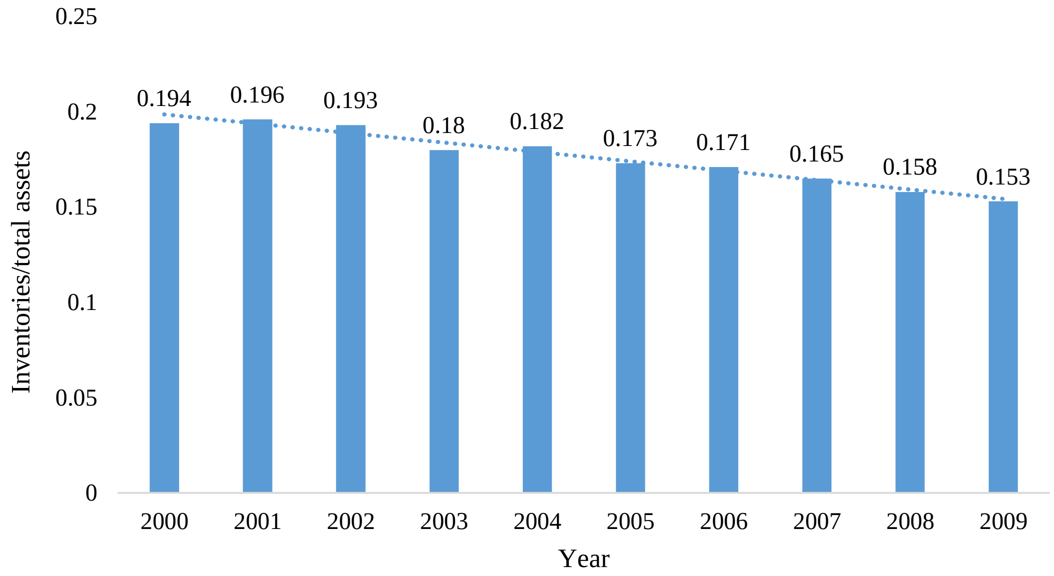

Table 3.3 display summary statistics of inventories to total assets ratio and the number of observations for each sample year. The number of observations ranges from a minimum of 149,851 firms to a maximum of 372,759 firms. A decline of inventories to total assets ratio could also be concluded during the sample period, from 19.4 in 2000 to 15.3% in 2009, which provides us a general picture of inventory reduction among Chinese manufacturing sectors (see Figure 3.4).

3.4 Estimation results and discussion

By estimating the target adjustment inventory investment model augmented with specific firms' characteristics, like the one presented in Equation (3.6), we report the main results for 26 two-digit industries/industry groups in Table 3.4(a), Table 3.4(b) and Table 3.4(c). Panel A presents the short-run dynamics, including the short-run coefficients of lags 1 and 2 of inventory level and the speed of adjustment while panel B contains the long-run coefficients on the determinants of target inventory level.

Generally speaking, the AR(2) and Hansen test of no second-order autocorrelation and valid instruments cannot be rejected at 5% conventional significance levels or better, which indicate that the estimation results are statistically sensible. Although a wide range of explanatory variables are included in the analysis, it is unlikely to have multicollinearity issue since the number of observations is vast and Z-values are not low.

We begin the discussion by focusing on the short-term dynamics. Coefficients of lag1 and lag2 of inventories are significantly positive and less than 1 for most industries, which provides evidence for the existent of partial adjustment phenomenon. The coefficients of lag1 of inventories tend to be larger than that of lag2 for all industries and furthermore, for some industries such as medical, metal and non-metal products, the significance of inventories coefficients decreases when the lag increased, thus indicating a loss in intensity of the adjustment path. The speed of adjustment towards the desired level of inventories is significant for 25 out of 26 industries and on average, Chinese firms could change about half of their deviation from target inventory level in short-run (the average speed of adjustment is around 0.5). It is interesting to note that the speed of adjustment is quite low for non-metal products industry, only 0.228, which means it would take almost 2.67[4] years to move half-way to reach the long term goals. It would only take about 0.64 years for firms in the leather industry to achieve the optimal long-term inventory level, since they have the fastest adjustment speed, 0.662, according to the results. For tobacco industry, coefficients of lag1 of inventories are 0.742, which is the second highest among all industries, and the speed of adjustment is insignificant. These indicate that tobacco manufacturers are confronted with very high adjustment cost so that they could not revise their outputs within a short-term when demand change.

In terms of long-run results, the elasticity of inventory level to sales is positive and significant for all industries but displays obvious heterogeneity among industries. The magnitude of the coefficients provides clear evidence of the role played by inventories

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[4] The time it takes to achieve an elimination of 50% of the gap is calculated by: $\mathrm{T} = -\frac{\ln(2)}{\ln(1-\delta)}$, where δ is the speed of adjustment. Details of the half-life convergence time is presented in appendix 3.

in buffering demand fluctuation, and the heterogeneity could be explained by the variety of inventory-to-sales ratio for different industries.

The five ownership structures that we examined have a distinctive influence on firms' inventory decisions. By setting the capital owned by Hong Kong/Macao and Taiwan as a benchmark, we find that the proportions of capital owned by the state, collective firms, corporations/legal entities and individual have significant negative relations with inventory holdings. On the other hand, the foreign ownership is positively associated with the level of inventory holdings in 6 out of 26 industries. These results indicate that a higher proportion of domestic or mainland ownership usually related to a lower level of inventories. In a corporate governance perspective, this could be due to a separation of ownership and management. When focusing on the state and individually owned firms, we find that each percent growth of state-owned ratio reduce fewer inventory holdings when compared with that of individually owned ratio, which means the state-owned firms tend to accumulate more inventories. This could be explained by the facts that individually owned firms usually have a higher level of productivity and are more likely to be financially constrained.

The coefficients of high and no political affiliation do not show completely symmetrical patterns. The impact of high political affiliation seems to be more widespread among industries, 20 industries are affected, compared to no political affiliation, the coefficient on which is significant only for 8 industries. Generally speaking, firms with higher level of political affiliation usually have a higher level of inventories, which is in line with the view that a close relationship with the government could benefit firms in better financial condition and the exposure in market competition could motivate firms to improve their productivity. However, issues arise in two most competitive industries and two highly monopolistic industry: it is shown that no political affiliation would make firms in apparel and footwear industry hold more inventories and high political affiliation has negative relation with the inventory level in culture and water production industries.

Following literature such as Guariglia and Mateut (2010), we take the impact of firm's financial condition on inventory into consideration. As stated before, liquidity is measured by the net working capital deducted by the value of inventories and the negative liquidity is captured by the dummy named *neg_liquidity*. We find that firms that are experiencing negative liquidity is associated with a significantly lower level of inventories for more than half of the industries. This finding is consistent with the fact that firms with bad financial condition could not afford the inventory accumulation or even convert inventories into other kind of current assets in order to ease their finance pressures. For industries like other mining, timber, non-metal product and water production, the liquidity is positively related to inventory level. This indicates that firms with better financial condition are able to afford the cost of inventory accumulation and tend to have a higher level of inventory. However, for industries like machinery & equipment, printing and textile etc., a higher liquidity ratio does not lead to an increase in the level of inventory. This may infers that the financial condition and inventory level is not linear related. Same as the reversed U-shape investment curve detected by Cleary et. al. (2007), when firms are experiencing a bad financial condition, a negative liquidity for instance, inventories tend to be seen as a source of internal funds and firms will reduce their inventory holdings to ease financial constraints. When the financial condition getting better and firms have enough liquidity, the relation between liquidity and inventory becomes positive. However, this relationship becomes negative when firms have much liquidity surplus (Baños-Caballero et al., 2014). One possible explanation would be that when firms have accumulated inventories to a certain level, an increase of liquidity will not lead to a growth of inventories since the cost of holding inventories would be very high and firms tend to do other investment so that they can get higher profits.

The result shows that dummy related to export activities is negatively related to inventory level, which indicates that firms undertaking export activities tend to have more inventories. This result is surprising to some extents, since, according to the literature, exporting firms are more likely to have superior performance compared to their non-exporting counterparts in terms of productivity and technology development (Bernard et al., 2007, De Loecker, 2007). Therefore, they should enjoy a shorter production cycle and lower inventory volume. The processing trade argument may provide a sensible explanation. Wang and Yu (2012) state that processing trade accounts for about 60% of Chinese export volume and processing exporters are usually suffer low productivity (Dai et al., 2012), which offsets the productivity advantage of undertaking export overall.

In terms of the fixed managerial cost, statistically, the rise of selling and distribution costs seems to motivate firms stock more. This impact could be found in most manufacturing industries in China (the tobacco industry is an exception). For this matter of fact, we believe that the managerial fixed cost is one of the common determinants across industries. The coefficient on city200 dummy is significant only for six industries. This variable has a positive impact on inventories for those industries that have a large product demand and higher inventory turnovers in the urban area, such as apparel and footwear, culture, non-metal products, machinery and equipment and measuring instrument. This refers that, for these industries, firms' goal of customer responsiveness provides motivation for having goods as near to the final consumer as possible (Nozick and Turnquist, 2001) and locating DCs in big cities is a good choice for them. However, for mining industry (apart from coal mining), firms which are located in top 200 cities seem to have fewer inventory holdings.

We examine three possible proxies which could measure technical improvements: time trend, firm age and research and development. These variables are included to account for technical changes which may motivate productivity within industries and exogenous improvements in corporate governance, especially the inventory management. The coefficient on the time trend is negative and significant for 18 out of 26 industries. This is reasonable since the productivity improvement shortens the producing process and modern inventory management systems, JIT for instance, are widely accepted. Both of the two changes result in the decline of firms' inventory level.

In contrast, we do not find any evidence for the hypotheses that undertaking R&D is expected to have a positive impact on reducing inventory level. Moreover, the coefficient on R&D dummy is actually significantly positive for the majority of industries, which means firms undertaking R&D tend to have a higher level of inventory level. One possible explanation could be that firms in developing countries are too far from the technological frontier and R&D investment could require longer time horizons to demonstrate results (Crespi and Zuniga, 2012). Firms' innovations are mostly based on imitation and technology transfer, e.g., acquisition of machinery and equipment and disembodied technology purchasing. Moreover, shortening the producing process is not the priority for firms conducting R&D, and instead, firms that have the ability to spend on R&D could be seen as financial unconstraint and, therefore, are willing to have a higher level of inventories (Ughetto, 2008). In other words, the R&D dummy could also be recognized as an alternative financial factor.

Firm age is found to affect inventory level significantly and positively for most industries. However, electronic power that has a significantly negative coefficient seems to be an exception. This is consistent with the belief that younger firms perform their business in a more efficient way and enjoy more advanced technologies than older firms. However, the opinion that firm would decline its inventory when become more experienced and familiar with the market during operation is not supported by our analysis.

Table 3.4a: System GMM estimation of the symmetric inventory model, China 2000-2009 (i)

Dependent Variable: lr_stocks	Other Mining sic10	Food Production sic14	Tobacco sic16	Textile sic17	Apparel & Footwear sic18	Leather sic19	Timber sic20	Furniture sic21	Paper-making sic22
Panel A: Short-run dynamics									
L.lr_stocks	0.438***	0.405***	0.742***	0.455***	0.393***	0.455*	0.457***	0.463***	0.486***
	(0.018)	(0.020)	(0.100)	(0.017)	(0.015)	(0.235)	(0.020)	(0.021)	(0.015)
L2.lr_stocks	0.106***	0.051***	0.086*	0.073***	0.061***	-0.116	0.104***	0.075***	0.110***
	(0.017)	(0.017)	(0.046)	(0.016)	(0.011)	(0.162)	(0.015)	(0.019)	(0.014)
Speed of	0.455***	0.544***	0.172	0.472***	0.546***	0.662***	0.439***	0.463***	0.405***
Adjustment	(0.031)	(0.032)	(0.115)	(0.032)	(0.023)	(0.104)	(0.031)	(0.034)	(0.024)
Panel B: Long-run equilibrium									
lr_sales	0.418***	0.652***	2.406*	0.456***	0.954***	0.244***	0.623***	0.476***	0.489***
	(0.061)	(0.056)	(1.440)	(0.042)	(0.114)	(0.056)	(0.092)	(0.072)	(0.054)
p_capstate	-0.245	-0.367***	1.141	-0.273***	-0.228*	-0.692***	-0.564***	-0.711***	-0.283**
	(0.239)	(0.104)	(2.877)	(0.063)	(0.131)	(0.235)	(0.153)	(0.264)	(0.118)
p_capcoll	-0.593**	-0.293***	1.434	-0.561***	-0.383***	-0.880***	-0.840***	-0.841***	-0.687***
	(0.234)	(0.086)	(2.914)	(0.056)	(0.074)	(0.095)	(0.151)	(0.158)	(0.091)
p_capcorporate	-0.415*	-0.188***	1.058	-0.460***	-0.312***	-0.665***	-0.551***	-0.558***	-0.454***
	(0.227)	(0.060)	(2.949)	(0.041)	(0.046)	(0.065)	(0.098)	(0.088)	(0.082)
p_capindividual	-0.451**	-0.196***	3.321	-0.517***	-0.374***	-0.846***	-0.683***	-0.727***	-0.568***
	(0.224)	(0.061)	(3.944)	(0.040)	(0.044)	(0.060)	(0.093)	(0.079)	(0.079)
p_capforeign	0.241	0.035	-7.770	-0.060	-0.134***	-0.063	0.060	-0.015	0.162*
	(0.279)	(0.057)	(9.966)	(0.046)	(0.042)	(0.063)	(0.102)	(0.082)	(0.093)

no_politics	0.050	-0.058*	-1.576	-0.145***	0.064**	0.014	-0.089	0.072	-0.058
	(0.062)	(0.034)	(1.433)	(0.024)	(0.030)	(0.047)	(0.058)	(0.066)	(0.038)
high_politics	0.862***	0.008	-2.357	0.313***	0.157	0.534**	0.422**	-0.005	0.335***
	(0.110)	(0.081)	(2.194)	(0.060)	(0.106)	(0.235)	(0.165)	(0.200)	(0.113)
no_exporter	-0.775***	-0.494***	0.526	-0.328***	0.046	-0.252***	-0.348***	-0.416***	-0.314***
	(0.086)	(0.040)	(0.900)	(0.023)	(0.030)	(0.035)	(0.054)	(0.058)	(0.053)
lage	0.067**	0.080***	-1.202	0.217***	0.151***	0.399***	0.031	0.124***	0.067**
	(0.033)	(0.025)	(1.400)	(0.024)	(0.025)	(0.044)	(0.038)	(0.045)	(0.027)
lliquid	0.587***	-0.160	-4.303	-0.831***	-0.451***	-0.789***	0.401**	-0.108	-0.108
	(0.206)	(0.136)	(3.339)	(0.090)	(0.103)	(0.117)	(0.195)	(0.212)	(0.175)
neg_liquid	-0.055	-0.034	-0.531	-0.095***	-0.132***	-0.203***	0.121**	-0.057	0.008
	(0.058)	(0.037)	(0.650)	(0.023)	(0.034)	(0.038)	(0.055)	(0.059)	(0.045)
lfc	0.083***	0.195***	0.631	0.091***	0.232***	0.083***	0.163***	0.264***	0.133***
	(0.026)	(0.018)	(0.400)	(0.014)	(0.019)	(0.025)	(0.030)	(0.033)	(0.024)
rd_dum	0.540***	0.253***	-0.836	0.406***	0.108	0.365***	0.373***	0.289***	0.483***
	(0.095)	(0.049)	(1.550)	(0.036)	(0.068)	(0.062)	(0.096)	(0.077)	(0.068)
city200	-0.291***	-0.055	0.561	0.015	0.228***	-0.059	-0.060	-0.101	-0.023
	(0.052)	(0.049)	(0.589)	(0.039)	(0.056)	(0.084)	(0.065)	(0.101)	(0.056)
t_trend	0.013	-0.046***	-0.177	-0.039***	-0.033***	-0.012	-0.024*	-0.002	-0.031***
	(0.012)	(0.009)	(0.177)	(0.004)	(0.009)	(0.009)	(0.013)	(0.012)	(0.007)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,860	21,950	1,019	89,546	45,433	23,968	18,952	11,612	31,309
Number of firm	6,547	7,225	289	28,175	14,864	7,609	7,205	3,927	9,226
AR(1)	-20.18	-18.76	-3.185	-39.58	-29.27	-2.282	-19.18	-16.04	-25.34

P(ar1)	0	0	0.00145	0	0	0.0225	0	0	0
AR(2)	-1.426	-0.163	0.939	0.736	1.720	1.072	0.192	1.161	1.014
P(ar2)	0.154	0.870	0.348	0.462	0.0855	0.284	0.848	0.246	0.311
Hansen test	6.990	5.345	2.886	1.221	5.494	5.823	10.84	5.193	7.430
P(Hansen)	0.136	0.148	0.409	0.269	0.139	0.121	0.0547	0.158	0.0594

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 3.4b: System GMM estimation of the symmetric inventory model, China 2000-2009 (ii)

Dependent Variable: lr_stocks	Printing sic23	Culture sic24	Petroleum Processing sic25	Chemical sic26	Medical sic27	Rubber sic29	Plastic sic30	Non-metal Products sic31	Metal Products sic34
Panel A: Short-run dynamics									
L.lr_stocks	0.483***	0.281**	0.385***	0.398***	0.464***	0.500***	0.448***	0.787***	0.363***
	(0.020)	(0.125)	(0.035)	(0.014)	(0.042)	(0.022)	(0.023)	(0.233)	(0.028)
L2.lr_stocks	0.111***	0.172***	0.098***	0.069***	0.072*	0.071***	0.075***	-0.015	0.049**
	(0.017)	(0.047)	(0.029)	(0.009)	(0.043)	(0.022)	(0.023)	(0.181)	(0.024)
Speed of Adjustment	0.406***	0.547***	0.516***	0.533***	0.464***	0.429***	0.477***	0.228***	0.588***
	(0.032)	(0.086)	(0.058)	(0.021)	(0.082)	(0.036)	(0.044)	(0.076)	(0.051)
Panel B: Long-run equilibrium									
lr_sales	0.599***	0.381***	0.687***	0.818***	0.308***	0.535***	0.407***	0.623***	1.095***
	(0.100)	(0.074)	(0.092)	(0.071)	(0.076)	(0.088)	(0.049)	(0.093)	(0.078)
p_capstate	-1.044***	-0.344*	-0.083	-0.273***	-0.313***	-0.618***	-0.389***	-0.236*	-0.213***
	(0.196)	(0.205)	(0.260)	(0.058)	(0.087)	(0.167)	(0.097)	(0.129)	(0.067)
p_capcoll	-0.807***	-0.711***	-0.351	-0.649***	-0.334***	-0.710***	-0.661***	-0.462***	-0.570***
	(0.142)	(0.123)	(0.289)	(0.055)	(0.087)	(0.136)	(0.070)	(0.136)	(0.063)
p_capcorporate	-0.708***	-0.612***	-0.292	-0.524***	-0.155**	-0.697***	-0.553***	-0.348***	-0.559***
	(0.123)	(0.088)	(0.254)	(0.042)	(0.072)	(0.115)	(0.056)	(0.119)	(0.049)
p_capindividual	-0.868***	-0.763***	-0.163	-0.577***	-0.224***	-0.626***	-0.694***	-0.377***	-0.562***
	(0.121)	(0.080)	(0.262)	(0.045)	(0.077)	(0.113)	(0.056)	(0.128)	(0.052)
p_capforeign	-0.174	-0.078	0.563*	-0.021	0.231***	0.172	0.075*	0.138	-0.055

	(0.132)	(0.069)	(0.328)	(0.042)	(0.085)	(0.108)	(0.044)	(0.123)	(0.057)
no_politics	0.039	-0.000	-0.017	-0.091***	-0.055*	-0.171***	-0.043	-0.039	-0.054**
	(0.051)	(0.054)	(0.067)	(0.019)	(0.033)	(0.059)	(0.028)	(0.059)	(0.023)
high_politics	0.319***	-0.333*	0.557**	0.143***	0.124**	0.245**	0.398***	0.355***	0.163**
	(0.093)	(0.194)	(0.224)	(0.053)	(0.054)	(0.116)	(0.078)	(0.093)	(0.076)
no_exporter	-0.437***	-0.206***	-0.412***	-0.280***	-0.398***	-0.449***	-0.392***	-0.267***	-0.110**
	(0.075)	(0.052)	(0.128)	(0.044)	(0.056)	(0.063)	(0.033)	(0.053)	(0.044)
lage	0.156***	0.193***	0.128***	0.106***	0.208***	0.227***	0.065**	0.016	0.092***
	(0.030)	(0.051)	(0.046)	(0.015)	(0.037)	(0.043)	(0.030)	(0.049)	(0.020)
lliquid	-0.692***	-0.676***	-0.452	-0.129	-0.035	-0.172	-0.537***	0.714*	-0.404***
	(0.208)	(0.160)	(0.288)	(0.080)	(0.150)	(0.219)	(0.109)	(0.408)	(0.091)
neg_liquid	-0.084	-0.155***	-0.141*	-0.066***	-0.075*	-0.036	-0.171***	-0.040	-0.067***
	(0.057)	(0.049)	(0.079)	(0.023)	(0.039)	(0.062)	(0.032)	(0.068)	(0.025)
lfc	0.145***	0.155***	0.122***	0.184***	0.172***	0.198***	0.204***	0.209***	0.171***
	(0.027)	(0.034)	(0.043)	(0.014)	(0.015)	(0.037)	(0.020)	(0.033)	(0.022)
rd_dum	0.416***	0.423***	0.352***	0.293***	0.399***	0.490***	0.473***	0.241***	0.088
	(0.115)	(0.063)	(0.118)	(0.044)	(0.038)	(0.070)	(0.045)	(0.063)	(0.061)
city200	0.093	0.147*	-0.072	0.006	0.011	0.089	-0.078	0.113**	-0.019
	(0.093)	(0.081)	(0.081)	(0.027)	(0.050)	(0.112)	(0.054)	(0.044)	(0.030)
t_trend	-0.005	-0.005	-0.030**	-0.061***	-0.001	-0.081***	-0.021***	-0.062***	-0.099***
	(0.016)	(0.010)	(0.014)	(0.007)	(0.011)	(0.012)	(0.005)	(0.016)	(0.010)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,503	12,393	6,936	80,370	21,714	11,537	39,503	90,496	54,683
Number of firm	5,903	3,867	2,349	24,741	6,060	3,690	13,447	27,603	20,859

