ABSTRACT

Title of Document: The Impact of Globalization on Inventory and Financial Performance: A Firm -Level and Industry -Level Analysis

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This dissertation investigates how globalization affects inventory and financial performance from both firm and industry perspectives. Drawing upon elements from classic inventory models, transaction costs, geographic economics, and international business and strategy literatures, this dissertation aims to contribute to the construction of a theory of global supply chain management through an empirical testing of hypotheses on the effects of global sourcing, exports and manufacturing offshoring (i.e., foreign subsidiaries) on inventory performance and financial performance, using data from multinational firms and U.S. manufacturing industries.

Motivated by the lack of empirical research on inventory management in a global context, and an uncertain relationship between globalization and financial performance reported in the international business and strategy literature, the first essay examines how globalization affects firm financial performance directly and indirectly through inventory management. Globalization is further examined by a two-dimensional measure: global

intensity and *extensity*. Due to increased uncertainties associated with global supply chains, globalization may significantly increase firm inventory levels. Even though manufacturing offshoring may benefit multinational firms through economies of scale and geographic diversification, escalating transaction costs and shrinking arbitrage opportunities may overwhelm benefits and lead to reduced financial performance. This direct-indirect effect model is tested using a large panel dataset of thousands of multinational firms over 1987-2007, collected from the COMPUSTAT global and segment databases. Essay 1 contributes to the supply chain management literature by providing a two-dimensional measure of globalization: foreign market penetration (*depth*) and geographic expansion (*breadth*), and may enhance our understanding of global supply chains.

The second essay analyzes the impact of global inbound and outbound supply chains on inventory performance within the U.S. economy. This research argues that global activity (i.e., global sourcing and exports) has offsetting effects on domestic inventory levels: an increasing impact due to risk considerations and a decreasing impact due to cost pressure from rising inventory costs. According to location theory, rooted in geographic economics, and "new trade theory" on intra-firm trade, firms may be able to efficiently allocate inventories to low cost regions along their global supply chains. To the extent that allocative efficiency may only be realized once a certain level of global activity is reached, it is hypothesized that the impact of international trade on domestic inventory is inverted-U shaped. i.e., as globalization increases, inventory levels first increase due to the longer and more complex supply chains, then decrease as firms determine how to more efficiently allocate their inventory across borders. The hypotheses

are tested using inventories at all three stages (raw materials, finished goods and work-in-process inventory) and industry operating data from U.S. manufacturers over the period 1997-2005. Regression results indicate a strong invert-U shaped relationships existing between import intensity (measured by imported raw materials as a percentage of industry total cost of materials) and raw materials inventory in days of supply, and between export intensity (measured by exported finished goods as a percentage of total value of industry shipments) and finished goods inventory in