AR(1)	-20.53	-2.912	-11.12	-37.44	-20.30	-15.22	-25.68	-2.661	-26.65
P(ar1)	0	0.00359	0	0	0	0	0	0.00779	0
AR(2)	-0.693	-1.354	1.825	0.355	-0.446	-1.234	0.175	0.822	0.430
P(ar2)	0.488	0.176	0.0680	0.723	0.656	0.217	0.861	0.411	0.667
Hansen test	6.245	9.475	3.120	5.499	1.648	1.551	5.316	3.020	0.206
P(Hansen)	0.182	0.0915	0.210	0.0640	0.649	0.460	0.150	0.388	0.650

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 3.4c: System GMM estimation of the symmetric inventory model, China 2000-2009 (iii)

Dependent Variable:	Machinery & Equipment	Transport Equipment	Measuring Instrument	Other Manufacturing	Electronic Power	Gas Production	Water Production	Coal Mining
lr_stocks	sic35	sic37	sic41	sic43	sic44	sic45	sic46	sic60
Panel A: Short-run dynamics								
L.lr_stocks	0.504***	0.435***	0.452***	0.445***	0.421***	0.418***	0.473***	0.318***
	(0.012)	(0.037)	(0.026)	(0.017)	(0.031)	(0.065)	(0.025)	(0.023)
L2.lr_stocks	0.122***	0.072**	0.041**	0.126***	0.072***	0.112***	0.088***	0.075***
	(0.012)	(0.030)	(0.020)	(0.015)	(0.022)	(0.038)	(0.027)	(0.018)
Speed of Adjustment	0.374***	0.493***	0.508***	0.430***	0.507***	0.470***	0.439***	0.607***
	(0.022)	(0.066)	(0.040)	(0.028)	(0.048)	(0.089)	(0.042)	(0.037)
Panel B: Long-run equilibrium								
lr_sales	0.437***	1.000***	0.617***	0.580***	1.018***	1.196***	0.682***	0.544***
	(0.034)	(0.090)	(0.091)	(0.057)	(0.121)	(0.371)	(0.149)	(0.092)
p_capstate	-0.325***	-0.107	-0.016	-0.360***	-0.843***	0.593	0.964**	-0.022
	(0.056)	(0.094)	(0.114)	(0.112)	(0.218)	(0.367)	(0.443)	(0.607)
p_capcoll	-0.743***	-0.510***	-0.362***	-0.683***	-0.548**	0.573	0.897**	-0.516
	(0.052)	(0.072)	(0.118)	(0.099)	(0.247)	(0.553)	(0.437)	(0.607)
p_capcorporate	-0.578***	-0.446***	-0.282***	-0.689***	-0.741***	0.431	1.066***	-0.312
	(0.042)	(0.055)	(0.080)	(0.067)	(0.183)	(0.338)	(0.413)	(0.602)
p_capindividual	-0.706***	-0.578***	-0.567***	-0.679***	-0.591**	0.643	0.530	-0.391
	(0.041)	(0.060)	(0.085)	(0.062)	(0.230)	(0.499)	(0.424)	(0.602)
p_capforeign	0.143***	-0.096	0.029	-0.077	-0.085	0.143	0.410	1.202*

	(0.041)	(0.064)	(0.085)	(0.067)	(0.198)	(0.317)	(0.647)	(0.636)
no_politics	-0.088***	-0.054*	0.017	-0.061	0.069	-0.046	0.036	0.001
	(0.020)	(0.029)	(0.043)	(0.044)	(0.070)	(0.172)	(0.133)	(0.054)
high_politics	0.405***	0.195***	0.250***	0.453***	-0.205	-0.448	-0.406*	1.042***
	(0.035)	(0.063)	(0.084)	(0.095)	(0.182)	(0.512)	(0.237)	(0.172)
no_exporter	-0.324***	-0.124**	-0.230***	-0.095**	-0.093	0.164	0.140	0.033
	(0.022)	(0.061)	(0.057)	(0.039)	(0.147)	(0.548)	(0.215)	(0.117)
lage	0.164***	0.161***	0.166***	0.284***	-0.306***	-0.100	0.042	0.110***
	(0.020)	(0.030)	(0.031)	(0.034)	(0.046)	(0.185)	(0.090)	(0.026)
lliquid	-0.441***	-0.386***	-0.735***	-0.462***	-0.038	-1.585***	0.707**	0.254
	(0.074)	(0.110)	(0.149)	(0.149)	(0.298)	(0.579)	(0.331)	(0.203)
neg_liquid	-0.089***	-0.040	-0.203***	-0.203***	0.159***	-0.353**	0.074	0.007
	(0.021)	(0.031)	(0.046)	(0.049)	(0.053)	(0.151)	(0.075)	(0.053)
lfc	0.278***	0.200***	0.252***	0.190***	0.055*	0.249***	0.092***	0.138***
	(0.013)	(0.018)	(0.029)	(0.026)	(0.034)	(0.076)	(0.029)	(0.023)
rd_dum	0.567***	0.169**	0.366***	0.528***	-0.319**	-0.483	0.183	0.527***
	(0.024)	(0.081)	(0.072)	(0.052)	(0.156)	(0.360)	(0.282)	(0.113)
city200	0.154***	0.036	0.184*	0.053	0.030	0.052	0.103	-0.025
	(0.030)	(0.045)	(0.100)	(0.073)	(0.084)	(0.253)	(0.120)	(0.046)
t_trend	-0.036***	-0.071***	-0.027***	-0.019**	-0.054***	-0.138***	0.017	-0.073***
	(0.004)	(0.011)	(0.007)	(0.008)	(0.017)	(0.053)	(0.021)	(0.012)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	148,039	44,393	14,754	25,924	15,860	1,864	9,062	16,248
Number of firm	49,026	13,999	6,556	9,354	4,473	535	2,293	5,521

AR(1)	-48.77	-23.80	-12.45	-20.49	-15.66	-6.427	-15.20	-19.56
P(ar1)	0	0	0	0	0	1.30e-10	0	0
AR(2)	-1.332	1.217	0.331	-1.544	-1.283	-1.131	-0.736	-1.200
P(ar2)	0.183	0.224	0.741	0.123	0.199	0.258	0.461	0.230
Hansen test	2.979	0.322	1.163	5.464	7.532	0.624	2.221	7.754
P(Hansen)	0.225	0.570	0.559	0.243	0.0567	0.732	0.329	0.101

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

3.5 Conclusions

We have exploited a large unbalanced panel datasets of Chinese manufacturing firms observed over the period 2000-2009 to assess how certain factors determines the long-run target inventory level and whether the inventory dynamics differ among industries. When estimating the equation, we favour the system GMM estimator because of its ability to capture firm-level fixed effects and to deal with the endogeneity of regressors. Besides the sales and liquidity variables, we include in the inventory adjustment model several other specific variables such as firms' political affiliation and ownership, geographic location, in order to make a more comprehensive long-run inventory analysis. Also, the estimations are separate for each industry to allow for heterogeneity in unobserved industry-specific characteristics.

Generally speaking, in terms of short-run dynamics, a partial adjustment mechanism has been proved. The speeds of adjustment toward the desired level of inventories are significantly positive, and they are various among different industries from 0.228 to 0.662. From the long-run perspectives, sales, ownership structure and managerial fixed cost are important indicators of the target inventory level among all industries. Heterogeneous exists on the effect of political affiliation and the coefficients of high and no political affiliation do not show completely symmetrical patterns. Neither export behaviour nor R&D spending is found to impact strongly consistent with our expectations, possibly due to the facts of the large volume of processing trade and long distance from the technological frontier in the Chinese economy. From 2000 to 2009, 18 out of 26 industries have reduced their long run target level of inventory. Moreover, in line with previous literature, younger firms perform with a lower level of inventories with more advanced technologies than older firms and the U-shaped inventory-financial performance relation is detected for most of the industries.

Chapter 4. Asymmetric inventory adjustment: new evidence from dynamic panel threshold model

Chapter 4. Asymmetric inventory adjustment: new evidence from dynamic panel threshold model

4.1 Introduction

In the previous chapter, we document evidence in favour of firm level inventory short-run dynamic and long-run target adjustment pattern. However, an important limitation of this analysis, same as recent empirical research in this field of study, is that we assume symmetry in the mechanism of adjustment, such that firms adjust at the same rate toward desired inventory level regardless of exogenous parameters that affect the macro business environment. Consequently, we did not allow for a possibility that firms employ differential adjustment policy toward their optimal inventory structure following macro business cycle fluctuation.

Research on inventory investment has been focused on its role in business cycles. Due to its procyclical and persistent properties, inventory investment is found to be a leading indicator of business cycles. Inventory research at the macro-level provides a huge amount of evidence that questions the motivations of holding inventory at the firm level. For example, if firms hold inventory to smooth production, then why is it observed at the macro-level that production is more volatile than sales? The related puzzle is why inventory investment shows a strong procyclical and persistent movement. The discrepancy between inventory theories and stylised empirical evidence has worried economists for decades. There might be some factors missing in the existing literature on inventory investment. For instance, the impact of the volatility of stochastic variables on inventory investment is hardly discussed.

A non-linear model of investment behaviour incorporating time-varying adjustment speeds with threshold effects is estimated for the UK manufacturing sector, which suggests that uncertainty has a large and significant effect on both steady state levels and rates of adjustment (Price, 1996). Bo (2000) takes the volatility of sales into consideration and examines the relationship between demand uncertainty and inventory investment based on the accelerator buffer stock inventory model. By invovling a panel of Dutch listed firms in the period 1984-1996, it is found that the estimated coefficient of the speed parameter of adjusting inventories increases vastly when the volatility of sales is used as the proxy for unexpected sales in the inventory adjustment equation.

This chapter aims at filling this gap in the literature by developing a more comprehensive empirical approach, allowing for an asymmetric adjustment mechanism. The concept of asymmetry implies that the cost of adjusting to a higher target level are not necessarily marginally equivalent to the cost of adjusting to a lower target level (Escribanao and Pfann, 1998). In particular, we propose a dynamic panel threshold model of inventory (an industry-specific business cycle dummy is employed as a transition variable), allowing for asymmetries in the mechanism of adjustment of firms in different macro business regimes associated with differential adjustment speed and target. Our model entertains a possibility that firms not only adjust at heterogeneous speed in short-run dynamics but also adjust toward heterogeneous inventory targets in the long-run. To illustrate the advantage of our approach, consider a dynamic setting in which a firm faces different costs of inventory adjustment according to its characteristics. Rather than having a unique inventory target, the firm may have a target range within which allows its inventory level to fluctuate.

The structure of this chapter is as follows. Section 2 describes the empirical methodology to construct asymmetric inventory adjustment model with the descriptive statistics. Section 3 illustrates the results of our estimation while section 4 discusses the results and concludes the chapter.

4.2 Asymmetric inventory adjustment analysis

4.2.1 Theoretical backgrounds

In quadratic-cost models, the optimal behaviour is based on balancing the gains from production smoothing with the costs of deviating from some "target" level of inventories. The models of Arrow et al. (1958) remind us that optimal production and inventory decisions balance three margins: the benefits of production smoothing, the costs of holding inventories, and the costs incurred if inventories are too low to meet demand and a stockout occurs.

Differences in holding and stockout costs make it optimal for a firm to replenish inventories following a positive demand surprise, a shock that lowers inventories and increases the probability of experiencing a stockout, at a different speed than it reduces output following unexpectedly low sales, a shock that increases inventory holding costs. In particular, the difference between holding and stockout costs causes firms' production decisions to depend on whether or not shocks push inventories above or below desired levels.

4.2.2 Dynamic threshold model of inventory

Reminded that we define the symmetric adjustment model of inventory as a variant of Error-correction model (Guariglia and Mateut, 2006), and the partial adjustment process is written as:

$$\Delta I_{it} = I_{it} - I_{i,t-1} = \delta\left(I_{it}^{*} - I_{i,t-1}\right) + v_{it} \qquad (4.1)$$

Denoting the logarithm of the actual and target level of inventories of firm i at time t with I_{it} and $I_{it}*$, respectively. δ indicates the speed of adjustment that measures how fast firms move towards their target inventory level.

The target inventory level ($I_{it}*$) is then determined by a set of firms' characteristics such as sales, age, liquidity, etc.:

$$I_{it}^{*} = \beta' X_{it} \qquad (4.2)$$

To estimate the two equations, we employ the one-stage procedure (Flannery and Rangan, 2006, Ozkan, 2001) and yields:

$$\Delta I_{it} = \delta\left(\beta' X_{it} - I_{i,t-1}\right) + v_{it} = \delta\beta' X_{it} - \delta I_{i,t-1} + v_{it}$$

$$I_{it} = (1-\delta)I_{i,t-1} + \delta\beta' X_{it} + v_{it}$$

$$I_{it} = \varphi I_{i,t-1} + \pi' X_{it} + v_{it} \quad (4.3)$$

Where $\varphi = 1 - \delta$ and $\pi = \delta\beta$.

Testing the target adjustment model using equation (4.3) assumes that firms undertake inventory adjustment in a symmetric fashion. In order to analyse the asymmetric adjustment behaviour, we develop the regime-switching dynamic threshold model:

$$I_{it} = \left(\varphi_1 I_{i,t-1} + \pi_1' X_{it}\right) + \left[(\varphi_2 - \varphi_1)I_{i,t-1} + (\pi_2 - \pi_1)' X_{it}\right]1_{\{q<c\}} + v_{it} \quad (4.4)$$

Where $1_{\{.\}}$ is an indicator function taking the value 1 if the event is true and 0 otherwise. Equation (4.4) represents an important extension of the linear partial adjustment model, equation (4.3). It allows for short-run asymmetries ($\varphi_1 \neq \varphi_2$), as well as long-run asymmetries in the target leverage relationship ($\pi_1 \neq \pi_2$), conditional on the exogenous regime-switching transition variable, q_{it}, and the threshold parameter, c.

4.2.3 Regime-switching transition variable

In this section, we examine a number of potential reasons why we choose the industry-specific business cycle as the transition variable, in our regime-switching framework, equation (4.4). Our discussion is motivated by some recent empirical studies investigating the influence of recessions on firm performance.

It is commonly accepted that during recessions, financial institutions tend to tight their lending requirement, which dramatically change the firms' ability to create new lines of credit, dry up the flow of money and slow economic growth. Other shocks such as demand decreasing and risk rising are other concerns.

4.2.3.1 Credit supply shock channel and its impact on real economy

Much of the narrative on the financial crisis has focused on the impact of a credit supply shock: Tong and Wei (2008) propose a methodological framework to study the underlying mechanisms by which a financial-sector crisis may affect the real sector and apply it to the case of the most recent financial crisis. In particular, they quantify the importance of tightening credit supply and deterioration of consumer confidence in non-financial firms by comparing their impact on the firms' share price. The results show that both channels are at work, but credit supply constraints appear to be more quantitatively significant in explaining cross-firm differences in the magnitude of share price declines.

Ivashina and Scharfstein (2010) explain the decline of bank loans after the crisis from both of demand and supply side. From the demand side, due to the recession, firms usually slow down their expansion plan and limit their investment projects and, therefore, the need for external finance declines. From the supply side, the amount of funds that banks are willing to lend also decrease since banks find it difficult to get deposits.

Campello et al. (2010) analyse firms' investment policies during the financial crisis, in order to test the impact of credit shock. The authors undertake a survey-based measure of financial constraints which engaged 1050 Chief Financial Officers (CFOs) in the US, Europe and Asia. In their study, it is said that during the crisis, financially constrained firms cut more investment than their financially unconstrained counterparts. For cash accumulation aspect, this paper point out that financially constrained firms have to reduce their cash accumulations during the crisis and decrease their planned dividend payout but this behaviour among financially unconstrained firms is not significant. However, Duchin et al. (2010) point out that informational asymmetry could lead to a problem which may influence the reliability of these results. More specifically, it is possible that some of the questions in the survey were misunderstood or otherwise produce noisy measures of the desired variables of interest. In addition, when interpreting field studies, we need to consider that market participants do not necessarily have to understand the reason they do in order to make optimal decisions. Therefore, Duchin et al. (2010) introduce archival data in order to fill this gap and provide a similar conclusion to the prior one.

Tong and Wei (2010) expand this topic by analysing the impact of foreign investment on financial crisis transmission from the western market to other parts of the world. It is said that the impact of foreign investment is not uniform. In some countries, local firms obtain a relatively large fraction of their funding from foreign banks and other pools of liquid capital. However, the funds which arrive quickly also depart quickly and these firms suffered the most in the crisis. In contrast, other countries in which investment tend to be direct, and thus sticky, were less affected.

4.2.3.2 Other transmission channels

A number of other papers have challenged the credit supply shock channel by analysing other possible transmission channels. Using accounting data for 7722 non-financial firms in 42 countries, Claessens et al. (2012) examine how the 2007-2009 crisis affected firm performance, especially sales, profits, and capital expenditure, and how various transmission channels propagated shocks across borders. They employ a framework to distinguish the impact of three possible channels: a financial channel (the effect of the credit shock), a domestic demand channel (the effect of demand decreasing), and a trade channel (the effect of a decreased international trade volume). It is believed that firstly, if a reduction of available credit plays an important role for firms, it should be reflected in the performance of those firms that rely more on external finance for investment and working capital. Similarly, if the trade channel is important, it should be reflected in a relatively worse performance of those firms that rely more heavily on exports. Finally, if the crisis triggered a negative domestic demand shock, it should be reflected in a relatively worse performance of those firms that are more demand sensitive. The results show that the crisis had a more severe negative impact on firms with greater sensitivity to demand and trade, particularly in countries that are more open to trade. However, the financial openness appears to have made limited differences. In other words, the trade and demand channels are the most important. It is also shown that the trade channel played a significant role in the spill-over of crisis while the evidence for the role of the financial channel is considerably weaker.

Kahle and Stulz (2011) point out that, despite the credit supply shock, the crisis also reduced demand for goods and increased risk. Therefore, they explore the impact of the financial crisis on financial and investment policies. They believe that if the bank credit supply shock were the dominant shock, the more bank-dependent firms should have lower net debt issuance, a greater decrease in cash holdings, an increase in net equity issuance and a greater drop in capital expenditures than less bank-dependent firms. However, their results show that the credit supply shock cannot explain important features of the financial and investment policies of industrial firms. More specifically, the net equity issuance of small firms and unrated firms is abnormally low throughout the crisis. Moreover, firms that are more bank-dependent before the crisis tend to increase their cash holdings rather than use them to mitigate the impact of the increased risk associated with the credit supply shock and do not reduce their capital expenditures more than other firms during the crisis. The authors then show evidence which is strongly supportive of theories that emphasize the importance of collateral and corporate net worth in financing and investment policies, as firms with stronger balance sheets reduce capital expenditures less during the crisis.

4.2.3.3 Macroeconomic movements in Chinese market

Over the past several years, China has enjoyed one of the world's fastest growing economies and has been a major contributor to world economic growth. However, the recent global financial crisis threatens to significantly slow China's economy. Liu (2009) investigates how China is affected by the global economic slowdown by analysing business cycle co-movements through time between China and the USA, the

EU and Japan (G-3 economies). It appears that business movement in China is quite correlated with that in the USA in the 1980s, but it is not correlated with economic fluctuations in the EU and Japan. Interestingly, the correlation coefficients between China and the G-3 declined in the 1990s, suggesting that China was moving on its own path of economic growth independently from the G-3 economies. However, the correlation with the USA and Japan has become highly positive since the 2000s. In contrast, the correlation between China and the EU was still negative over the post-2000 period. The divergence between China and the EU was probably a result of the weak economic performance in the EU during this period. For the G-3 economies as a whole, the correlation coefficient was 0.23 in the 2000s, higher than the correlation coefficients in the 1980s and the 1990s. These simple business cycle synchronisation measures suggest that there is an increased degree of economic linkage between China and the G-3 economies.

When focusing on the 2007-2009 financial crisis, N'Diaye et al. (2010), using a structural macroeconomic model, estimate that a 1-percent slowdown in the G-3 economies is likely to cause more than 2-percent growth decline in emerging Asia markets. According to Morrison (2009), the value of Shanghai Stock Exchange Composite Index has decreased more than 67% from December 31, 2007, to December 31, 2008. China's trade and FDI have experienced a dramatically negative impact during the crisis. For example, China's exports and imports in February 2009 were down 25.7% and 24.1%, respectively on a year-on-year basis. The level of FDI flows to China has declined in each of the seven months (November 2008-April 2009) on a year-on-year basis as well. A high unemployment rate was recorded during the crisis, and 20 million migrant workers were estimated to lose their jobs in 2008 because of the global economic slowdown.

There seems to be a lack of research focusing on the real effect of the financial crisis on the firms' inventory investment decisions. Most of these studies concentrate on Chinese market are conducted based on small samples and focus only on the effects of financial constraints on fixed investment, with the exception of Guariglia et al. (2011) who study the effects of financial constraints on firms' asset growth in China. Study based on inventory investment is motivated by the fact that inventory investment plays an important role in the explanation of business cycle. Despite its small magnitude relative to total production, inventory investment typically accounts for a significant proportion of the reduction in GDP during recession. Since they can be converted into cash rapidly with a low adjustment cost, inventories are likely to be much more sensitive to financial variables when compared with fixed investment. Moreover, according to the data that we have collected so far, the inventory also place an important role in the Chinese market. It shows that inventories (defined as the sum of finished goods and work-in-process inventories) represent 20% of firms' total assets on average, and are about 22% of sales in terms of value. Therefore, it is crucial to have a better understanding of the inventory investment behaviour in China when firms confront different business environment.

4.2.3.4 Recessions and inventory investment

Sangalli (2013) seems to be the first study that explores how firms adjust their inventories during recessionary periods. Involving three large unbalanced panels of Italian manufacturing firms observed over the period 1991–2009, it is claimed a significant recessionary effect during the Nineties, accounting for inventories being more sensitive to financial frictions during the main recessionary peaks, 1993 and 1996. The result is not confirmed by the most recent estimates, especially the ones referring to the 2008–2009 recessionary shock. Firms are found to rely on inventory decumulation to a lesser extent compared to the past, to generate internal financing. More specifically, disinvestments in working capital are found to represent, as a matter of fact, one of the main drivers adopted to ease liquidity tensions: a negative and strongly significant relationship with inventory investment is detected, after controlling for short-run liquidity constraints at firm level. By contrast, only a weak negative relationship is established with fixed capital during the same recessionary period. Although this study only focuses on the link between inventory investments and financial constraint in the Italian market, it still sheds some lights on our research in this chapter.

4.2.4 Description of business cycle dummy and summary statistics

In our study, the business cycle dummy is established according to the difference between the real sales (S_{real}) and the expected sales' trend (S_{trend}). In other words, the business cycle dummy equals one (down regime) if the S_{real} in a specific industry is less than or equal to S_{trend} and equals zero (up regime) otherwise.

The Christiano and Fitzgerald (2003)'s band-pass filter is used in order to separate the cyclical components ($S_{cyclical}$) from the time series (S_{real}). The trend component (S_{trend}) is calculated by the difference: $S_{trend} = S_{real} - S_{cyclical}$. The finite-length CF band-pass filter places two important restrictions: First, it is restricted to be a linear filter. Second, the time series is assumed to be a random-walk process[5]. Although in finite samples, it is not possible to exactly satisfy the conditions that a filter must fulfil to perfectly separate out the specified stochastic cycles; the expansive filter literature reflects the

[5] This assumption is quoted from the Stata manual, however, according to Christinano and Fitzgerald (2003), it is imposed on the filtered (cyclical) component of the time series, rather than the raw time series. The raw time series should be a covariance-stationary process, possibly with non-zero mean and a deterministic trend, or it can contain a unit root.

trade-offs involved in choosing a finite-length filter to separate out the specified stochastic cycles. Burns and Mitchell (1946) define ‘oscillations in business data with recurring periods between 1.5 and 8 years to be business-cycle fluctuations’. And therefore, we use this commonly accepted definition.

Taking regional heterogeneity into consideration, aggregate, region-level and province-level business cycle dummies are generated for each industry. Figure 4.1 and Figure 4.2 describe the number of firms by region and province respectively. Accordingly, the number of firms that are located in the three regions is not equal. 71% of firms are located in the coastal past of China, which accounts for the majority of our dataset. Firms that are located in the central and western part of China only stand for 17% and 12% of the whole sample respectively. More specifically, Jiangsu province seems to have the largest number of enterprises followed by Zhejiang and Guangdong. Provinces that are located in the Western part of China tend to have few manufacture firms (Table 4.1 provides the description of region and province code).

Table 4.2 presents the summary statistics showing the frequencies of the three levels of business cycle dummy from 2000 to 2009. The province-level dummy has a smaller number of observations since we could not generate the expected sales’ trends for some industries due to the discontinuous data in certain provinces (e.g. Hainan and Tibet). According to the table, the proportion of the firms that fall into down regime peaks in 2005 and 2009, which means most of the Chinese manufacturers have experienced bad business environment during this two periods. This could be due to the impacts of Asia economic crisis started from 2003 and the recent global financial crisis which began at the end of 2007.

However, the distributions of the three dummy vary during the research period. More specifically, the aggregative dummy is the most concentrated one, and the province-level dummy seems to be the most scattered (see Figure 4.3). This could be due to the fact that the business environment shocks affect the firms' performance in different time across the country. Therefore, the province-level business cycle dummy is used in the following analysis in order to take this factor into consideration.

Figure 4.1 Number of firms by region

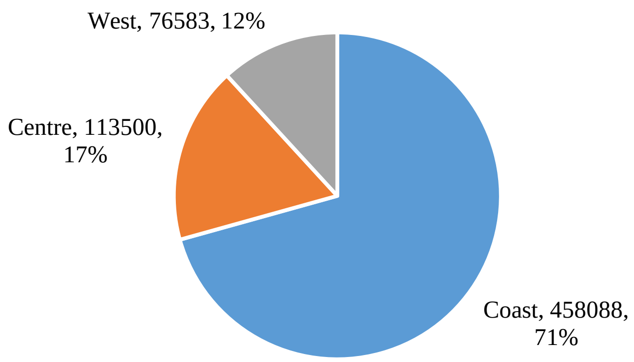


Figure 4.2 Number of firms by province

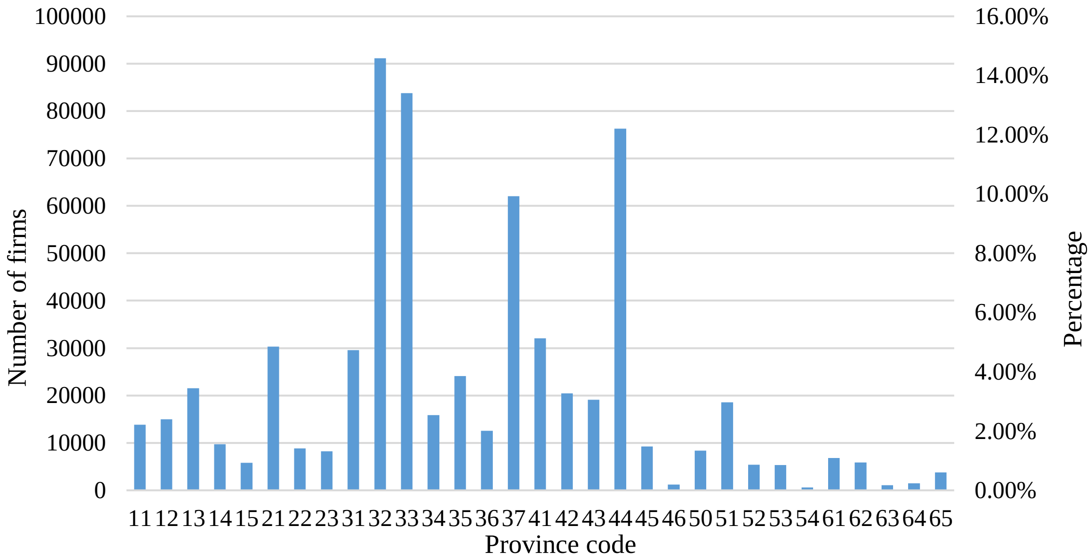


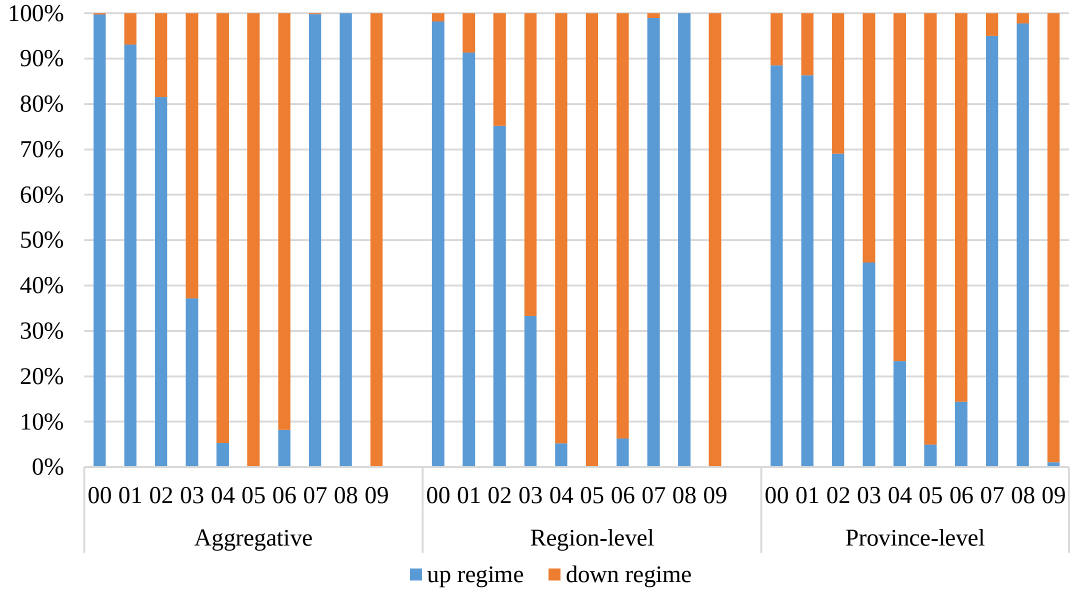
Table 4.1. Description of region and province codes

Coastal Region=1		Central Region=2		Western Region=3	
11	Beijing	14	Shanxi(a)	50	Chongqing
12	Tianjin	15	Inner Mongolia	51	Sichuan
13	Hebei	22	Jilin	52	Guizhou
21	Liaoning	23	Heilongjiang	53	Yunnan
31	Shanghai	34	Anhui	54	Tibet
32	Jiangsu	36	Jiangxi	61	Shanxi(b)
33	Zhejiang	41	Henan	62	Gansu
35	Fujian	42	Hubei	63	Qinghai
37	Shandong	43	Hunan	64	Ningxia
44	Guangdong			65	Xinjiang
45	Guangxi				
46	Hainan				

Table 4.2: Frequencies of the business cycle dummy

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Aggregative											
0	129,298	126,380	119,630	57,964	11,710	0	19,654	262,093	314,174	0	1,040,903
(up regime)	(99.76)	(93.12)	(81.54)	(37.19)	(5.28)	(0.00)	(8.22)	(99.81)	(100.00)	(0.00)	(53.30)
1	312	9,332	27,080	97,883	209,973	216,075	219,483	510	0	131,496	912,144
(down regime)	(0.24)	(6.88)	(18.46)	(62.81)	(94.72)	(100.00)	(91.78)	(0.19)	(0.00)	(100.00)	(46.70)
Total	129,610	135,712	146,710	155,847	221,683	216,075	239,137	262,603	314,174	131,496	1,953,047
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Region-level											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
0	127,206	123,968	110,301	51,925	11,544	471	15,113	259,874	314,174	0	1,014,576
(up regime)	(98.15)	(91.35)	(75.18)	(33.32)	(5.21)	(0.22)	(6.32)	(98.96)	(100.00)	(0.00)	(51.95)
1	2,404	11,744	36,409	103,922	210,139	215,604	224,024	2,729	0	131,496	938,471
(down regime)	(1.85)	(8.65)	(24.82)	(66.68)	(94.79)	(99.78)	(93.68)	(1.04)	(0.00)	(100.00)	(48.05)
Total	129,610	135,712	146,710	155,847	221,683	216,075	239,137	262,603	314,174	131,496	1,953,047
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Province-level											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
0	114,658	117,173	101,233	70,200	51,759	10,737	34,507	249,385	307,140	1,449	1,008,241
(up regime)	(88.51)	(86.35)	(69.01)	(45.06)	(23.35)	(4.97)	(14.43)	(94.97)	(97.77)	(1.10)	(54.19)
1	14,885	18,516	45,452	85,584	169,919	205,329	204,619	13,207	7,020	130,043	844,574
(down regime)	(11.49)	(13.65)	(30.99)	(54.94)	(76.65)	(95.03)	(85.57)	(5.03)	(2.23)	(98.90)	(45.81)
Total	129,543	135,689	146,685	155,784	221,678	216,066	239,126	262,592	314,160	131,492	1,952,815
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Figure 4.3 Frequencies of business cycle dummy



We then divided the whole sample into two subgroups. An observation is classified into the downswing (upswing) if its province-level business cycle dummy equals one (zero). Table 4.3 provides a general description of the two subgroups. It could be concluded that, comparing with the firms in the upswing, firms in the downswing tends to have a lower inventories to total assets ratio but a higher liquidity ratio. This is supported by the literature stating that firms tend to reduce their inventory level to finance internal funds.

Besides, firms with a higher percentage of state, collective sector and corporate ownership are more likely to be classified into the upswing. In contrast, a higher proportion of individual and foreign ownership may refer to a higher possibility to be in the downswing. A high political affiliation tends to help firms get rid of the downswing business cycle. But, surprisingly, the average age of firms in the downswing is younger than that of firms in the upswing.

Finally, firms in the downswing are more likely to be exporters and located in big cities. This could be due to the fact that exporters may experience international economic shocks frequently, and firms in big cities are more likely influenced by severe competitions.

Table 4.3: Descriptive statistics for two subgroups

Variables	Definition	Whole sample		upswing		downswing	
		Mean	SD	Mean	SD	Mean	SD
r_stocks/totass	Inventories to total assets ratio	0.174	0.230	0.171	0.156	0.168	0.309
p_capstate	Proportion of capital owned by the State	0.086	0.270	0.093	0.279	0.080	0.261
p_capcoll	Proportion of capital owned by collective firms	0.085	0.263	0.098	0.279	0.077	0.253
p_capcorporate	Proportion of capital owned by corporations/legal entities	0.212	0.382	0.228	0.392	0.191	0.367
p_capindividual	Proportion of capital owned by individuals	0.465	0.480	0.438	0.476	0.505	0.483
p_capforeign	Proportion of capital owned by foreigners	0.074	0.245	0.070	0.236	0.071	0.241
no_politics	No political affiliations	0.638	0.481	0.597	0.490	0.680	0.466
high_politics	High political affiliations with central or provincial governments	0.044	0.205	0.048	0.213	0.044	0.205
no_exporter	A dummy variable for non-exporters	0.745	0.436	0.754	0.431	0.740	0.438
lage	ln firm age (based on year-of-birth	2.157	0.874	2.180	0.880	2.147	0.872
lliquid	ln [1+ratio of (current assets-current liabilities-inventories) to total assets]	0.116	0.154	0.105	0.150	0.127	0.157
neg_liquid	Dummy =1 if ratio of (current assets-current liabilities- inventories) to total assets ≤ 0	0.459	0.498	0.508	0.500	0.407	0.491
city200	Dummy=1 for firms located in top 200 cities based on population size	0.870	0.336	0.865	0.341	0.874	0.331
N	Number of observations	2,290,530		1,008,241		844,574[6]	

[6] The numbers of firm-year observations in the upswing and downswing regions do not sum up to the number in the whole sample since we could not generate the expected sales' trends for some industries due to the discontinuous data in certain provinces (e.g. Hainan and Tibet).

4.3 Estimation results

Table 4.4(a), Table 4.4(b) and Table 4.4(c) present the results from the system GMM estimation of the asymmetric error-correction model, equation (4.4) and the business cycle dummy is employed as the transition variable. Firm-years are classified into down (up) regime when the value of the transition variable equals to one (zero). Panel A and B presents the short-run dynamics and the long-run equilibrium for samples in the upswing region, namely the short-run speed of adjustment towards the target inventory level and the long-run coefficients on the determinants of the target inventory level while panel C and D contains the deviations due to the impact of the bad business environment. Further, this table also contains the AR(2) and Hansen test statistics, which allow us to check the validity of the instruments used in the GMM regressions. It is worth noting that throughout the empirical analysis below, both tests are not rejected at the 5% significance level, suggesting that all GMM regressions use valid instruments.

Since we are mainly focusing on the asymmetric phenomenon of the target adjustment model in this chapter, the results in panel C and D becomes more important. Overall, it could be claimed that the deviations caused by the bad business environment vary among industries and across the target inventory level determinants.

In terms of the short-term dynamics, the partial adjustment mechanism is captured for most of the industries since the speeds of adjustment are significantly positive and lower than 1. When allowing for the asymmetric adjustment mechanism, it is found that the deviations of speed of adjustment are considerable: in panel C, they are estimated to be significantly positive for 18 out of 26 industries, which indicate a higher speed of adjustment during the economic slowdown. For example, the speed of adjustment for the food production industry is 0.507 in the upswing region, and it increases to 0.515 (0.507+0.008) in the year of recession, which means with annual data that 50.7% of the difference between actual inventory level and the target inventory level is eliminated in one year in upswing and the percentage rise to 51.5% in downswing. These results indicate that firms spend 1.972 years (23.664 months) to eliminate the gap in the upswing and 1.941 years (23.292 months) in the downswing, and so the difference is 0.372 months (about 11 days). Therefore, we can conclude that, during the recession, firms in these industries become more sensitive to the economic fluctuations and react quicker when they confront the demand shocks. This could be supported by numbers of studies suggesting that, with a low adjustment cost, inventories are likely to be quite sensitive to the business environment under imperfect capital markets (Sangalli, 2013, Guariglia, 2000, Guariglia and Mateut, 2006). While, for firms in tobacco, timber, other mining, petroleum processing, transport equipment and electronic power industries, which have a high adjustment cost, the deviations of speed of adjustment are proved to be significantly negative. For instance, the speed of adjustment for tobacco industry is 0.290 in the upswing region, and it decreases to 0.273 (0.290-0.017) in the year of recession, which means with annual data that 29.0% [27.3%] of the difference between actual inventory level and the target inventory level is eliminated in one year in upswing [downswing]. Firms spend 3.448 years (41.376 months) to eliminate the gap in the upswing and 3.663 years (43.956 months) in the downswing, therefore firms in tobacco industry will spend 2.58 months (about 79 days) more to cover the distance to the long-term level during recession.

Taking into account the impact of the volatility of demand on inventory investment enhances the estimated value of the speed parameter of adjusting inventories. More specifically, we find that the impact of demand uncertainty, which is measured by the volatility of sales[7], on inventory investment is positive, suggesting that firms are very cautious about unknown demand conditions in making inventory decisions. A change of claasification from upswing to downswing will lead to an increase on the speed of adjustment. However, part of the inventories are accumulated simply to avoid possible stockout when demand is unexpectedly high. This result implies that Chinese manufacturing firms are more stockout avoidance motivated. The evidence found in

[7] When sales declined, the real sales (S_{real}) would be lower than expected sales (S_{trend}) and the observation will be classified into the downswing.

this paper helps to explain why inventory investment is so procyclical and persistent in business cycles.

In terms of long-run results, the elasticity of inventory level to sales is positive and significant for the entire sample and the industrial heterogeneity is obvious. The business cycle dummy affects the inventory-sales relationship in two different directions. In panel D, the positive coefficient on sales for tobacco, textile, chemical, plastic and other manufacturing industries indicates that the same amount of growth in sales would make the firms produce more during recessions and firms in these industries seems to be more optimistic when compared to their counterparts. For instance, the coefficient on sales is 0.341 in the upswing region, and the deviation due to the business cycle downwards is 0.141. In other words, for 1% of sales growth, the textile manufacturer usually increase 0.341% of inventory in good time. However, during recessions, this amount increase to 0.482 (0.341+0.141) percent. Contrary, during recession, the coefficient on sales falls for industries like other mining, culture, rubber, metal products, machinery and equipment and measuring instrument. The impact of business environment downwards is most obvious for firms in metal products industry. It shows that 1% of sales growth in this industry makes firms produce 0.618% less during recessions.

For the ownership structure, we could rarely find evidence to support the asymmetric impact of foreign ownership on inventories between the upswing and the downswing. Apart from this, the links between other ownerships and inventories are more likely to be significant in the down regime. Reminded that the capital owned by Hong Kong/Macao and Taiwan is set to be the benchmark, the asymmetric impact between the two regimes is proved to be more obvious for domestic or mainland owned firms.

By setting firms with middle level of political affiliation as benchmark, we find that firms with higher level of political affiliation usually have a higher level of inventories. This could be explained by the facts that firms which are closely related to the government are more likely to be financially unconstrained, and the exposure in market competition helps firms with no political affiliation improve efficiency. Including the business cycle dummy in our model do not change the coefficients of high and no political affiliation a lot. Although the impacts are limited, we can still suggest that, for the furniture industry, firms with no political affiliation increase their inventory levels significantly, but firms that are closely linked to the government keep fewer inventories during bad times. These results indicate that the negative influences of recession can offset the benefits of financial unconstraint and high productivity.

Generally speaking, a worse macroeconomic environment makes the reversed U-shaped inventory-liquidity relation becomes more obvious for some industries. It is said that during recessions, a negative liquidity is associated with lower level of inventory when compared to the whole sample period. This finding is consistent with the literature which claims that financially constraint firms are more likely to reduce their inventory investment especially during the recession period (Sangalli, 2013). However, the Chinese data shows that this result is not commonly supported by all industries. Another thing that is worth to be mentioned is that, for textile and furniture industries, the advantages in inventory reducing, which is enjoyed by firms with rich liquidity, disappears during a downward business cycle. Furthermore, the bad external environment does not make much difference on the R&D-inventory relationship (most deviations are not significant). As an alternative financial factor, the R&D dummy seems to affect the inventory level in similar paths in the two regimes.

As shown in the symmetric analysis, the rise of selling and distribution costs tends to motivate firms to purchase more inventories. However, this impact weakens during bad times for six industries. In contrast, one percent increase in managerial fixed cost relates to 9.4% rise in inventory level for firms in coal mining industry on average and this figure would reach to 14.2% in the down regime. It is indicated that the coefficient on city200 dummy stays consistent for most of the industries during good time and bad time. However, when focusing on the Tobacco industry, locating in a big city would make firms accumulate more inventories (around 70%) than others but during the recession, this value declines to 43%. The water production industry tends to be another exception, and the demand shock will make the impact of city200 increases significantly.

According to Ding et al. (2014), younger firms tend to perform their business in a more efficient way and enjoy the advanced technology than older firms, which means they have a shorter production cycle and a lower level of inventory holdings. However, other studies claim that firms would decline their inventories when they become more experienced and are familiar with the market during operation. For furniture and water production industries, the impact of firm age on inventory level becomes significant in the down regime. The advanced technology could make the production becomes more flexible and, therefore, the younger firms have the ability to adjust their inventory holdings immediately when the business environment change. However, for industries like textile, chemical, other manufacturing and machinery and equipment, the benefits that younger firm enjoys are not obvious according to the results.

The time trend variable is used to measure technical improvement and the impact of business cycle on time trend-inventory relation is interesting to be discussed. For industries such as tobacco, printing, non-metal products, machinery and equipment and measuring instrument, the economic recession would strengthen the inventory reducing impact caused by technical development. However, for petroleum processing, metal products, other manufacturing and gas production industry, this impact is offset to some extents.

Table 4.4a: System GMM estimation of the asymmetric threshold model, China 2000-2009 (i)

Dependent Variable: *lr_stocks*	Other Mining sic10	Food Production sic14	Tobacco sic16	Textile sic17	Apparel & Footwear sic18	Leather sic19	Timber sic20	Furniture sic21	Paper-making sic22
Panel A: Short-run dynamics									
Speed of Adjustment	0.456***	0.507***	0.290***	0.352***	0.523***	0.642***	0.439***	0.400***	0.386***
	(0.031)	(0.031)	(0.102)	(0.025)	(0.023)	(0.103)	(0.032)	(0.042)	(0.024)
Panel B: Long-run equilibrium									
lr_sales	0.519***	0.819***	1.177***	0.341***	1.137***	0.254***	0.750***	0.551***	0.468***
	(0.081)	(0.146)	(0.324)	(0.114)	(0.192)	(0.066)	(0.269)	(0.109)	(0.079)
p_capstate	-0.140	-0.116	-0.526	-0.450***	0.074	-0.692**	-0.531**	-0.931**	-0.447**
	(0.310)	(0.259)	(2.373)	(0.107)	(0.266)	(0.276)	(0.233)	(0.412)	(0.183)
p_capcoll	-0.571*	-0.236*	-0.843	-0.621***	-0.307***	-0.957***	-1.029***	-1.081***	-0.704***
	(0.302)	(0.143)	(2.317)	(0.100)	(0.112)	(0.113)	(0.195)	(0.256)	(0.147)
p_capcorporate	-0.351	-0.218**	-0.873	-0.480***	-0.332***	-0.740***	-0.714***	-0.686***	-0.474***
	(0.294)	(0.099)	(2.425)	(0.067)	(0.067)	(0.078)	(0.121)	(0.125)	(0.121)
p_capindividual	-0.408	-0.151	0.003	-0.496***	-0.367***	-0.863***	-0.781***	-0.822***	-0.502***
	(0.290)	(0.114)	(2.359)	(0.071)	(0.072)	(0.068)	(0.131)	(0.113)	(0.120)
p_capforeign	-0.022	0.003	-3.211	0.037	-0.101*	-0.094	-0.073	-0.132	0.243*
	(0.367)	(0.086)	(3.105)	(0.081)	(0.057)	(0.072)	(0.137)	(0.126)	(0.140)
no_politics	0.031	-0.036	-0.481	-0.218***	0.097**	-0.033	-0.039	-0.067	-0.063
	(0.080)	(0.050)	(0.588)	(0.043)	(0.046)	(0.054)	(0.073)	(0.112)	(0.062)
high_politics	0.789***	0.080	-0.758	0.263***	0.296**	0.480*	0.424	0.181	0.478***

	(0.137)	(0.114)	(0.656)	(0.102)	(0.137)	(0.253)	(0.295)	(0.345)	(0.166)
no_exporter	-0.778***	-0.434***	-0.165	-0.348***	0.090*	-0.260***	-0.303***	-0.534***	-0.363***
	(0.105)	(0.078)	(0.422)	(0.055)	(0.048)	(0.041)	(0.081)	(0.092)	(0.082)
lage	0.043	0.095***	-0.258	0.189***	0.143***	0.361***	0.037	0.051	0.052
	(0.044)	(0.036)	(0.366)	(0.034)	(0.033)	(0.047)	(0.049)	(0.098)	(0.037)
lliquid	0.710***	0.035	-2.152*	-1.111***	-0.300*	-0.753***	0.381	-0.277	0.193
	(0.253)	(0.218)	(1.300)	(0.181)	(0.180)	(0.161)	(0.272)	(0.330)	(0.268)
neg_liquid	0.028	0.012	-0.311	-0.114***	-0.109**	-0.149***	0.120	-0.048	0.136*
	(0.079)	(0.059)	(0.325)	(0.043)	(0.048)	(0.048)	(0.074)	(0.102)	(0.069)
lfc	0.116***	0.207***	0.372*	0.139***	0.204***	0.081***	0.158***	0.234***	0.130***
	(0.034)	(0.028)	(0.206)	(0.025)	(0.027)	(0.029)	(0.038)	(0.051)	(0.035)
rd_dum	0.439***	0.127	0.921*	0.488***	-0.065	0.402***	0.225	0.224*	0.429***
	(0.120)	(0.127)	(0.527)	(0.103)	(0.152)	(0.076)	(0.259)	(0.122)	(0.111)
city200	-0.285***	-0.099	0.728*	0.080	0.174**	-0.135	-0.091	-0.499**	-0.047
	(0.067)	(0.071)	(0.402)	(0.058)	(0.071)	(0.097)	(0.083)	(0.207)	(0.079)
t_trend	0.008	-0.050*	0.037	-0.028**	-0.030**	-0.004	-0.030	-0.034	-0.011
	(0.018)	(0.026)	(0.061)	(0.011)	(0.015)	(0.010)	(0.038)	(0.024)	(0.015)
Effects of the business cycle dummy variable:									
Panel C: Short-run dynamics									
Speed of Adjustment'	-0.005***	0.008***	-0.017***	0.006***	0.001	0.005***	-0.002***	0.000	0.003***
	(0.005)	(0.004)	(0.027)	(0.002)	(0.013)	(0.004)	(0.005)	(0.025)	(0.003)
Panel D: Long-run equilibrium									
lr_sales'	-0.097**	-0.177	0.195**	0.141**	-0.227	0.014	-0.118	-0.050	0.021
	(0.039)	(0.144)	(0.085)	(0.064)	(0.245)	(0.035)	(0.263)	(0.049)	(0.044)
p_capstate'	-0.081	-0.245	1.231	0.121**	-0.318	0.021	-0.024	0.726***	0.105
	(0.173)	(0.235)	(0.761)	(0.050)	(0.275)	(0.173)	(0.149)	(0.206)	(0.079)

p_capcoll’	-0.006	-0.054	1.407*	0.072	-0.090	0.096	0.128	0.300**	0.014
	(0.175)	(0.098)	(0.788)	(0.045)	(0.109)	(0.086)	(0.107)	(0.124)	(0.064)
p_capcorporate’	-0.059	0.003	1.465*	0.056*	-0.008	0.098	0.144**	0.110	0.021
	(0.168)	(0.070)	(0.774)	(0.030)	(0.068)	(0.066)	(0.063)	(0.069)	(0.054)
p_capindividual’	-0.014	-0.037	1.396	0.040	-0.022	0.032	0.086	0.075	-0.030
	(0.164)	(0.089)	(0.867)	(0.032)	(0.079)	(0.047)	(0.080)	(0.057)	(0.052)
p_capforeign’	0.267	0.040	-1.039	-0.040	-0.041	0.034	0.119	0.113*	-0.056
	(0.211)	(0.048)	(2.819)	(0.034)	(0.042)	(0.052)	(0.073)	(0.065)	(0.061)
no_politics’	0.022	-0.033	-0.278	0.051***	-0.052	0.053	-0.057	0.116**	-0.001
	(0.052)	(0.033)	(0.241)	(0.018)	(0.034)	(0.039)	(0.046)	(0.055)	(0.028)
high_politics’	0.062	-0.069	-0.148	-0.021	-0.127	0.063	-0.009	-0.339**	-0.092
	(0.073)	(0.064)	(0.193)	(0.039)	(0.097)	(0.120)	(0.169)	(0.152)	(0.065)
no_exporter’	0.028	-0.074	0.088	0.020	-0.041	0.019	-0.035	0.058	0.021
	(0.061)	(0.061)	(0.139)	(0.029)	(0.048)	(0.032)	(0.051)	(0.045)	(0.037)
Lage’	0.020	-0.023	-0.036	-0.032***	0.005	0.035	-0.009	0.074*	0.006
	(0.026)	(0.025)	(0.097)	(0.012)	(0.018)	(0.024)	(0.025)	(0.044)	(0.016)
Lliquid’	-0.189	-0.178	-0.573	0.151*	-0.183	-0.038	-0.013	0.363**	-0.176
	(0.169)	(0.159)	(0.489)	(0.082)	(0.191)	(0.139)	(0.188)	(0.177)	(0.118)
neg_liquid’	-0.091*	-0.082	-0.126	0.005	-0.064	-0.069*	-0.019	-0.024	-0.085***
	(0.052)	(0.051)	(0.146)	(0.019)	(0.062)	(0.040)	(0.049)	(0.052)	(0.030)
lfc’	-0.026	-0.004	0.012	-0.020**	0.037	0.004	0.004	-0.002	0.008
	(0.019)	(0.018)	(0.063)	(0.010)	(0.024)	(0.021)	(0.020)	(0.022)	(0.016)
rd_dum’	0.102	0.131	-0.535**	-0.068	0.173	-0.048	0.109	0.050	0.034
	(0.076)	(0.116)	(0.207)	(0.054)	(0.152)	(0.054)	(0.186)	(0.065)	(0.053)
city200’	0.002	0.055	-0.297**	-0.031	0.057	0.086	0.024	0.006	0.016
	(0.042)	(0.054)	(0.118)	(0.026)	(0.048)	(0.064)	(0.048)	(0.062)	(0.036)

t_trend'	-0.004	-0.005	-0.072**	-0.002	-0.010	-0.006	0.005	0.010	-0.008
	(0.011)	(0.019)	(0.028)	(0.004)	(0.013)	(0.007)	(0.025)	(0.010)	(0.007)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,860	21,950	1,019	89,546	45,433	23,968	18,952	11,612	31,309
Number of firm	6,547	7,225	289	28,175	14,864	7,609	7,205	3,927	9,226
AR(1)	-20.09	-18.75	-3.101	-40.56	-28.34	-2.289	-19.16	-15.25	-25.44
P(ar1)	0	0	0.00193	0	0	0.0221	0	0	0
AR(2)	-1.190	-0.798	1.038	-1.238	0.643	0.807	0.104	1.315	0.662
P(ar2)	0.234	0.425	0.299	0.194	0.520	0.420	0.917	0.189	0.508
Hansen test	10.30	8.619	4.843	22.07	10.21	5.086	17.11	3.670	13.07
P(Hansen)	0.244	0.196	0.564	0.0613	0.263	0.533	0.0720	0.721	0.0419

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 4.4b: System GMM estimation of the asymmetric threshold model, China 2000-2009 (ii)

Dependent Variable: *lr_stocks*	Printing sic23	Culture sic24	Petroleum Processing sic25	Chemical sic26	Medical sic27	Rubber sic29	Plastic sic30	Non-metal Products sic31	Metal Products sic34
Panel A: Short-run dynamics									
Speed of Adjustment	0.388***	0.501***	0.490***	0.552***	0.312***	0.408***	0.337***	0.121	0.343**
	(0.034)	(0.086)	(0.058)	(0.029)	(0.063)	(0.038)	(0.030)	(0.083)	(0.140)
Panel B: Long-run equilibrium									
lr_sales	0.035	0.474***	0.850***	0.565***	0.539***	0.714***	0.420***	0.134	1.693***
	(0.444)	(0.105)	(0.202)	(0.147)	(0.155)	(0.124)	(0.087)	(0.601)	(0.562)
p_capstate	-1.844**	-0.201	0.123	-0.446***	-0.406***	-0.340	-0.325**	-0.304	0.010
	(0.724)	(0.240)	(0.403)	(0.098)	(0.154)	(0.210)	(0.148)	(0.472)	(0.252)
p_capcoll	-1.177***	-0.750***	-0.237	-0.845***	-0.405***	-0.649***	-0.772***	-0.332	-0.215
	(0.388)	(0.183)	(0.483)	(0.105)	(0.144)	(0.179)	(0.118)	(0.411)	(0.360)
p_capcorporate	-1.158***	-0.551***	-0.065	-0.611***	-0.265**	-0.636***	-0.562***	-0.192	-0.437***
	(0.347)	(0.114)	(0.413)	(0.058)	(0.116)	(0.147)	(0.089)	(0.353)	(0.167)
p_capindividual	-1.240***	-0.630***	0.175	-0.727***	-0.298**	-0.574***	-0.684***	-0.245	-0.307
	(0.376)	(0.111)	(0.432)	(0.080)	(0.120)	(0.148)	(0.085)	(0.368)	(0.268)
p_capforeign	-0.001	-0.063	0.597	-0.006	0.130	0.072	0.045	0.358	-0.239
	(0.188)	(0.093)	(0.510)	(0.070)	(0.138)	(0.138)	(0.077)	(0.400)	(0.163)
no_politics	0.042	-0.124	-0.087	-0.151***	-0.032	-0.087	-0.107**	0.031	0.073
	(0.078)	(0.079)	(0.096)	(0.041)	(0.060)	(0.078)	(0.052)	(0.171)	(0.124)
high_politics	0.769**	-0.111	0.211	0.256**	0.083	0.143	0.318***	0.976	-0.245
	(0.358)	(0.190)	(0.431)	(0.101)	(0.088)	(0.154)	(0.113)	(0.630)	(0.376)
no_exporter	-0.759***	-0.216***	-0.334	-0.519***	-0.306***	-0.431***	-0.431***	-0.612**	0.169

	(0.236)	(0.075)	(0.285)	(0.106)	(0.114)	(0.089)	(0.061)	(0.307)	(0.301)
lage	0.116**	0.157**	0.063	0.139***	0.149***	0.193***	-0.050	-0.155	0.114**
	(0.056)	(0.068)	(0.060)	(0.025)	(0.056)	(0.054)	(0.045)	(0.197)	(0.053)
lliquid	-1.279**	-0.525**	-0.298	-0.610***	0.094	-0.131	-0.646***	0.997	0.109
	(0.517)	(0.242)	(0.459)	(0.181)	(0.278)	(0.307)	(0.216)	(1.066)	(0.589)
neg_liquid	-0.253*	-0.165**	-0.039	-0.093***	-0.031	-0.013	-0.261***	-0.076	0.021
	(0.132)	(0.069)	(0.106)	(0.031)	(0.082)	(0.088)	(0.064)	(0.227)	(0.080)
lfc	0.178***	0.231***	0.221***	0.149***	0.177***	0.233***	0.254***	0.280**	0.368**
	(0.041)	(0.053)	(0.065)	(0.028)	(0.025)	(0.047)	(0.034)	(0.119)	(0.176)
rd_dum	1.161**	0.298***	0.172	0.500***	0.397***	0.362***	0.459***	0.888	-0.523
	(0.520)	(0.095)	(0.282)	(0.120)	(0.087)	(0.097)	(0.088)	(0.607)	(0.573)
city200	0.316	0.038	-0.099	0.048	-0.079	0.051	-0.222**	0.062	0.088
	(0.228)	(0.108)	(0.103)	(0.037)	(0.081)	(0.134)	(0.089)	(0.160)	(0.109)
t_trend	0.108	-0.000	-0.107***	-0.044***	-0.025	-0.106***	-0.018	-0.011	-0.225**
	(0.077)	(0.015)	(0.032)	(0.017)	(0.022)	(0.019)	(0.012)	(0.107)	(0.109)
Effects of the business cycle dummy variable:									
Panel C: Short-run dynamics									
Speed of	0.005***	0.015***	-0.006***	0.010***	0.007***	0.002***	0.002***	0.013***	0.020***
Adjustment’	(0.005)	(0.004)	(0.012)	(0.005)	(0.005)	(0.006)	(0.003)	(0.009)	(0.016)
Panel D: Long-run equilibrium									
lr_sales’	0.367	-0.065**	-0.136	0.509*	-0.027	-0.084**	0.066*	0.155	-0.618*
	(0.258)	(0.032)	(0.192)	(0.283)	(0.073)	(0.042)	(0.038)	(0.120)	(0.347)
p_capstate’	0.599	-0.130	-0.173	0.322*	0.090	-0.189*	0.050	0.062	-0.249
	(0.468)	(0.152)	(0.238)	(0.170)	(0.074)	(0.103)	(0.071)	(0.103)	(0.165)
p_capcoll’	0.267	0.002	-0.119	0.320**	0.057	-0.032	0.125**	0.018	-0.365
	(0.239)	(0.095)	(0.351)	(0.162)	(0.061)	(0.093)	(0.050)	(0.070)	(0.224)

p_capcorporate’	0.319	-0.093	-0.188	0.181**	0.090*	-0.022	0.080**	-0.012	-0.133
	(0.208)	(0.060)	(0.279)	(0.087)	(0.050)	(0.076)	(0.039)	(0.046)	(0.115)
p_capindividual’	0.268	-0.115**	-0.329	0.258*	0.115**	0.001	0.078**	0.035	-0.261
	(0.235)	(0.050)	(0.319)	(0.133)	(0.052)	(0.072)	(0.034)	(0.058)	(0.167)
p_capforeign’	-0.120	-0.030	-0.069	-0.089	0.042	0.078	0.014	-0.028	0.140*
	(0.081)	(0.053)	(0.255)	(0.096)	(0.060)	(0.069)	(0.034)	(0.051)	(0.074)
no_politics’	-0.005	0.073*	0.055	0.072	-0.000	-0.066*	0.044*	-0.004	-0.058
	(0.041)	(0.043)	(0.063)	(0.045)	(0.025)	(0.039)	(0.023)	(0.021)	(0.041)
high_politics’	-0.296	-0.228	0.252	-0.248	-0.010	0.037	0.004	-0.164**	0.495*
	(0.208)	(0.143)	(0.394)	(0.165)	(0.037)	(0.080)	(0.049)	(0.083)	(0.270)
no_exporter’	0.193	0.020	-0.074	0.355**	0.001	0.008	0.036	0.068**	-0.332
	(0.124)	(0.043)	(0.233)	(0.171)	(0.059)	(0.043)	(0.028)	(0.032)	(0.208)
Lage’	0.010	0.032	0.055	-0.058*	-0.015	0.015	0.013	0.010	-0.078
	(0.026)	(0.030)	(0.035)	(0.035)	(0.016)	(0.023)	(0.015)	(0.011)	(0.049)
Lliquid’	0.426	-0.153	-0.147	0.667**	-0.000	-0.007	0.101	0.171	-0.547
	(0.320)	(0.144)	(0.365)	(0.283)	(0.110)	(0.151)	(0.087)	(0.120)	(0.362)
neg_liquid’	0.121	-0.008	-0.076	0.085**	-0.039	-0.024	0.038	-0.021	-0.151**
	(0.086)	(0.046)	(0.065)	(0.038)	(0.041)	(0.044)	(0.026)	(0.032)	(0.077)
lfc’	-0.029	-0.061**	-0.092*	0.065	0.007	-0.023	-0.008	0.004	-0.172*
	(0.022)	(0.024)	(0.053)	(0.043)	(0.011)	(0.022)	(0.013)	(0.009)	(0.091)
rd_dum’	-0.474	0.112**	0.125	-0.333*	-0.033	0.070	-0.011	-0.148**	0.589*
	(0.297)	(0.049)	(0.255)	(0.191)	(0.050)	(0.049)	(0.041)	(0.071)	(0.329)
city200’	-0.153	0.088	0.024	-0.051	0.024	0.030	0.067	-0.002	-0.082
	(0.133)	(0.060)	(0.071)	(0.033)	(0.032)	(0.063)	(0.043)	(0.035)	(0.052)
t_trend’	-0.068*	-0.009	0.057***	-0.026	-0.004	0.013	0.001	-0.027*	0.071**
	(0.039)	(0.008)	(0.020)	(0.024)	(0.010)	(0.009)	(0.005)	(0.015)	(0.028)

Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,503	12,393	6,936	80,370	21,714	11,537	39,503	90,496	54,683
Number of firm	5,903	3,867	2,349	24,741	6,060	3,690	13,447	27,603	20,859
AR(1)	-16.90	-3.125	-11.37	-36.64	-20.38	-15.21	-27.03	-2.766	-8.897
P(ar1)	0	0.00178	0	0	0	0	0	0.00568	0
AR(2)	-1.625	-0.855	1.623	-1.439	-1.843	-1.303	-2.038	0.848	-1.535
P(ar2)	0.104	0.392	0.105	0.150	0.0747	0.193	0.0415	0.396	0.125
Hansen test	8.956	13.57	9.470	3.250	9.276	6.846	12.89	7.500	0.307
P(Hansen)	0.346	0.194	0.0504	0.517	0.0667	0.144	0.0426	0.277	0.857

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 4.4c: System GMM estimation of the asymmetric threshold model, China 2000-2009 (iii)

Dependent Variable: *lr_stocks*	Machinery & Equipment sic35	Transport Equipment sic37	Measuring Instrument sic41	Other Manufacturing sic43	Electronic Power sic44	Gas Production sic45	Water Production sic46	Coal Mining sic60
Panel A: Short-run dynamics								
Speed of Adjustment	0.264***	0.518***	0.428***	0.404***	0.516***	0.488***	0.423***	0.592***
	(0.017)	(0.108)	(0.033)	(0.026)	(0.049)	(0.087)	(0.042)	(0.038)
Panel B: Long-run equilibrium								
lr_sales	0.733***	0.950***	0.874***	0.574***	0.974***	1.077***	0.841***	0.651***
	(0.085)	(0.185)	(0.093)	(0.063)	(0.223)	(0.358)	(0.171)	(0.149)
p_capstate	-0.043	-0.050	0.069	-0.309**	-0.960*	0.654	1.261**	0.004
	(0.110)	(0.157)	(0.139)	(0.133)	(0.529)	(0.405)	(0.568)	(0.747)
p_capcoll	-0.581***	-0.458***	-0.329**	-0.545***	-0.860	0.044	1.263**	-0.596
	(0.095)	(0.087)	(0.154)	(0.139)	(0.577)	(0.613)	(0.570)	(0.749)
p_capcorporate	-0.513***	-0.415***	-0.269***	-0.583***	-0.822**	0.712*	1.288**	-0.497
	(0.073)	(0.071)	(0.094)	(0.090)	(0.402)	(0.386)	(0.546)	(0.725)
p_capindividual	-0.524***	-0.548***	-0.457***	-0.611***	-0.771	0.892	0.662	-0.450
	(0.075)	(0.073)	(0.096)	(0.085)	(0.529)	(0.588)	(0.555)	(0.731)
p_capforeign	0.076	-0.024	-0.130	0.024	-0.221	0.101	0.217	1.448*
	(0.075)	(0.149)	(0.100)	(0.093)	(0.291)	(0.404)	(0.980)	(0.841)
no_politics	-0.085**	-0.108***	-0.021	0.020	0.076	-0.168	0.174	0.084
	(0.037)	(0.033)	(0.058)	(0.058)	(0.090)	(0.226)	(0.192)	(0.071)
high_politics	0.373***	0.229**	0.060	0.588***	-0.122	-0.269	-0.638	0.938***
	(0.062)	(0.117)	(0.104)	(0.117)	(0.320)	(0.521)	(0.388)	(0.274)
no_exporter	-0.255***	-0.163	-0.093	-0.119**	-0.415	-0.327	0.685	0.150

	(0.049)	(0.140)	(0.067)	(0.051)	(0.581)	(0.756)	(1.025)	(0.157)
lage	0.089***	0.180***	0.163***	0.359***	-0.321***	-0.072	-0.110	0.099***
	(0.028)	(0.033)	(0.040)	(0.044)	(0.062)	(0.195)	(0.113)	(0.036)
lliquid	-0.104	-0.175	-0.506**	-0.266	0.221	-2.791***	1.393**	0.117
	(0.151)	(0.203)	(0.200)	(0.200)	(0.416)	(0.969)	(0.557)	(0.334)
neg_liquid	-0.044	0.006	-0.137**	-0.120*	0.120	-0.384*	0.232**	0.000
	(0.042)	(0.050)	(0.065)	(0.064)	(0.083)	(0.231)	(0.112)	(0.082)
lfc	0.352***	0.207***	0.300***	0.305***	0.074	0.238***	0.092**	0.094***
	(0.023)	(0.028)	(0.034)	(0.038)	(0.048)	(0.088)	(0.036)	(0.033)
rd_dum	0.474***	0.202	0.203***	0.563***	-0.315	-0.624	0.255	0.744***
	(0.061)	(0.219)	(0.077)	(0.066)	(0.297)	(0.379)	(0.288)	(0.167)
city200	0.121**	0.005	0.146	0.026	0.038	0.134	-0.084	-0.048
	(0.051)	(0.054)	(0.120)	(0.086)	(0.123)	(0.310)	(0.144)	(0.059)
t_trend	-0.029**	-0.054*	-0.021*	-0.052***	-0.029	-0.182**	-0.013	-0.073***
	(0.013)	(0.028)	(0.011)	(0.010)	(0.032)	(0.071)	(0.029)	(0.022)
Effects of the business cycle dummy variable:								
Panel C: Short-run dynamics								
Speed of	0.003***	-0.005***	0.009***	0.005***	-0.009***	0.019***	0.008***	0.005***
Adjustment’	(0.002)	(0.012)	(0.005)	(0.003)	(0.007)	(0.020)	(0.005)	(0.007)
Panel D: Long-run equilibrium								
lr_sales’	-0.072***	0.061	-0.071**	0.075**	0.081	-0.024	-0.061	-0.081
	(0.028)	(0.284)	(0.029)	(0.032)	(0.209)	(0.102)	(0.058)	(0.170)
p_capstate’	-0.059	-0.031	0.076	-0.351***	0.176	-0.187	-0.138	0.020
	(0.038)	(0.240)	(0.083)	(0.103)	(0.473)	(0.199)	(0.258)	(0.658)
p_capcoll’	-0.014	-0.038	0.100	-0.061	0.363	0.225	-0.197	0.109
	(0.031)	(0.093)	(0.102)	(0.077)	(0.519)	(0.348)	(0.265)	(0.669)

p_capcorporate’	0.019	-0.017	0.086	-0.087	0.116	-0.374*	-0.097	0.257
	(0.024)	(0.044)	(0.063)	(0.061)	(0.343)	(0.197)	(0.251)	(0.628)
p_capindividual’	-0.020	-0.019	0.010	-0.037	0.233	-0.475*	-0.013	0.104
	(0.023)	(0.078)	(0.056)	(0.051)	(0.475)	(0.247)	(0.253)	(0.638)
p_capforeign’	0.031	-0.072	0.036	-0.101*	0.108	0.075	0.204	-0.208
	(0.026)	(0.168)	(0.056)	(0.059)	(0.189)	(0.247)	(0.413)	(0.598)
no_politics’	0.014	0.048**	0.033	-0.099**	-0.019	0.037	-0.106	-0.114**
	(0.013)	(0.022)	(0.038)	(0.040)	(0.055)	(0.141)	(0.090)	(0.057)
high_politics’	-0.014	-0.046	0.059	-0.360***	-0.152	-0.082	0.116	0.036
	(0.023)	(0.170)	(0.062)	(0.113)	(0.311)	(0.253)	(0.188)	(0.296)
no_exporter’	-0.020	0.051	-0.066*	0.023	0.181	0.254	-0.286	-0.656***
	(0.018)	(0.198)	(0.035)	(0.029)	(0.341)	(0.349)	(0.394)	(0.205)
Lage’	-0.015**	-0.018	-0.015	-0.131***	0.006	0.038	0.090**	0.009
	(0.007)	(0.028)	(0.024)	(0.040)	(0.043)	(0.091)	(0.044)	(0.027)
Lliquid’	-0.126***	-0.191	-0.146	-0.063	-0.201	0.749	-0.457*	0.160
	(0.049)	(0.222)	(0.128)	(0.110)	(0.261)	(0.551)	(0.268)	(0.236)
neg_liquid’	-0.044***	-0.040	-0.085*	-0.006	0.026	0.059	-0.096*	0.009
	(0.014)	(0.056)	(0.045)	(0.038)	(0.052)	(0.142)	(0.056)	(0.067)
lfc’	-0.013**	-0.010	-0.009	-0.047***	-0.018	-0.004	-0.002	0.048*
	(0.006)	(0.028)	(0.019)	(0.016)	(0.036)	(0.046)	(0.017)	(0.026)
rd_dum’	0.020	-0.056	0.039	-0.042	-0.051	0.260	-0.111	-0.262
	(0.023)	(0.307)	(0.039)	(0.040)	(0.279)	(0.184)	(0.162)	(0.172)
city200’	0.007	0.029	0.004	0.031	-0.035	-0.047	0.108*	0.008
	(0.020)	(0.056)	(0.080)	(0.046)	(0.102)	(0.133)	(0.064)	(0.046)
t_trend’	-0.013***	-0.015	-0.012*	0.023***	-0.027	0.043*	0.010	0.004
	(0.004)	(0.031)	(0.007)	(0.008)	(0.028)	(0.025)	(0.012)	(0.020)

Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	148,039	44,393	14,754	25,924	15,860	1,864	9,062	16,248
Number of firm	49,026	13,999	6,556	9,354	4,473	535	2,293	5,521
AR(1)	-49.39	-18.75	-12.63	-20.88	-15.55	-6.539	-15.29	-19.54
P(ar1)	0	0	0	0	0	6.17e-11	0	0
AR(2)	-2.032	1.015	-0.0689	-1.735	-1.366	-1.391	-0.890	-1.637
P(ar2)	0.0496	0.310	0.945	0.0827	0.172	0.164	0.373	0.102
Hansen test	19.84	1.917	5.006	4.735	9.387	2.488	2.022	9.637
P(Hansen)	0.0208	0.384	0.287	0.786	0.153	0.647	0.732	0.131

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

4.4 Conclusions

In this chapter, we employed the asymmetric error-correction model in order to detect the asymmetric adjustment mechanism. The whole sample is divided into two parts according to the industry-specific business cycle, and the deviations of the estimated coefficients between the upswing and downswing parts provide evidence on the mechanism of asymmetric adjustment.

Generally speaking, the asymmetric mechanism in the adjustment model could be commonly found in the short-run: during bad business environment, firms become more sensitive and react quicker when they confront the demand shocks. However, the target inventory level indicators seem to performance symmetrically regardless of the exogenous business movements. Reminded that fluctuations with periods between 1.5 and 8 years are considered to be business-cycle fluctuations, Chinese manufacturers could adjust their inventory accumulation speed efficiently when business environment change. But the arrangement of their target inventory level according to specific characteristics is not flexible, and it will cost a long time so that firms could shift their target inventory to another level during the business cycle fluctuation. One possible explanation could be that the development of inventory management is not as much as expectation and the implementation of recent management developments, such as JIT, WCM and advanced IT, needs to be considered critically in the Chinese context.

Chapter 5. The role of innovation in inventory performance: a total factor productivity perspective

Chapter 5. The role of innovation in inventory performance: a total factor productivity perspective

5.1 Introduction

“Inventory management” and “investment in innovations” has generated great interest in the academic and business press in recent years. It is said that inventory reduction has been a remarkable outcome of inventory management, and a flourishing literature states that the inventory reduction diminishes working capital investment needs and releases funds for alternative uses. In order to maintain competitive advantage, firms have been investing heavily in intangible resources, especially innovations, over the past decade (Zhou et al., 2011). For example, Science and Engineering Indicators: 2010 (National Science Board, 2010) reports that the global research and development (R&D) expenditure has doubled from $525 billion in 1996 to $1.1 trillion in 2007. The U.S. leads all other countries in R&D expenditure, with $369 billion in 2007.

However, prior studies show no clear consensus on the relationship between innovations and inventory performance (Cannon, 2008). The success in implementation of inventory management innovations is not universal since the adoption of initiatives such as JIT and WCM requires significant organisational effort and change. Besides, the inventory reduction puts pressure on internal operations to improve (e.g. quality, logistics, production flexibility and operational efficiency) by taking away the convenient supply and/or demand buffer. This chapter attempts to associates a firm's inventory performance with its capabilities of utilizing the technology progress and technical efficiency improvement, approximated here by total factor productivity.

Remained that in Chapter 3 and Chapter 4, the R&D dummy, firm age, time trend and a location dummy are included in our dynamic inventory adjustment model to capture innovations. However, these factors are only indirect indicators, and we could not find clear evidence to support the link between technical improvement and inventory reduction using these measurements. For instance, R&D is expected to have a positive impact on inventory level reduction however the estimated coefficient of R&D dummy is significantly positive for a majority of industries, which is opposite to the prediction. This could be due to the fact that firms in developing countries are too far from the technological frontier, and R&D investment could require longer time horizons to demonstrate results (Crespi and Zuniga, 2012). Moreover, firms that have the ability to spend on R&D could be seen as financially unconstrained and, therefore, are willing to have a higher level of inventories (Ughetto, 2008).

TFP, which attempts to measure the change in output net of the change in all inputs, is a more comprehensive indicator when we examine the impact of innovation on inventory performance in the Chinese market. TFP is commonly regarded as a measure of productivity (Lieberman and Asaba, 1997) and findings of the empirical studies show that one of the important sources of the productivity heterogeneity at the firm level is related to R&D and innovation activities (Griliches, 1998). More often than not, the concept of TFP change is used synonymously with technological progress and technical efficiency change in the productivity literature (Nishimizu and Page, 1982). The technological progress is defined as the movement of the best practice or frontier production function over time, and the technical efficiency change refers to all other factors affecting productivity that move the firm towards the current best practice frontier.

Decomposition of TFP into technological progress and technical efficiency improvement is vital when analysing the impact of innovation on inventory performance, especially in developing countries (Felipe, 1999). In the previous chapters, the failure of the R&D dummy in capturing the development of inventory management is due to the fact that, in an economy such as China which “borrows” technology extensively from abroad, failures to acquire and adapt technology to new international standards will be reflected in the lack of technological progress at the frontier. Moreover, Cassiman et al. (2010) suggests that different innovation activities tend to affect productivity differentially: Product innovation should relate more to firm-specific demand variations whereas process innovation is expected to affect technical efficiency; and thus the use of R&D can be seen as an imperfect proxy because it can be related, differently, to both types of innovation.

Comin and Mulani (2009) model the development of disembodied innovations such as managerial and organizational techniques, personnel, accounting, work practices and financial innovations, and claim the contributions of this kind of innovations to TFP. According to Yue and Liu (2006), in China, TFP growth is found for the data period 1996-2003, and it is accomplished mainly through the efficiency improvement which was underestimated by previous studies. Several improvements in inventory and SCM are more likely to be classified as technical efficiency changes and therefore, the TFP seems to be a more complex indicator.

Accordingly, in this chapter, we re-estimate the error-correction model augmented with a proxy for TFP to further analyse the inventory reduction effect of productivity improvement which is mainly related to process and efficiency innovations. Our research makes two significant contributions to the inventory management literature. First, to the best of our knowledge, we are the first to empirically link TFP to inventory performance. By taking innovations, especially process and efficiency improvements into consideration, we find that the effectiveness with which a firm utilizes its factor inputs affects its inventory level significantly. Second, we empirically examine the inventory reducing impact of process innovation under different business environment. By doing this, it could be proved that the benefits of productivity improvement and technical efficiency innovations cannot be discharged by demand shocks.

This chapter is organized as follows: Section 2 is a review of inventory reducing impact of TFP; Section 3 is the theoretical and empirical background on conducting TFP; Section 4 introduces the data involved and provides the descriptive statistics; Section 5 includes the research methods for symmetric and asymmetric inventory adjustment model followed by the results discussion. The conclusion of this chapter will be presented in Section 6.

5.2 Review of inventory reducing impact of total factor productivity

Since TFP in this chapter is used to proxy how successful a firm is at adopting new technological progress and technical efficiency improvement, the relationships between inventory performance and two different types of innovation (product innovation and process innovation) are discussed, and the impacts of TFP on inventory are summarized in Table 5.1.

Table 5.1: Summary of inventory reducing impact of TFP

Innovation	Method	Impact
Product innovation	Supply of a new product	Inventory volume (-)
	Effect of learning curves	Inventory volume (-)
(Technological progress)	Management of product transition	Inventory volume (-)
Process innovation	Flow time	Inventory volume (-)
	Waste, defects and returns	Inventory volume (-)
(Technical efficiency)	Recorder point and safety inventory	Inventory volume (-)

5.2.1 Product innovation

Product innovation may affect inventory level in three ways: the supply of a new product, the effect of learning curves, and the management of product transition (Zhou et al., 2011).

Supply of a new product

For a new-product introduction, firms can choose either the expand-early or the wait-and-see strategy to determine the timing of production expansion (Stevenson, 2009). The expand-early strategy increases the amount of production before the demand increment and results in an inventory surplus. Firms choose this strategy if the cost of lost sales is high, the demand increment is fairly certain, the economy of scale generates great savings, or if their priority is competing for market shares. Firms adopting the wait-and-see strategy tend to increase actual production after the demand increment is realized. Firms prefer this strategy if adding capacity is expensive or if the technology becomes obsolete quickly. This strategy implies relatively high inventory turnover; firms can maintain a low inventory level and might even experience a shortage and backlog in inventory. Because of the uncertain nature of new-product introduction, it is very likely that firms that are afraid of committing themselves to a large production level will adopt the wait-and-see strategy keeping inventory volume relatively low in the product life cycle.

Effect of learning curves

Norton and Bass (1987) extend the original Bass diffusion model to incorporate successive generations of technology. According to the Norton-Bass model, if a firm invents new products on a regular basis, the same diffusion process is valid for each generation. After repeatedly facing challenges in production planning and inventory management in the product innovation process, a firm might learn from its past experiences/mistakes and become more sophisticated in managing inventory. For example, a firm might achieve a more accurate demand forecast for its new products.

We, therefore, could suggest that product innovation enhances a firm's ability to manage its inventory level through learning by doing.

Management of product transition

It is important that firms with frequent new product introductions properly manage inventory during product transitions. In the early introduction stage, immature manufacturing processes and technologies can cause high defective rates, forcing firms to carry more inventory as a buffer against production disruptions. Another factor that can lead to higher inventory levels for new products is the potential for return and exchange requests due to defects. In addition, the new product can speed up the obsolescence of old products; if the transition is not properly managed, the firm can end up with an excessive inventory of old products. Therefore, it seems to be that firms with frequent product innovation will become increasingly efficient in inventory management as they gain experience in handling product transitions.

5.2.2 Process innovation

A process innovation could reduce production cost, increase production efficiency, and/or improve product quality and contribute to flexible product lines, low waste, and on-time delivery.

Flow time

Flow time, the time required to transform raw materials into finished products, has been a key indicator of the efficiency of a production system since the late 19th century. According to Little's law (Little, 1961), if a firm shortens flow time, either by modifying the process or by enhancing productivity, the inventories of raw materials, work-in-progress, and finished products will be reduced, and inventory turnover will improve.

Waste, defects and returns

An advanced production system tends to reduce mistakes and defects on the production line, save waste resulting from discarded defective parts or products and increase the consistency of product quality. For example, Lieberman and Demeester (1999) claim that JIT has been successful in eliminating defects. By lowering defect rates, a firm can reduce the amount of buffer inventory required to guard against production disruptions. Besides, consistent product quality means fewer returns or exchanges from customers, and this could be a further reason for firms to lower inventory.

Reorder point and safety inventory

As discussed earlier, a major benefit of process innovation is the reduced flow time and hence the reduced production lead time. A shorter and more consistent lead time means a lower reorder point, the inventory level at which a firm places its production orders, in a continuous review system (Stevenson, 2009). It also means that there would be no need to carry a high safety inventory as a buffer against potential stockout risks. Reducing reorder point and safety inventory will improve inventory turnover and keep the inventory level under a relatively low level.

5.3 Total factor productivity in Chinese manufacturing industries

Studies focusing on TFP in China are quite limited. Recent research conducted by Guo and Jia (2005) provide a general description about TFP. It is claimed that the TFP growth rate experienced severe fluctuations from 1979-1993. The growth rate decreased from 1993 to 2000, after which the growth rate increases steadily. These fluctuations may be due to the economic structure transition. During the research period, it is found that the TFP growth rate in China is higher than that in developed countries (Japan, Germany and the US) but lower than developing countries such as Thailand, Singapore and South Korea. Ding et al. (2014) estimate TFP growth in China for 1998 to 2007, and it is said that the growth rate is very high during that period of time.

The objective of productivity measurement is to identify output differences that cannot be explained by input differences (Van Biesebroeck, 2007). The paper conducted by Ding et al. (2014) is one of a small number of papers that examine firm-level TFP and its determinants in China. A Cobb-Douglas log-linear production function approach including fixed effects is employed in order to calculate TFP:

$$y_{it} = \alpha_i + \alpha_E e_{it} + \alpha_M m_{it} + \alpha_K k_{it} + \alpha_X X_{it} + \alpha_T t + \varepsilon_{it} \qquad (5.1)$$

where endogenous *y*, *e*, *m* and *k* refer respectively to the logarithms of real gross output, employment, intermediate inputs, and the capital accumulation in firm *i* at time *t*; and X_{it} is a vector of observed (proxy) variables determining TFP. More specifically, they include firm characteristics such as firm age, political affiliation, firm ownership, export behaviour, whether the firm engaged in R&D, financial variables, and geographic location into the vector X_{it}. Lastly, *t* is a time trend, measuring exogenous gains in TFP over time.

Ding et al. (2014) first estimates equation (5.1) for different industries and obtain an unbiased estimation of elasticity of output with respect to inputs (α_E, α_M and α_K). TFP can then be calculated as the level of output that is not attributable to factor inputs (employment, intermediate inputs and capital). In other words, productivity is due to efficiency levels and technical progress. Thus, such a measure of TFP can be expressed as:

$$ln\widehat{TFP}_{it} = y_{it} - \widehat{a_E}e_{it} - \widehat{a_M}m_{it} - \widehat{a_K}k_{it} = \widehat{a_\iota} + \widehat{a_X}X_{it} + \widehat{a_T}t + \varepsilon_{it} \quad (5.2)$$

Table 5.2a: Long-run two-step system-GMM production function, various industries, China 2000-2007 (i)

Dependent Variable: *ln_sales*	Other Mining sic10+80	Food Production sic14	Tobacco sic16	Textile sic17	Apparel & Footwear sic18	Leather sic19	Timber sic20	Furniture sic21	Paper-making sic22
ln intermediate inputs	0.308***	0.366***	0.386***	0.853***	0.653***	0.763***	0.493***	0.494***	0.843***
	(0.074)	(0.157)	(0.082)	(0.019)	(0.049)	(0.058)	(0.118)	(0.068)	(0.032)
ln employment	0.505***	0.311*	0.613**	0.153***	0.294***	0.095***	0.483***	0.446***	0.166***
	(0.064)	(0.174)	(0.287)	(0.033)	(0.041)	(0.053)	(0.114)	(0.078)	(0.045)
ln capital	0.225***	0.357*	0.387**	0.037**	0.085***	0.143***	0.130*	0.169***	0.040***
	(0.065)	(0.196)	(0.161)	(0.019)	(0.038)	(0.073)	(0.076)	(0.046)	(0.009)

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 5.2b: Long-run two-step system-GMM production function, various industries, China 2000-2007 (ii)

Dependent Variable: *ln_sales*	Printing sic23	Culture sic24	Petroleum Processing sic25+70	Chemical sic26+28	Medical sic27	Rubber sic29	Plastic sic30	Non-metal Products sic31	Metal Products sic32+33+34
ln intermediate inputs	0.634***	0.754***	0.265*	0.850***	0.550***	0.555***	0.860***	0.191***	0.441**
	(0.046)	(0.051)	(0.145)	(0.022)	(0.040)	(0.112)	(0.048)	(0.040)	(0.035)
ln employment	0.230**	0.239***	0.743***	0.203***	0.768***	0.249*	0.110**	0.700***	0.344***
	(0.104)	(0.067)	(0.145)	(0.052)	(0.102)	(0.146)	(0.048)	(0.182)	(0.045)
ln capital	0.174***	0.059*	0.245**	0.016**	0.065**	0.153*	0.066***	0.449***	0.462***
	(0.049)	(0.031)	(0.100)	(0.006)	(0.027)	(0.080)	(0.024)	(0.133)	(0.059)

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 5.2c: Long-run two-step system-GMM production function, various industries, China 2000-2007 (iii)

Dependent Variable: *ln_sales*	Machinery & Equipment sic35+36	Transport Equipment sic37	Measuring Instrument sic41	Other Manufacturing sic42+43	Electronic Power sic44	Gas Production sic45	Water Production sic46	Coal Mining sic60
ln intermediate inputs	0.626***	0.640***	0.562***	0.649***	0.375***	0.265***	0.142*	0.568***
	(0.035)	(0.071)	(0.142)	(0.045)	(0.090)	(0.092)	(0.082)	(0.027)
ln employment	0.450***	0.383***	0.460**	0.162***	0.871**	0.348***	1.220***	0.391***
	(0.065)	(0.104)	(0.197)	(0.053)	(0.303)	(0.110)	(0.161)	(0.062)
ln capital	0.104**	0.094*	0.202*	0.135***	0.191*	0.461***	0.216**	0.083*
	(0.046)	(0.050)	(0.117)	(0.030)	(0.110)	(0.117)	(0.092)	(0.044)

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 5.2a, Table 5.2b and Table 5.2c present estimated coefficients of inputs (α_E , α_M and α_K) of the long-run two-step system-GMM production function (equation 5.1) covering the Chinese manufacturing industries through 1998-2007 (Ding et al., 2014). Equation 5.1 was estimated, in dynamic form with additional lagged values of output and factor inputs, using the system GMM approach since it is sufficiently flexible to allow for both endogenous regressors and a first-order autoregressive error term. The elasticities of output with respect to intermediate input, labor and capital display significant heterogeneity among various industries. Since we employ the same dataset as Ding et al. (2014), these coefficients are used directly to predict firm-level TFP values, based on equation 5.2.

5.4 Data and descriptive statistics

Due to data availability (data related to intermediate inputs are not recorded in 2008 and 2009), the sample period is 2000-2007 in this chapter. Table 5.3 summarises the average overall TFP value, adjusted average TFP value (after normalising the value of TFP in 1998 to 1 for all firms) and the number of observations for each year. The number of observations ranges from a minimum of 126,444 firms in 2000 to a maximum of 261,765 firms in 2007. Consistent with Guo and Jia (2005), Figure 5.1

shows that the average expected value of TFP keeps increasing during the whole sample period, from 1.069 to 1.132, which means that the productivity raises regardless of the industry heterogeneity. Table 5.3 also presents adjusted average TFP values for firms in the upswing and downswing separately. It seems that a higher level of productivity could not help firms get rid of the business cycle downswing.

Figure 5.1: Normalized TFP (2000-2007)

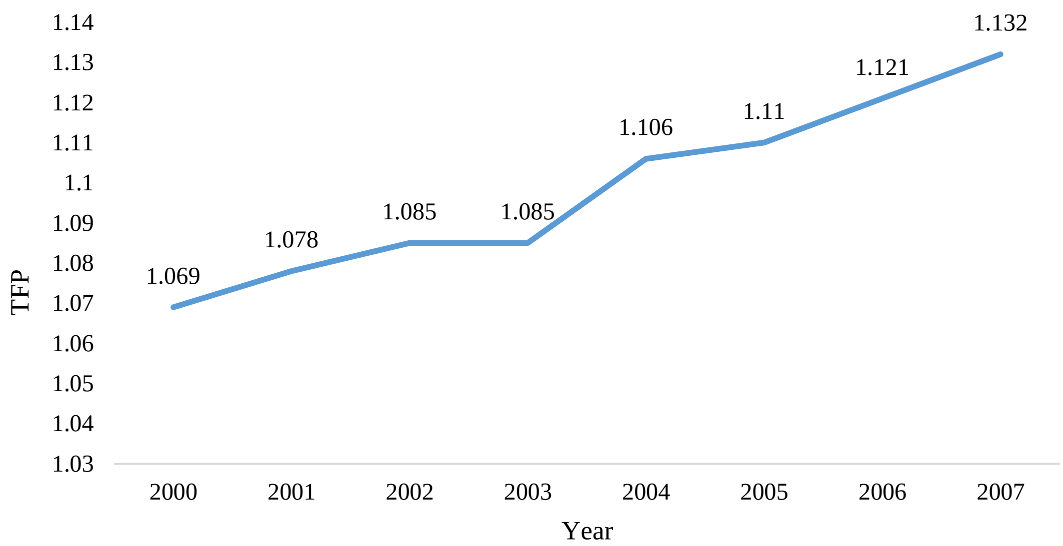


Table 5.3: Descriptive statistics (2000-2007)

	2000	2001	2002	2003	2004	2005	2006	2007	2000-2007	upswing	downswing
N	126,444	132,877	143,781	153,547	219,819	214,915	238,160	261,765	1,491,308	739,946	751,153
Mean (Ln TFP)	-2.674	-2.553	-2.469	-2.469	-2.243	-2.204	-2.115	-2.023	-2.288	-2.343	-2.233
Normalization (Ln TFP_{1998}=1)	1.069	1.078	1.085	1.085	1.106	1.110	1.121	1.132	1.101	1.096	1.107
Ste. Dev.	1.836	1.803	1.779	1.699	1.585	1.547	1.498	1.400	1.625	1.636	1.611

5.5 Empirical models and results

5.5.1 Symmetric inventory adjustment approach

In addition to Chapter 3, we re-estimate the target adjustment inventory model augmented with the predicted TFP:

$$I_{it} = \varphi I_{i,t-1} + \pi' X_{it} + v_{it} \qquad (5.3)$$

where the variables are expressed in logarithms and I_{it} refers to the amount of inventories and X_{it} denotes the $k \times 1$ vector of variables that determining target level of inventory. In addition to the factors that are estimated in the previous chapters, the predicted TFP variable is now also included in X_{it}.

Consistent with the approach used in previous chapters, the two steps system-GMM estimator is employed and TFP is treated as endogenous and is therefore instrumented using lagged values of itself as the instruments. We report the main estimation results for 26 two-digit industries/industry groups in Table 5.4(a), Table 5.4(b) and Table 5.4(c). Panel A presents the short-run dynamics, including the short-run coefficients of lags 1 and 2 of inventory level while panel B contains the long-run coefficients on the determinants of target inventory level. We focus on the coefficients on TFP and technology-related variables in this study. The AR(2) and Hansen test of no second-order autocorrelation and valid instruments cannot be rejected at 5% conventional significance levels or better, which ensure the reliability of our estimation results.

After including TFP into the symmetric inventory adjustment model, we find that the partial adjustment pattern in short-run still can be detected for most industries since the coefficients of lag1 and lag2 of inventories are significantly positive and less than 1. Consistent with the estimation results in Chapter 3, the significance of inventory coefficient tends to decline when the lag increases, which indicates a loss in intensity of the adjustment path.

In terms of long-run results, the significantly negative coefficient of TFP is consistent with our expectation that advanced inventory management and control, such as JIT and WCM, would help firms reduce their inventory level (Pong and Mitchell, 2012, Robb et al., 2012). Compared to other factors that we used to proxy innovation, TFP seems to be a more appropriate determinant. According to the results, the TFP-inventory relation is significant for almost all industries, showing its more general impact on inventory reducing. Apparel and footwear industry is proved to have the closest TFP-inventory relationship. The coefficient of TFP on inventory is -1.253, which means each percent of TFP growth results in 1.253% of inventory reduction. Firms in apparel and footwear industry release new products regularly and frequently.

Therefore, these firms tend to be more experienced in forecasting demand for new product and handling product transitions. When compared with the figure in Table 3.4, we find that the estimated coefficients of sales is relatively larger for most of the industries, which indicate that the omission of TFP leads to an under-estimation of the effect of sales on inventory and a positive relationship between TFP and sales could be find in these industries. However, for industries such as Chemical, Metal Product, Measuring Instrument, Other Manufacturing and Water Production, the omission of TFP leads to an upward bias which means that TFP is negatively related to sales[8].

After including TFP, the coefficient of R&D falls significantly when comparing with the estimation result in Table 3.4. According to the Table 5.4, the inventory reducing impact of R&D is not as significant as that of TFP. This could be due to the lack of technological progress at the frontier in China (Cassiman et al., 2010) and the benefit of R&D investment may takes a long time to be achieved(Crespi and Zuniga, 2012).

[8] Although TFP is estimated using sales as output in Ding et.al. (2014), this is no particular reason for a positive correlation between TFP and sales.

Table 5.4a: System GMM estimation of the symmetric inventory model augmented with TFP, China 2000-2007 (i)

Dependent Variable: *lr_stocks*	Other Mining sic10	Food Production sic14	Tobacco sic16	Textile sic17	Apparel & Footwear sic18	Leather sic19	Timber sic20	Furniture sic21	Paper-making sic22
Panel A: Short-run dynamics									
L.lr_stocks	0.447***	0.386***	0.720***	0.441***	0.405***	-0.501	0.585***	0.375***	-0.867
	(0.028)	(0.028)	(0.087)	(0.024)	(0.019)	(0.421)	(0.143)	(0.056)	(0.747)
L2.lr_stocks	0.109***	0.038*	0.098**	0.066***	0.073***	0.955**	0.089*	-0.001	1.258**
	(0.023)	(0.020)	(0.044)	(0.021)	(0.013)	(0.474)	(0.052)	(0.056)	(0.624)
Speed of	0.445***	0.576***	0.181*	0.493***	0.521***	0.546**	0.327***	0.626***	0.609***
Adjustment	(0.046)	(0.042)	(0.099)	(0.043)	(0.028)	(0.243)	(0.098)	(0.108)	(0.170)
Panel B: Long-run equilibrium									
lr_sales	1.002***	0.896***	2.732*	0.783***	1.269***	0.862***	0.748***	0.557***	0.697***
	(0.162)	(0.090)	(1.397)	(0.084)	(0.202)	(0.259)	(0.187)	(0.111)	(0.154)
lr_tfp	-1.013***	-0.721***	-1.216	-0.746***	-1.253***	-0.735***	-0.993***	-1.014***	0.173
	(0.150)	(0.090)	(0.885)	(0.061)	(0.181)	(0.231)	(0.226)	(0.110)	(1.329)
p_capstate	-0.709***	-0.345***	1.388	-0.108*	-0.028	-0.243	-0.861***	-0.641**	0.023
	(0.226)	(0.111)	(3.356)	(0.062)	(0.176)	(0.369)	(0.199)	(0.251)	(0.164)
p_capcoll	-0.925***	-0.254***	2.374	-0.427***	-0.250***	-0.603***	-0.893***	-0.636***	-0.500***
	(0.227)	(0.089)	(3.753)	(0.059)	(0.093)	(0.165)	(0.202)	(0.145)	(0.110)
p_capcorporate	-0.827***	-0.203***	1.130	-0.401***	-0.226***	-0.440***	-0.674***	-0.493***	-0.327***
	(0.221)	(0.063)	(3.449)	(0.042)	(0.059)	(0.144)	(0.150)	(0.096)	(0.098)
p_capindividual	-0.766***	-0.107	4.717	-0.437***	-0.277***	-0.615***	-0.759***	-0.730***	-0.389***
	(0.213)	(0.068)	(5.261)	(0.042)	(0.067)	(0.134)	(0.162)	(0.088)	(0.097)

p_capforeign	-0.236	-0.072	-4.713	-0.016	-0.159***	-0.107	0.085	0.081	0.139
	(0.305)	(0.060)	(8.790)	(0.049)	(0.049)	(0.091)	(0.138)	(0.071)	(0.103)
no_politics	0.178**	-0.004	-1.311	-0.133***	0.121***	-0.069	-0.126	-0.001	-0.076*
	(0.071)	(0.036)	(1.082)	(0.028)	(0.036)	(0.067)	(0.089)	(0.062)	(0.046)
high_politics	0.476***	0.094	-2.724	0.494***	0.339***	0.639***	0.713***	0.239	0.336**
	(0.156)	(0.078)	(2.087)	(0.054)	(0.114)	(0.224)	(0.164)	(0.146)	(0.143)
no_exporter	-0.308***	-0.399***	0.790	-0.180***	0.186***	-0.163**	-0.379***	-0.233***	-0.187**
	(0.094)	(0.047)	(0.931)	(0.036)	(0.047)	(0.077)	(0.085)	(0.054)	(0.082)
lage	-0.103**	0.023	-1.116	0.139***	0.062	0.010	-0.018	-0.008	-0.052
	(0.042)	(0.024)	(1.085)	(0.027)	(0.039)	(0.259)	(0.059)	(0.053)	(0.083)
lliquid	0.771***	0.294*	-3.029	-0.797***	-0.289*	-0.681***	0.702	0.052	-0.371
	(0.248)	(0.172)	(2.466)	(0.108)	(0.161)	(0.261)	(0.604)	(0.219)	(0.346)
neg_liquid	-0.045	-0.122***	-0.490	-0.098***	-0.227***	-0.221**	-0.058	-0.101*	0.076
	(0.070)	(0.040)	(0.647)	(0.027)	(0.046)	(0.107)	(0.092)	(0.056)	(0.057)
lfc	0.090***	0.137***	0.519*	0.095***	0.216***	0.058	0.147***	0.127***	0.091***
	(0.027)	(0.022)	(0.313)	(0.015)	(0.024)	(0.039)	(0.048)	(0.028)	(0.034)
rd_dum	0.087	0.115*	-1.331	0.248***	0.028	0.125	0.371***	0.235***	0.267**
	(0.153)	(0.065)	(1.529)	(0.054)	(0.096)	(0.153)	(0.134)	(0.069)	(0.105)
city200	-0.283***	-0.240***	0.598	-0.180***	0.175***	-0.108	-0.126	0.246***	-0.206**
	(0.054)	(0.050)	(0.649)	(0.038)	(0.061)	(0.109)	(0.081)	(0.089)	(0.085)
Observations	12,784	16,074	882	63,452	33,301	17,114	12,648	7,941	23,095
Number of firm	5,222	6,132	273	23,241	12,571	6,327	5,421	3,116	7,998
AR(1)	-13.89	-13.00	-2.803	-28.17	-22.43	-2.575	-4.068	-10.61	-6.348
P(ar1)	0	0	0.00506	0	0	0.0100	4.74e-05	0	2.19e-10
AR(2)	-0.487	0.216	1.274	0.541	1.879	-1.778	0.901	1.853	-1.905

P(ar2)	0.626	0.829	0.203	0.589	0.0602	0.0754	0.367	0.0639	0.0568
Hansen test	4.005	9.968	4.733	1.737	7.786	1.864	7.976	5.471	5.659
P(Hansen)	0.261	0.0761	0.316	0.188	0.0506	0.172	0.0925	0.140	0.129

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 5.4b: System GMM estimation of the symmetric inventory model augmented with TFP, China 2000-2007 (ii)

Dependent Variable: *lr_stocks*	Printing sic23	Culture sic24	Petroleum Processing sic25	Chemical sic26	Medical sic27	Rubber sic29	Plastic sic30	Non-metal Products sic31	Metal Products sic34
Panel A: Short-run dynamics									
L.lr_stocks	0.295**	0.468***	0.383**	0.437***	0.367***	0.470***	0.472***	0.446*	-0.835
	(0.141)	(0.072)	(0.178)	(0.037)	(0.063)	(0.055)	(0.019)	(0.266)	(0.778)
L2.lr_stocks	-0.097	0.132*	0.091	0.081***	0.005	0.057	0.084***	0.297	1.086**
	(0.146)	(0.075)	(0.199)	(0.020)	(0.055)	(0.049)	(0.015)	(0.211)	(0.546)
Speed of	0.801***	0.400***	0.526	0.482***	0.628***	0.473***	0.444***	0.256***	0.748***
Adjustment	(0.286)	(0.144)	(0.376)	(0.054)	(0.115)	(0.099)	(0.031)	(0.074)	(0.260)
Panel B: Long-run equilibrium									
lr_sales	0.741***	0.573**	0.915*	0.572**	0.448***	0.733***	0.471***	0.931***	0.934***
	(0.147)	(0.224)	(0.514)	(0.265)	(0.060)	(0.136)	(0.050)	(0.124)	(0.070)
lr_tfp	-0.830***	-0.833***	-0.490***	6.146	-0.472***	-0.775***	-0.534***	-0.704***	-0.569***
	(0.164)	(0.260)	(0.181)	(5.155)	(0.031)	(0.190)	(0.050)	(0.056)	(0.034)
p_capstate	-0.898***	-0.076	-0.388	0.641	-0.284***	-0.358**	-0.286***	-0.241*	-0.072
	(0.277)	(0.526)	(0.439)	(0.758)	(0.077)	(0.140)	(0.102)	(0.125)	(0.093)
p_capcoll	-0.756***	-0.852***	-0.538	-0.423**	-0.313***	-0.434***	-0.602***	-0.380***	-0.282***
	(0.180)	(0.206)	(0.619)	(0.211)	(0.075)	(0.136)	(0.075)	(0.119)	(0.073)
p_capcorporate	-0.690***	-0.860***	-0.459	-0.166	-0.181***	-0.553***	-0.536***	-0.332***	-0.225***
	(0.165)	(0.164)	(0.417)	(0.302)	(0.063)	(0.106)	(0.059)	(0.103)	(0.074)
p_capindividual	-0.913***	-0.929***	-0.328	-0.297	-0.213***	-0.486***	-0.710***	-0.269**	-0.323***
	(0.163)	(0.216)	(0.622)	(0.272)	(0.067)	(0.112)	(0.057)	(0.116)	(0.060)

p_capforeign	-0.130	-0.151	0.403	-0.506	0.192**	0.212*	0.090*	0.109	0.148*
	(0.081)	(0.117)	(0.278)	(0.436)	(0.077)	(0.116)	(0.050)	(0.112)	(0.078)
no_politics	-0.043	-0.129*	0.059	-0.278*	-0.026	-0.139**	-0.044	0.006	0.005
	(0.043)	(0.075)	(0.079)	(0.158)	(0.028)	(0.060)	(0.034)	(0.048)	(0.034)
high_politics	0.295***	-0.108	0.076	0.195	0.186***	0.353***	0.482***	0.228**	0.298***
	(0.084)	(0.242)	(1.041)	(0.144)	(0.044)	(0.110)	(0.078)	(0.099)	(0.074)
no_exporter	-0.203***	-0.110	-0.052	-0.471*	-0.242***	-0.324***	-0.323***	-0.107*	-0.122**
	(0.063)	(0.089)	(0.383)	(0.247)	(0.048)	(0.076)	(0.039)	(0.057)	(0.057)
lage	0.135***	0.108	0.033	0.478	0.104***	0.133**	0.044	-0.189***	-0.138***
	(0.046)	(0.175)	(0.189)	(0.324)	(0.031)	(0.063)	(0.029)	(0.049)	(0.047)
lliquid	-0.385*	-0.538**	0.012	-1.512	0.171	-0.083	-0.681***	1.313***	-0.395**
	(0.218)	(0.271)	(1.060)	(1.130)	(0.123)	(0.263)	(0.132)	(0.341)	(0.180)
neg_liquid	-0.102***	-0.289***	-0.116	0.112	-0.068**	-0.111	-0.187***	-0.166**	-0.183***
	(0.035)	(0.097)	(0.111)	(0.146)	(0.034)	(0.075)	(0.040)	(0.084)	(0.042)
lfc	0.091***	0.080	0.172	0.327***	0.115***	0.130***	0.183***	0.129***	0.060***
	(0.018)	(0.053)	(0.112)	(0.116)	(0.013)	(0.039)	(0.022)	(0.022)	(0.022)
rd_dum	0.265**	0.426***	0.040	0.455***	0.266***	0.392***	0.430***	0.063	0.073
	(0.115)	(0.096)	(0.437)	(0.175)	(0.037)	(0.081)	(0.050)	(0.075)	(0.058)
city200	-0.048	-0.012	0.040	-0.336**	-0.067	0.067	-0.067	0.033	-0.083**
	(0.093)	(0.159)	(0.082)	(0.151)	(0.042)	(0.103)	(0.063)	(0.055)	(0.036)
Observations	14,822	8,954	5,141	59,665	16,529	8,253	28,148	66,990	41,781
Number of firm	5,160	3,277	1,988	20,934	5,285	3,086	11,177	23,347	18,214
AR(1)	-11.00	-10.83	-7.309	-2.637	-14.03	-9.828	-18.71	-1.368	-5.224
P(ar1)	0	0	0	0.00835	0	0	0	0.171	1.75e-07
AR(2)	0.648	0.365	0.762	-0.552	0.817	0.824	0.751	-0.680	-1.734

P(ar2)	0.517	0.715	0.446	0.581	0.414	0.410	0.453	0.497	0.0828
Hansen test	2.538	4.775	2.572	3.898	2.320	2.316	6.825	3.975	1.914
P(Hansen)	0.111	0.189	0.276	0.420	0.509	0.510	0.0777	0.137	0.384

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 5.4c: System GMM estimation of the symmetric inventory model augmented with TFP, China 2000-2007 (iii)

Dependent Variable: *lr_stocks*	Machinery & Equipment sic35	Transport Equipment sic37	Measuring Instrument sic41	Other Manufacturing sic43	Electronic Power sic44	Gas Production sic45	Water Production sic46	Coal Mining sic60
Panel A: Short-run dynamics								
L.lr_stocks	0.453***	0.775***	0.421***	0.348***	0.491***	0.262**	0.303***	0.462***
	(0.019)	(0.272)	(0.055)	(0.068)	(0.029)	(0.110)	(0.107)	(0.072)
L2.lr_stocks	0.064***	-0.118	-0.003	0.001	0.096***	0.004	-0.108	0.129*
	(0.018)	(0.212)	(0.039)	(0.069)	(0.023)	(0.097)	(0.116)	(0.078)
Speed of	0.483***	0.343***	0.582***	0.651***	0.413***	0.735***	0.805***	0.409***
Adjustment	(0.036)	(0.071)	(0.090)	(0.136)	(0.046)	(0.193)	(0.220)	(0.148)
Panel B: Long-run equilibrium								
lr_sales	0.459***	1.345***	0.590***	0.348***	1.214***	1.284**	0.562***	0.725**
	(0.037)	(0.226)	(0.074)	(0.102)	(0.151)	(0.499)	(0.114)	(0.287)
lr_tfp	-0.780***	-1.138***	-0.470***	-0.209	-0.668***	-0.771**	-0.204***	-0.650**
	(0.034)	(0.210)	(0.054)	(0.137)	(0.065)	(0.342)	(0.034)	(0.324)
p_capstate	-0.494***	0.031	-0.066	-0.541***	-1.022***	0.544	0.481	-1.714**
	(0.051)	(0.215)	(0.104)	(0.106)	(0.299)	(0.333)	(0.409)	(0.774)
p_capcoll	-0.751***	-0.410**	-0.409***	-0.770***	-0.518	0.714	0.814**	-1.987***
	(0.048)	(0.166)	(0.114)	(0.081)	(0.321)	(0.567)	(0.329)	(0.761)
p_capcorporate	-0.652***	-0.425***	-0.284***	-0.740***	-0.972***	0.455	0.716**	-1.903**
	(0.038)	(0.104)	(0.074)	(0.057)	(0.244)	(0.337)	(0.358)	(0.753)
p_capindividual	-0.799***	-0.555***	-0.678***	-0.877***	-0.747**	0.762	0.458	-1.919**
	(0.038)	(0.126)	(0.085)	(0.066)	(0.297)	(0.615)	(0.368)	(0.749)

p_capforeign	0.305***	-0.202	0.122*	-0.002	-0.238	0.371	0.379	0.233
	(0.038)	(0.128)	(0.073)	(0.058)	(0.248)	(0.314)	(0.359)	(0.931)
no_politics	-0.133***	-0.021	0.006	-0.121***	0.172*	0.133	0.026	-0.050
	(0.019)	(0.050)	(0.043)	(0.037)	(0.091)	(0.143)	(0.109)	(0.119)
high_politics	0.524***	0.070	0.293***	0.778***	-0.410**	-0.572	-0.057	0.718
	(0.030)	(0.123)	(0.062)	(0.074)	(0.207)	(0.651)	(0.225)	(0.450)
no_exporter	-0.166***	0.175	-0.077	0.041	0.262	0.287	0.114	0.289
	(0.021)	(0.142)	(0.055)	(0.037)	(0.192)	(0.554)	(0.138)	(0.186)
lage	0.122***	-0.014	0.070*	0.397***	-0.459***	-0.193	0.045	-0.031
	(0.022)	(0.054)	(0.039)	(0.055)	(0.065)	(0.273)	(0.081)	(0.075)
lliquid	-0.245***	-0.109	-0.369**	-0.604***	0.672*	-0.533	0.568**	0.600
	(0.072)	(0.243)	(0.152)	(0.138)	(0.365)	(0.709)	(0.264)	(0.448)
neg_liquid	-0.179***	-0.159***	-0.231***	-0.130***	0.092	-0.105	0.005	-0.065
	(0.020)	(0.051)	(0.048)	(0.042)	(0.066)	(0.135)	(0.056)	(0.094)
lfc	0.199***	0.164***	0.266***	0.102***	0.033	0.162***	0.091***	0.225***
	(0.010)	(0.026)	(0.026)	(0.028)	(0.041)	(0.054)	(0.021)	(0.046)
rd_dum	0.475***	-0.107	0.385***	0.624***	-0.515**	-0.242	0.298	0.485**
	(0.023)	(0.199)	(0.063)	(0.050)	(0.200)	(0.426)	(0.225)	(0.228)
city200	0.108***	-0.074	0.197**	0.088	-0.065	0.051	0.113	-0.158
	(0.027)	(0.067)	(0.088)	(0.067)	(0.128)	(0.263)	(0.124)	(0.105)
Observations	101,543	32,628	11,120	19,181	13,108	1,429	7,691	11,762
Number of firm	39,180	11,701	5,908	8,000	4,117	463	2,170	4,393
AR(1)	-31.41	-2.393	-8.139	-13.71	-14.80	-4.518	-10.65	-14.66
P(ar1)	0	0.0167	0	0	0	6.23e-06	0	0
AR(2)	1.948	1.111	1.336	1.048	-1.541	0.399	1.572	-1.291

P(ar2)	0.0514	0.267	0.182	0.295	0.123	0.690	0.116	0.197
Hansen test	1.474	5.847	2.731	5.696	7.674	1.159	3.663	2.694
P(Hansen)	0.225	0.119	0.255	0.127	0.104	0.763	0.300	0.260

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

5.5.2 Asymmetric inventory adjustment approach

$$I_{it} = \left(\varphi_1 I_{i,t-1} + \pi_1' X_{it}\right) + \left[(\varphi_2 - \varphi_1) I_{i,t-1} + (\pi_2 - \pi_1)' X_{it}\right] 1_{\{q<c\}} + v_{it} \qquad (5.4)$$

Table 5.5(a), Table5.5(b) and Table5.5(c) present the results from the system GMM estimation of the threshold partial adjustment model, equation (5.4), and the business cycle dummy is employed as the transition variable. Firm-years are classified into down (up) regime when the value of the transition variable equals to one (zero). Panel A and Panel B focus on samples in the up regime and present the short-run speed of adjustment towards desired inventory level and the long-run coefficients on the determinants of target inventory level. Panel C and Panel D contain the deviations between the two regimes. The AR(2) and Hansen tests are not rejected at the 5% significance level, suggesting that all GMM regressions use valid instruments.

In terms of the short-term dynamics, the partial adjustment mechanism is captured for most of the industries in the up regime since the speeds of adjustment are significantly positive and lower than 1. When allowing for the asymmetric adjustment mechanism, results in panel C show that the deviations of the speed of adjustment between the two regimes are significant. They are estimated to be significantly positive for 14 out of 26 industries, which indicate a higher speed of adjustment during economic slowdown.

In short-run, firms in the 14 industries spend less time to change their deviation from target inventory level during business cycle downwards. For example, the speed of adjustment for the printing industry is 0.523 in the upswing region, and it increases to 0.674 (0.523+0.151) in the downswing region, which means with annual data that 52.3% [67.4%] of the difference between actual inventory level and the target inventory level is eliminated in one year in upswing [downswing]. Firms spend 1.912 years (22.944 months) to eliminate the gap in the upswing and 1.484 years (17.808 months) in the downswing, therefore, firms in printing industry will spend 5.136 months (about 157 days) less to cover the distance to the long-term level during recession.

This could be supported by a number of studies suggesting that, with a low adjustment cost, inventories are likely to be quite sensitive to business environment under imperfect capital markets (Sangalli, 2013, Guariglia, 2000, Guariglia and Mateut, 2006).

However, the deviations of the speed of adjustment are negatively significant for other 11 industries (e.g. Machinery & equipment industry, electronic power industry and other manufacturing industry). Firms in these industries usually have high adjustment costs and therefore, the speed of adjustment is relatively low even for firms in the up regime. During the recession, these firms tend to have a higher level of financial constraint and cannot afford the adjustment cost, thus, become less sensitive to demand shocks.

In terms of long-run results, same as the symmetric analysis, when compared with the results in Table 4.4, including TFP into the equation makes the estimated coefficient of sales decreased considerably in the two regimes for the majority of industries. When focusing on TFP, firms in the up regime tend to have significantly negative coefficients of TFP for most of the industries (23 out of 26), which indicates the inventory reducing impact of TFP. Outcomes in Panel C show that the deviations of TFP coefficient between the two regimes are not as obvious as that of adjustment speed in short-run perspective. This finding illustrates that the inventory reducing impact of TFP is not sensitive to macroeconomic fluctuation. In other words, the negative impact of business cycle downwards does not offset the benefits associated with the product and process innovations.

Moreover, for industries such as tobacco and printing, the inventory reducing impact of TFP becomes clear during recessions. In the up regime, the coefficient of TFP is not significant for the tobacco and printing industries, which represents that a growth of TFP does not result in a drop of inventory volume. According to Panel D, the deviation of TFP's coefficient between up regime and down regime is significantly negative for the two industries. More specifically, for firms in the tobacco industry and printing industry, each percentage of TFP growth results in 0.236% and 0.628% of inventory reduction respectively, during the downward business cycle. One reasonable explanation could be that firms in these consumer non-durable industries tend to adopt the wait-and-see strategy in the period of recession and a higher level of productivity could help firms in these industries get a better inventory performance.

Table 5.5a: System GMM estimation of the asymmetric threshold model augmented with TFP, China 2000-2007 (i)

Dependent Variable: *lr_stocks*	Other Mining sic10	Food Production sic14	Tobacco sic16	Textile sic17	Apparel & Footwear sic18	Leather sic19	Timber sic20	Furniture sic21	Paper-making sic22
				Panel A: Short-run dynamics					
Speed of Adjustment	0.432***	0.570***	0.305***	0.424***	0.519***	0.264	0.385***	0.381***	0.317***
	(0.042)	(0.041)	(0.104)	(0.032)	(0.029)	(0.197)	(0.086)	(0.077)	(0.104)
				Panel B: Long-run equilibrium					
lr_sales	0.925**	1.039***	1.111***	0.896***	1.286***	1.168*	0.679***	0.793***	0.921***
	(0.435)	(0.121)	(0.385)	(0.101)	(0.194)	(0.672)	(0.211)	(0.191)	(0.224)
lr_tfp	-0.903**	-0.902***	-0.163	-0.860***	-1.289***	-1.773	-0.947***	-1.243***	-3.982
	(0.406)	(0.137)	(0.304)	(0.118)	(0.251)	(1.160)	(0.253)	(0.201)	(2.550)
p_capstate	-0.639**	-0.236	-0.221	-0.153	0.074	0.175	-1.005***	-0.846**	-1.073*
	(0.283)	(0.182)	(2.938)	(0.114)	(0.220)	(0.726)	(0.256)	(0.423)	(0.647)
p_capcoll	-0.900***	-0.203	-0.414	-0.313**	-0.218*	-0.442	-1.136***	-0.469	-1.006**
	(0.301)	(0.149)	(2.896)	(0.123)	(0.120)	(0.477)	(0.229)	(0.331)	(0.394)
p_capcorporate	-0.754***	-0.208**	-0.668	-0.322***	-0.222***	-0.261	-0.827***	-0.253	-0.781**
	(0.266)	(0.100)	(2.962)	(0.086)	(0.081)	(0.432)	(0.150)	(0.185)	(0.325)
p_capindividual	-0.771***	-0.055	0.462	-0.314***	-0.314***	-0.321	-0.946***	-0.515***	-0.720**
	(0.298)	(0.115)	(3.041)	(0.090)	(0.086)	(0.425)	(0.157)	(0.160)	(0.327)
p_capforeign	-0.466	-0.159*	-2.873	0.208**	-0.136**	-0.004	0.018	0.036	-0.252
	(0.389)	(0.096)	(3.841)	(0.099)	(0.067)	(0.297)	(0.168)	(0.146)	(0.259)
no_politics	0.219*	0.085	-0.438	-0.107**	0.153***	-0.216	0.061	0.108	-0.216*

	(0.116)	(0.059)	(0.661)	(0.049)	(0.051)	(0.162)	(0.118)	(0.131)	(0.121)
high_politics	0.658**	0.186*	-0.818	0.565***	0.563***	0.238	0.956***	0.591*	0.713**
	(0.311)	(0.112)	(0.810)	(0.092)	(0.153)	(0.595)	(0.216)	(0.328)	(0.303)
no_exporter	-0.331*	-0.393***	-0.376	-0.120**	0.186***	-0.312	-0.351***	-0.361***	-0.430**
	(0.173)	(0.072)	(0.464)	(0.053)	(0.058)	(0.229)	(0.088)	(0.118)	(0.219)
lage	-0.091	0.042	-0.260	0.179***	0.048	0.021	0.070	-0.182*	-0.520**
	(0.082)	(0.035)	(0.379)	(0.034)	(0.043)	(0.350)	(0.060)	(0.098)	(0.216)
lliquid	0.866*	0.488*	-1.659	-0.829***	-0.162	-0.620	0.382	0.107	-0.093
	(0.446)	(0.291)	(1.213)	(0.208)	(0.238)	(1.116)	(0.437)	(0.427)	(0.532)
neg_liquid	0.027	-0.128**	-0.056	-0.085*	-0.206***	-0.390	-0.066	-0.199	-0.235
	(0.097)	(0.063)	(0.353)	(0.049)	(0.061)	(0.413)	(0.103)	(0.128)	(0.209)
lfc	0.103**	0.141***	0.324*	0.145***	0.174***	0.118	0.105**	0.199***	0.015
	(0.052)	(0.031)	(0.173)	(0.025)	(0.029)	(0.110)	(0.048)	(0.058)	(0.110)
rd_dum	0.115	0.050	0.835	0.075	-0.039	-0.066	0.298	0.158	0.218
	(0.448)	(0.099)	(0.598)	(0.088)	(0.130)	(0.344)	(0.188)	(0.149)	(0.194)
city200	-0.336***	-0.283***	0.591	-0.014	0.032	-0.166	-0.120	0.062	-0.395**
	(0.070)	(0.062)	(0.395)	(0.073)	(0.089)	(0.519)	(0.090)	(0.153)	(0.177)
Effects of the business cycle dummy variable:									
Panel C: Short-run dynamics									
Speed of Adjustment’	0.008***	-0.004***	-0.032***	0.019***	-0.014***	0.078***	-0.022***	-0.019***	0.020***
	(0.007)	(0.007)	(0.028)	(0.012)	(0.010)	(0.071)	(0.009)	(0.009)	(0.024)
Panel D: Long-run equilibrium									
lr_sales’	0.067	-0.138	0.229**	-0.103	0.014	-0.165	0.002	0.070	0.058
	(0.480)	(0.106)	(0.099)	(0.063)	(0.165)	(0.268)	(0.103)	(0.047)	(0.091)
lr_tfp’	-0.106	0.170	-0.236*	0.052	0.008	0.348	0.046	-0.018	0.846

	(0.453)	(0.123)	(0.123)	(0.067)	(0.222)	(0.312)	(0.103)	(0.053)	(0.643)
p_capstate’	-0.088	-0.100	0.194	0.001	-0.062	-0.226	0.113	0.497***	0.459
	(0.147)	(0.156)	(0.509)	(0.062)	(0.164)	(0.376)	(0.120)	(0.178)	(0.290)
p_capcoll’	-0.041	-0.044	0.492	-0.095	-0.008	-0.140	0.161	0.078	0.263
	(0.148)	(0.118)	(0.524)	(0.071)	(0.097)	(0.266)	(0.117)	(0.149)	(0.197)
p_capcorporate’	-0.089	0.002	0.379	-0.048	0.009	-0.061	0.104	-0.006	0.234
	(0.137)	(0.075)	(0.544)	(0.046)	(0.063)	(0.198)	(0.069)	(0.071)	(0.158)
p_capindividual’	-0.023	-0.049	0.162	-0.081	0.051	-0.146	0.111	0.002	0.180
	(0.151)	(0.095)	(0.853)	(0.052)	(0.075)	(0.190)	(0.072)	(0.065)	(0.161)
p_capforeign’	0.207	0.079	-0.672	-0.127***	-0.014	-0.036	0.039	0.037	0.149
	(0.199)	(0.055)	(4.105)	(0.049)	(0.047)	(0.084)	(0.088)	(0.071)	(0.135)
no_politics’	-0.029	-0.088**	-0.034	-0.009	-0.035	0.019	-0.106**	0.008	0.057
	(0.077)	(0.043)	(0.268)	(0.025)	(0.034)	(0.059)	(0.052)	(0.058)	(0.047)
high_politics’	-0.154	-0.093	-0.068	-0.038	-0.209**	0.120	-0.157	-0.206	-0.154*
	(0.353)	(0.059)	(0.220)	(0.042)	(0.092)	(0.175)	(0.108)	(0.145)	(0.093)
no_exporter’	0.030	-0.001	0.208	-0.065*	0.012	0.004	0.008	0.084	0.159
	(0.166)	(0.055)	(0.159)	(0.034)	(0.045)	(0.093)	(0.047)	(0.057)	(0.114)
Lage’	-0.013	-0.022	0.006	-0.031***	0.004	-0.035	-0.053*	0.026	0.155
	(0.057)	(0.023)	(0.096)	(0.012)	(0.022)	(0.089)	(0.029)	(0.036)	(0.098)
Lliquid’	-0.065	-0.189	-0.316	-0.030	-0.082	-0.291	0.087	0.210	0.226
	(0.423)	(0.254)	(0.612)	(0.126)	(0.212)	(0.575)	(0.180)	(0.193)	(0.221)
neg_liquid’	-0.064	0.003	-0.188	-0.019	-0.012	-0.046	0.012	0.019	0.091
	(0.064)	(0.046)	(0.177)	(0.027)	(0.048)	(0.150)	(0.052)	(0.057)	(0.092)
lfc’	-0.011	-0.008	-0.027	-0.033**	0.033*	0.005	0.016	-0.029	0.029
	(0.031)	(0.020)	(0.076)	(0.013)	(0.017)	(0.030)	(0.024)	(0.027)	(0.038)

rd_dum’	-0.010	0.064	-0.541**	0.153***	0.042	0.116	0.035	-0.019	0.003
	(0.493)	(0.091)	(0.242)	(0.055)	(0.100)	(0.176)	(0.098)	(0.073)	(0.082)
city200’	0.050	0.047	-0.216	-0.119***	0.143**	0.005	0.027	0.063	0.131
	(0.054)	(0.036)	(0.141)	(0.042)	(0.064)	(0.189)	(0.041)	(0.072)	(0.099)
Observations	12,784	16,074	882	63,452	33,301	17,114	12,648	7,941	23,095
Number of firm	5,222	6,132	273	23,241	12,571	6,327	5,421	3,116	7,998
AR(1)	-13.90	-13.07	-2.904	-28.62	-2.153	-2.213	-4.272	-10.54	-1.653
P(ar1)	0	0	0.00368	0	0.0313	0.0269	1.94e-05	0	0.0983
AR(2)	-0.513	0.119	1.501	-0.0806	1.147	-1.238	0.555	1.518	-1.182
P(ar2)	0.608	0.905	0.133	0.936	0.251	0.216	0.579	0.129	0.237
Hansen test	6.374	7.893	12.57	3.568	4.376	2.619	7.246	3.024	7.723
P(Hansen)	0.383	0.639	0.127	0.168	0.112	0.106	0.510	0.0820	0.259

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 5.5b: System GMM estimation of the asymmetric threshold model augmented with TFP, China 2000-2007 (ii)

Dependent Variable: *lr_stocks*	Printing sic23	Culture sic24	Petroleum Processing sic25	Chemical sic26	Medical sic27	Rubber sic29	Plastic sic30	Non-metal Products sic31	Metal Products sic34
Panel A: Short-run dynamics									
Speed of Adjustment	0.523***	0.201**	0.248*	0.548***	0.525***	0.372***	0.405***	0.239**	0.227
	(0.113)	(0.083)	(0.135)	(0.023)	(0.123)	(0.092)	(0.029)	(0.097)	(0.166)
Panel B: Long-run equilibrium									
lr_sales	0.483*	1.299**	1.957**	0.910***	0.497***	0.830***	0.465***	0.171	0.948***
	(0.266)	(0.629)	(0.917)	(0.042)	(0.159)	(0.270)	(0.065)	(0.218)	(0.235)
lr_tfp	-0.359	-2.064**	-0.815***	-2.089***	-0.510***	-0.876**	-0.496***	-0.367***	-0.684***
	(0.375)	(0.865)	(0.314)	(0.521)	(0.087)	(0.389)	(0.061)	(0.102)	(0.162)
p_capstate	-1.873***	1.357	1.114	-0.698***	-0.333*	-0.102	-0.148	-1.142***	-0.457
	(0.549)	(1.343)	(1.286)	(0.206)	(0.187)	(0.244)	(0.139)	(0.375)	(0.410)
p_capcoll	-1.512***	-0.717	0.913	-0.848***	-0.344**	-0.231	-0.581***	-1.097***	-0.501*
	(0.380)	(0.544)	(1.465)	(0.148)	(0.175)	(0.276)	(0.107)	(0.315)	(0.264)
p_capcorporate	-1.432***	-0.138	0.767	-0.742***	-0.213	-0.384*	-0.549***	-0.765***	-0.551**
	(0.356)	(0.575)	(1.115)	(0.130)	(0.140)	(0.202)	(0.088)	(0.232)	(0.274)
p_capindividual	-1.606***	0.182	1.490	-0.809***	-0.258	-0.330	-0.681***	-0.892***	-0.430*
	(0.354)	(0.744)	(1.589)	(0.131)	(0.180)	(0.217)	(0.082)	(0.277)	(0.237)
p_capforeign	-0.501**	0.115	1.069	0.028	0.142	0.136	0.062	-0.282	0.012
	(0.242)	(0.334)	(0.848)	(0.093)	(0.119)	(0.197)	(0.074)	(0.229)	(0.206)
no_politics	-0.059	-0.391	0.108	-0.036	0.004	0.086	-0.083	0.034	-0.067

	(0.077)	(0.251)	(0.231)	(0.031)	(0.067)	(0.146)	(0.052)	(0.086)	(0.125)
high_politics	0.435**	0.712	-1.704	0.346***	0.224***	0.273	0.465***	0.835***	0.341*
	(0.188)	(0.457)	(1.625)	(0.067)	(0.059)	(0.175)	(0.096)	(0.229)	(0.175)
no_exporter	-0.686***	-0.031	0.688	-0.171***	-0.244*	-0.363**	-0.327***	-0.537***	-0.197
	(0.200)	(0.263)	(0.766)	(0.042)	(0.145)	(0.141)	(0.060)	(0.146)	(0.167)
lage	0.126**	-0.468	-0.218	-0.056	0.091**	0.092	0.033	-0.195***	-0.321
	(0.050)	(0.439)	(0.283)	(0.055)	(0.043)	(0.093)	(0.043)	(0.075)	(0.200)
lliquid	-1.891***	0.339	1.492	0.038	0.231	0.212	-0.792***	-0.275	-0.414
	(0.658)	(0.906)	(1.613)	(0.130)	(0.313)	(0.525)	(0.201)	(0.488)	(0.538)
neg_liquid	-0.281***	-0.435*	0.082	-0.137**	-0.067	-0.175	-0.249***	-0.299**	-0.258**
	(0.099)	(0.249)	(0.256)	(0.057)	(0.086)	(0.116)	(0.061)	(0.142)	(0.117)
lfc	0.125***	0.341*	0.447*	0.136***	0.109***	0.191***	0.236***	0.085**	0.001
	(0.037)	(0.176)	(0.233)	(0.036)	(0.021)	(0.065)	(0.032)	(0.035)	(0.081)
rd_dum	0.963***	-0.169	-0.912	0.231***	0.297***	0.427***	0.340***	0.650***	0.328
	(0.303)	(0.393)	(0.837)	(0.037)	(0.098)	(0.155)	(0.075)	(0.214)	(0.245)
city200	-0.023	-0.352	-0.172	-0.135**	-0.071	0.143	0.045	-0.027	-0.244*
	(0.143)	(0.386)	(0.242)	(0.054)	(0.054)	(0.140)	(0.093)	(0.134)	(0.146)
Effects of the business cycle dummy variable:									
Panel C: Short-run dynamics									
Speed of	0.151***	0.001***	0.042***	-0.006***	0.000	0.001***	-0.013***	-0.047***	0.019***
Adjustment’	(0.075)	(0.012)	(0.024)	(0.004)	(0.160)	(0.010)	(0.007)	(0.041)	(0.014)
Panel D: Long-run equilibrium									
lr_sales’	0.414**	-0.061	-0.145**	0.005	-0.058	0.004	0.005	0.395***	0.061
	(0.187)	(0.075)	(0.067)	(0.028)	(0.172)	(0.153)	(0.036)	(0.139)	(0.086)
lr_tfp’	-0.628**	0.165	-0.007	0.298	0.043	-0.001	-0.039	-0.140***	-0.023

	(0.281)	(0.113)	(0.032)	(0.252)	(0.090)	(0.232)	(0.043)	(0.051)	(0.020)
p_capstate’	0.985**	-0.039	-0.413**	0.164	0.044	-0.182	-0.086	0.424***	-0.007
	(0.411)	(0.174)	(0.173)	(0.156)	(0.181)	(0.113)	(0.080)	(0.158)	(0.094)
p_capcoll’	0.658***	0.039	-0.392**	0.147	0.028	-0.077	0.004	0.331**	-0.005
	(0.251)	(0.113)	(0.200)	(0.123)	(0.149)	(0.119)	(0.056)	(0.133)	(0.140)
p_capcorporate’	0.620***	-0.140	-0.356**	0.121	0.047	-0.087	0.034	0.203**	0.032
	(0.235)	(0.086)	(0.163)	(0.110)	(0.117)	(0.082)	(0.045)	(0.095)	(0.094)
p_capindividual’	0.570**	-0.197**	-0.490***	0.106	0.076	-0.051	0.011	0.310***	0.018
	(0.236)	(0.082)	(0.166)	(0.110)	(0.140)	(0.085)	(0.042)	(0.112)	(0.122)
p_capforeign’	0.277*	-0.052	-0.198	0.101	0.056	0.059	0.011	0.114	0.010
	(0.154)	(0.072)	(0.190)	(0.063)	(0.076)	(0.087)	(0.038)	(0.072)	(0.091)
no_politics’	0.033	0.061	-0.013	-0.002	-0.023	-0.122**	0.035	0.008	0.018
	(0.043)	(0.053)	(0.067)	(0.022)	(0.045)	(0.053)	(0.026)	(0.031)	(0.029)
high_politics’	-0.221*	-0.439***	0.194	-0.016	-0.050	0.033	-0.014	-0.324***	-0.050
	(0.125)	(0.157)	(0.145)	(0.038)	(0.034)	(0.079)	(0.046)	(0.095)	(0.070)
no_exporter’	0.415***	0.011	-0.129	0.047	-0.008	0.041	0.003	0.189***	0.061
	(0.142)	(0.060)	(0.117)	(0.033)	(0.161)	(0.094)	(0.033)	(0.056)	(0.068)
Lage’	0.002	0.038	-0.003	0.040	-0.003	-0.013	-0.011	0.007	0.017
	(0.028)	(0.036)	(0.036)	(0.041)	(0.023)	(0.032)	(0.020)	(0.014)	(0.024)
Lliquid’	1.289***	-0.232	-0.014	0.146	-0.022	-0.149	0.086	0.729***	0.209
	(0.498)	(0.202)	(0.292)	(0.090)	(0.259)	(0.251)	(0.109)	(0.247)	(0.176)
neg_liquid’	0.164**	0.010	-0.108	0.034	-0.013	-0.003	0.034	0.042	-0.033
	(0.071)	(0.060)	(0.070)	(0.043)	(0.091)	(0.047)	(0.031)	(0.036)	(0.057)
lfc’	-0.012	-0.060**	-0.065*	0.010	0.010	-0.036	-0.033**	0.006	0.035
	(0.019)	(0.031)	(0.036)	(0.025)	(0.018)	(0.025)	(0.015)	(0.011)	(0.030)

rd_dum’	-0.540***	0.165**	0.180	-0.007	-0.015	-0.023	0.062	-0.302***	-0.066
	(0.203)	(0.075)	(0.119)	(0.026)	(0.113)	(0.100)	(0.040)	(0.088)	(0.095)
city200’	0.024	0.024	0.107	0.015	0.007	-0.036	-0.071	0.019	0.058
	(0.070)	(0.071)	(0.070)	(0.044)	(0.028)	(0.069)	(0.046)	(0.031)	(0.043)
Observations	14,822	8,954	5,141	59,665	16,529	8,253	28,148	66,990	41,781
Number of firm	5,160	3,277	1,988	20,934	5,285	3,086	11,177	23,347	18,214
AR(1)	-12.78	-10.27	-8.445	-2.653	-14.42	-10.18	-8.061	-2.238	-3.191
P(ar1)	0	0	0	0.00797	0	0	0	0.0252	0.00142
AR(2)	-1.454	0.494	0.101	-0.608	-0.0309	0.0938	-1.642	0.392	-1.889
P(ar2)	0.146	0.621	0.920	0.543	0.975	0.925	0.101	0.695	0.0589
Hansen test	2.329	4.613	2.375	7.443	7.271	4.491	5.276	2.835	2.983
P(Hansen)	0.312	0.0996	0.667	0.114	0.296	0.611	0.153	0.586	0.225

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

Table 5.5c: System GMM estimation of the asymmetric threshold model augmented with TFP, China 2000-2007 (iii)

Dependent Variable: *lr_stocks*	Machinery & Equipment sic35	Transport Equipment sic37	Measuring Instrument sic41	Other Manufacturing sic43	Electronic Power sic44	Gas Production sic45	Water Production sic46	Coal Mining sic60
Panel A: Short-run dynamics								
Speed of Adjustment	0.188***	0.371***	0.349***	0.284***	0.337***	0.755***	0.674***	0.320***
	(0.019)	(0.045)	(0.053)	(0.054)	(0.041)	(0.151)	(0.158)	(0.095)
Panel B: Long-run equilibrium								
lr_sales	1.497***	1.334***	0.588***	0.567**	1.560***	1.173***	0.642***	2.283***
	(0.235)	(0.138)	(0.106)	(0.223)	(0.181)	(0.404)	(0.111)	(0.782)
lr_tfp	-1.560***	-1.151***	-0.568***	-0.621*	-0.718***	-0.768**	-0.183***	-2.482***
	(0.185)	(0.128)	(0.088)	(0.355)	(0.079)	(0.305)	(0.043)	(0.912)
p_capstate	0.912**	0.006	-0.107	-0.364	-0.235	0.610*	0.852	-0.911
	(0.364)	(0.144)	(0.171)	(0.224)	(0.428)	(0.364)	(0.615)	(1.225)
p_capcoll	0.659*	-0.551***	-0.457**	-0.808***	-0.248	0.550	1.128**	-1.436
	(0.361)	(0.125)	(0.203)	(0.185)	(0.493)	(0.605)	(0.542)	(1.213)
p_capcorporate	0.416	-0.513***	-0.310**	-0.750***	-0.425	0.743**	0.997*	-1.760
	(0.289)	(0.103)	(0.121)	(0.143)	(0.358)	(0.366)	(0.573)	(1.175)
p_capindividual	0.549*	-0.670***	-0.708***	-0.753***	-0.117	1.060*	0.576	-1.257
	(0.334)	(0.099)	(0.132)	(0.147)	(0.437)	(0.628)	(0.580)	(1.215)
p_capforeign	0.384***	-0.245**	0.098	-0.033	-0.159	0.782**	0.308	-2.923
	(0.128)	(0.119)	(0.121)	(0.135)	(0.337)	(0.378)	(0.777)	(2.271)
no_politics	0.278**	-0.128**	0.021	-0.103	0.300**	-0.055	0.087	0.264

	(0.115)	(0.055)	(0.082)	(0.088)	(0.151)	(0.189)	(0.150)	(0.241)
high_politics	0.174	0.072	0.195*	0.830***	-0.800***	-0.182	-0.231	-1.689
	(0.130)	(0.089)	(0.114)	(0.136)	(0.251)	(0.574)	(0.351)	(1.263)
no_exporter	0.284*	0.132	-0.083	0.015	0.576	-0.004	0.465	0.791**
	(0.150)	(0.096)	(0.097)	(0.092)	(0.516)	(0.669)	(0.745)	(0.325)
lage	-0.321***	-0.058	-0.052	0.130	-0.556***	-0.159	-0.028	-0.352*
	(0.101)	(0.053)	(0.064)	(0.103)	(0.092)	(0.255)	(0.099)	(0.196)
lliquid	1.492***	0.085	-0.740**	-0.770**	1.263**	-1.024	1.121***	1.265
	(0.481)	(0.222)	(0.288)	(0.384)	(0.609)	(0.869)	(0.423)	(0.836)
neg_liquid	-0.002	-0.120*	-0.295***	-0.233**	0.005	-0.154	0.092	-0.101
	(0.090)	(0.064)	(0.092)	(0.111)	(0.128)	(0.205)	(0.084)	(0.196)
lfc	0.272***	0.178***	0.267***	0.271***	0.111	0.120**	0.083***	0.168**
	(0.032)	(0.029)	(0.044)	(0.071)	(0.071)	(0.051)	(0.026)	(0.073)
rd_dum	-0.240	-0.127	0.376***	0.760***	-0.970***	-0.221	0.418*	-0.051
	(0.205)	(0.122)	(0.110)	(0.137)	(0.276)	(0.359)	(0.215)	(0.507)
city200	0.430***	-0.049	0.097	0.139	-0.361**	0.073	0.024	-0.695**
	(0.112)	(0.067)	(0.129)	(0.128)	(0.172)	(0.262)	(0.127)	(0.276)
Effects of the business cycle dummy variable								
Panel C: Short-run dynamics								
Speed of Adjustment'	-0.082***	0.012***	0.003***	-0.002***	-0.003***	0.011***	0.007***	0.032***
	(0.021)	(0.011)	(0.007)	(0.006)	(0.006)	(0.019)	(0.005)	(0.009)
Panel D: Long-run equilibrium								
lr_sales'	-0.157***	-0.026	0.107	0.172*	0.018	0.085	-0.017	-0.590***
	(0.027)	(0.065)	(0.069)	(0.095)	(0.025)	(0.149)	(0.055)	(0.179)
lr_tfp'	0.144***	0.050	-0.017	-0.158	-0.038*	0.050	-0.032	0.704***

	(0.035)	(0.058)	(0.049)	(0.158)	(0.022)	(0.128)	(0.027)	(0.218)
p_capstate'	-0.188***	-0.050	0.179*	0.037	-0.111	-0.113	-0.198	0.168
	(0.046)	(0.073)	(0.097)	(0.107)	(0.132)	(0.227)	(0.424)	(0.282)
p_capcoll'	-0.190***	0.045	0.168	0.094	0.178	0.172	-0.181	0.250
	(0.046)	(0.056)	(0.114)	(0.082)	(0.189)	(0.405)	(0.376)	(0.275)
p_capcorporate'	-0.134***	0.030	0.100	0.061	-0.095	-0.342*	-0.170	0.487*
	(0.037)	(0.044)	(0.073)	(0.064)	(0.127)	(0.206)	(0.393)	(0.278)
p_capindividual'	-0.162***	0.043	0.154*	0.112*	-0.059	-0.419	0.021	0.240
	(0.035)	(0.050)	(0.081)	(0.064)	(0.144)	(0.325)	(0.409)	(0.278)
p_capforeign'	-0.053	0.042	-0.063	0.005	-0.007	-0.422	0.110	1.525**
	(0.037)	(0.059)	(0.073)	(0.054)	(0.135)	(0.264)	(0.619)	(0.751)
no_politics'	-0.043**	0.065**	0.045	-0.024	-0.074	0.172	-0.087	-0.118
	(0.018)	(0.029)	(0.043)	(0.037)	(0.058)	(0.172)	(0.111)	(0.079)
high_politics'	-0.015	0.017	0.021	-0.056	-0.053	-0.324	0.086	0.891***
	(0.022)	(0.041)	(0.065)	(0.053)	(0.062)	(0.294)	(0.239)	(0.308)
no_exporter'	-0.082***	-0.004	0.031	0.049	-0.005	0.282	-0.226	-0.717***
	(0.026)	(0.051)	(0.072)	(0.044)	(0.156)	(0.415)	(0.442)	(0.201)
Lage'	-0.031***	0.018	0.023	-0.017	0.006	0.028	0.041	0.121**
	(0.009)	(0.016)	(0.027)	(0.024)	(0.023)	(0.108)	(0.048)	(0.050)
Lliquid'	-0.379***	-0.190	0.341*	0.241	-0.203	0.555	-0.505*	-0.221
	(0.097)	(0.138)	(0.196)	(0.184)	(0.220)	(0.702)	(0.288)	(0.314)
neg_liquid'	-0.070***	-0.026	-0.021	0.018	0.049	0.043	-0.067	0.003
	(0.021)	(0.033)	(0.060)	(0.049)	(0.050)	(0.159)	(0.057)	(0.074)
lfc'	-0.014*	-0.013	0.023	-0.037*	-0.030	0.056	0.007	0.043
	(0.008)	(0.013)	(0.027)	(0.019)	(0.027)	(0.040)	(0.017)	(0.029)

rd_dum’	0.127***	0.068	-0.083	-0.147**	0.001	-0.011	-0.209	0.216
	(0.030)	(0.069)	(0.071)	(0.071)	(0.082)	(0.211)	(0.187)	(0.208)
city200’	-0.100***	-0.000	0.069	0.047	0.007	-0.013	0.048	0.182***
	(0.029)	(0.029)	(0.070)	(0.060)	(0.043)	(0.128)	(0.068)	(0.064)
Observations	101,543	32,628	11,120	19,181	13,108	1,429	7,691	11,762
Number of firm	39,180	11,701	5,908	8,000	4,117	463	2,170	4,393
AR(1)	-32.29	-3.023	-7.302	-12.78	-4.967	-4.604	-11.99	-3.174
P(ar1)	0	0.00250	0	0	6.79e-07	4.15e-06	0	0.00150
AR(2)	1.351	1.884	1.485	1.027	-1.045	0.529	1.371	1.157
P(ar2)	0.177	0.0596	0.138	0.305	0.296	0.596	0.170	0.247
Hansen test	4.018	0.102	3.192	5.843	0.198	3.299	7.735	1.059
P(Hansen)	0.134	0.749	0.203	0.0539	0.656	0.771	0.258	0.303

All estimations are conducted using the Arellano and Bond (1991) system GMM technique. All variables are defined in the main text. The dependent variable is led by one period. The AR(2) is a test for a second-order serial correlation in the residuals, which is distributed as N(0,1) under the null hypothesis of no serial correlation.

Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

5.6 Conclusions

In this chapter, we supplied a study of the relationship between TFP and inventory performance in order to test the impact of innovation, especially the efficiency innovation, on inventory management. Generally speaking, TFP, as a proxy for firm's productivity, is detected to be a superior measurement of inventory management innovation since it captures both technological progress and technical efficiency change. The augment of TFP into the variant error-correction model increases the reliability of the estimations.

Our results suggest that the inventory reducing impact of TFP is significant for most of the industries. It states that firms with more product innovation are more capable of matching their production and inventory with demand over product life cycles, which leads to a more efficient inventory management. Moreover, an efficient production process reduces flow time and lead time, which allows firms eliminate waste, lower the reorder point and reduce safety inventory. All these benefits contribute to a lower inventory volume.

When allowing the asymmetric mechanism, we find that, same as other variables that determine long-run target inventory level, TFP works symmetrically between the upswing and downswing of business cycle, which means the benefits of productivity improvement are stable and cannot be discharged by adverse economic environment.

Chapter 6. Overall Conclusion

Chapter 6: Overall Conclusion

6.1 Introduction

This doctoral thesis examines the inventory management and performance in China. Numerous investigations acknowledge that inventory plays an essential role in the provision of products and services at all levels of an economy, and inventory management and its development have complex impacts on firm's performance. However, the literature lacks evidence to understand the industry heterogeneity in inventory control. In this thesis, an extensive review of the literature led us to seek to investigate firm' inventory management behaviour under different economic condition. This is done by adopting a regime-switching transition variable and analysing the error-correction model allowing an asymmetric adjustment mechanism. Moreover, following the study of TFP growth in China (Ding et al., 2014), this research attempts to uncover the relationship between innovation and inventory performance through examining TFP's inventory reducing impact.

This thesis has six chapters. The first chapter provides an overview of the research background, objectives, database, and contributions of this doctoral thesis. In Chapter 2, we supplied a literature review on the relationships between inventory management and firm's exogenous and endogenous factors, as well as the development of inventory control and the discussion of their influences on firm's performance. Chapter 3 is devoted to analysing firm's inventory adjustment pattern in short-run and the determinants of firm's target inventory level in long-run. This is done by estimating the error-correction model of inventory and taking the industry heterogeneity into consideration. Chapter 4 focuses on the influence of external environment fluctuations on firm's inventory performance. It aims to detect the asymmetric mechanism of inventory adjustment. Chapter 5 examines the outcome of inventory management development in China and TFP is employed as a comprehensive factor to capture the innovations. The current chapter, Chapter 6, supplies an overall conclusion to the research project and addresses the policy implications, research limitations and future research directions.

6.2 Overall summary

This doctoral thesis explores inventory management and performance in China with emphasis on the industry heterogeneity using a large unbalanced panel datasets of 648,030 firms in 26 manufacture industries reported by the Chinese National Bureau of Statistics (NBS). This doctoral thesis makes an empirical contributions to the literature in several ways. First, this thesis supplies an extension of the long-run equilibrium and short-run dynamics analysis of inventory over different Chinese manufacturing industries. Secondly, we analyse the impacts of business cycle on inventory accumulation by allowing an asymmetric partial adjust mechanism. Finally, this research extends the existing literature on inventory management improvement by using TFP as a determinant of innovation, and its relationship with inventory levels is analysed to examine the outcome of SCM development.

The main conclusion of the thesis can be summarised as follows: First, by estimating the variant error-correction model, we find a partial inventory adjustment mechanism and a loss in intensity of the adjustment path in short-run. The speeds of adjustment toward the desired level of inventories are significantly positive, and they are various among different industries. From the long-run perspectives, the state-owned ownership structure has a general impact of inventory increasing. The U-shaped inventory-financial performance relation is detected for most of the industries. Also, the managerial fixed cost is an important indicator of the target inventory level among all industries. Heterogeneous exists on the effect of political affiliation and the coefficients of high and no political affiliation do not show completely symmetrical patterns. The export behaviour is not found to impact strongly consistent with our expectations, possibly due to the facts of the large volume of processing trade. When considering the proxies of innovation, we find that firms in 18 industries tend to reduce their long-run target level of inventory continually from 2000 to 2009, to some extent, this could explain the inventory reducing impact of innovation. Moreover, in line with previous literature, younger firms perform with a lower level of inventories with more advanced technologies than older firms. However, we do not find any evidence to support the idea of inventory reducing impact of R&D spending because of the long distance from the technological frontier that the Chinese manufacturers encounter with.

Second, the whole sample is divided into two parts according to the industry-specific business cycle, and the deviations of the estimated coefficients between the upswing and downswing of business cycle provide evidence on the mechanism of asymmetric adjustment. This mechanism could be commonly found in the short-run: the deviations of the speed of adjustment are significantly positive for 18 out of 26 industries, which indicate a higher speed of adjustment during economic slowdown. However, the asymmetric phenomenon is not obvious in the long-run perspective, according to which we can conclude that Chinese firms only adjust at heterogeneous speed in short-run dynamic rather than adjust toward heterogeneous targets in terms of long-run during the business cycle fluctuation.

Third, the inventory reducing impact of innovation is claimed by adopting TFP as the indicator of innovation. TFP is detected to be a superior determinant of inventory management innovation since it measures the efficiency with which a firm utilizes its factor inputs and, therefore, captures both technological progress and technical efficiency improvement. Our results suggest a significantly negative relationship between TFP and inventory volume for most of the industries, which means by adopting innovations, Chinese firms can reduce their inventory accumulation considerably. When taking the asymmetric mechanism into consideration, we find that TPF works symmetrically between the upswing and downswing of business cycle, which means the benefits of product and process innovations are stable and cannot be discharged by adverse economic environment.

This thesis has important policy implications for the government and individual firms. First of all, this thesis provides a number of explanations on how different factors affect the level of inventory. Therefore, it may inspire firms to modify their inventory control system according to their own characteristics.

Besides, this research project suggests the important of innovation in inventory management. Our findings uncover the statistical results to support the idea of inventory reducing impact of innovation, which might urge the government to issue innovation promotion policies for the Chinese manufacturers and encourage firms to engage in product innovation and process efficiency improvement.

6.3 Limitations and future research

The study on inventory management and performance continues to be an interesting topic for the empirical researchers. In this section, we aim to briefly discuss the limitations of this thesis and suggest some possible future research direction to extend our research.

First, since the data related to intermediate inputs are not recorded in 2008 and 2009, we only take finished good into account when calculating the inventory volume in this research. However, Guariglia (1998) states that the work-in-process and raw material inventories, which are characterised by low adjustment costs, are generally more sensitive to financial factors than total inventories. Accordingly, it is expected that other determinants that we have discussed in previous chapters might also have stronger impacts on work-in-process and raw material inventories. Therefore, an interesting extension of this research project would be investigating inventory performance and its adjustment pattern by taking the work-in-process and raw material inventories into consideration.

In this thesis, when analysing the inventory reduction impact of TFP, TFP is treated as an instrument variable in the GMM estimation. However, Lieberman and Demeester (1999) provide another explanation of negative relation between TFP and inventories. They claims that the adoption of JIT minimise levels of inventory and then force firms improve their productivity so that they can eliminate waste. This reverse causality could be further analysed in future studies.

Besides, another extension of this research project would be investigating the inventory adjustment pattern by employing panel data with a higher frequency. The dataset involved in our study only contains annual observations. However, the change of inventory level is usually described as a high-frequency phenomenon and, therefore, quarterly data are desirable (Carpenter et.al., 1998). Our error-correction models might supply further insight into the inventory performance, especially the symmetric and asymmetric short-run adjustment pattern, of the Chinese manufacturers if quarterly or monthly data are used.

Last but not the least, the error correction model of inventory assumes a constant adjustment speed across firms of the same industry over time, which is a very strong assumption. It would be an interesting improvement if we take a three-stage procedure that allows for time-varying firm specific adjustment speeds into consideration.

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Appendix

Appendix 1. Descriptive statistics of main variables:

Variables	Definition	2000-2009		2000		2009	
		Mean	SD	Mean	SD	Mean	SD
stocks	inventories (billion RMB 2002 prices)	0.011	0.099	0.010	0.065	0.009	0.094
sales	sales (billion RMB 2002 prices)	0.084	0.827	0.052	0.462	0.097	1.093
age	firm age (based on year-of-birth)	16.700	59.059	25.256	88.306	12.388	37.205
liquidity	ratio of (current assets-current liabilities- inventories) to total assets	0.137	0.193	0.127	0.182	0.174	0.210
N	Number of observations	2,290,530		149,851		155,903	
firm_id	Number of firms	648,030					

This table is induced in order to show the real pattern of the main data. Accordingly, on average, firms have 0.011 billion inventories with 0.084 billion sales and the average firm age of the entire sample is 16.700 years.

Appendix 2. Average proprotion of capital over different ownership sub-groups:

	SOE	**Collectives**	**Private**	**HK/Macao/Taiwan**	**Foreign**
p_capstate	0.954	0.006	0.005	0.010	0.016
p_capcoll	0.007	0.922	0.010	0.015	0.015
p_capcorporate	0.010	0.016	0.339	0.023	0.037
p_capindividual	0.015	0.032	0.624	0.010	0.013
p_caphkmactai	0.006	0.012	0.010	0.940	0.002
p_capforeign	0.008	0.011	0.012	0.002	0.917

A firm is allocated into one ownership sub-group if proportion of capital owned by that kind of owner is equal or larger than 50%. For firms with less than 50% share ownership in a particular category, they were assigned to the largest ownership sub-group.

The problem of non-linear impact of ownership may not be a serious issue in this research. According to the table, for state owned enterprises, the average proportion of capital owned by state is 95.4%, which means the state plays a dominant role in these firms. a slight fluctuation of percentage of capital ownership will not lead to a huge change of ownership structure or even an transform of firm type. The situation is almost the same for other ownership sub-groups and therefore, the non-linear impact of ownership would not be a concern in this thesis.

Appendix 3. Speed of adjustment:

The half-life convergence time is usually calculated based on a model in which the dependent variable is specified as the difference between the observation in T and in 0:

$$\ln\frac{I_{T,i}}{I_{0,i}} = \alpha + \beta\ln I_{0,i} + \varepsilon_i$$

$$\ln I_{T,i} - ln I_{0,i} = \alpha + \beta\ln I_{0,i} + \varepsilon_i$$

$$\ln I_{T,i} = \alpha + (1 + \beta)\ln I_{0,i} + \varepsilon_i$$

where T is time period and β (assumed to be negative) can be used to measure the actual speed-of-convergence.

$$\mathrm{b} = -\frac{\ln(1+\beta)}{T}$$

The half-life is ln(2)/b.

The model estimated here (an autoregressive distributed lag model) is different. Recall that

$$I_{it} = \varphi I_{i,t-1} + \pi' X_{it} + v_{it} \qquad (3.6)$$

Here the speed-of-adjustment is calculated as (1- φ) and the long-run [short-run] impact of X on I is $\pi/(1-\varphi)$ $[\pi]$. That is, in the long-run the inventory level is given by: $I_i^* = [\frac{\pi'}{1-\varphi}]X_i$. The speed-of-adjustment here lies between 0 and 1 (low values of φ imply faster adjustment speed; the speed-of-adjustment = 0.455 which means with annual data that 45.5% of the difference between I and I* is eliminated in one year, which means it would take 2.198 years to eliminate the gap).

A good reference explaining this modelling approach is:

http://www.econ.uiuc.edu/~wsosa/econ471/dinamicmodels.pdf.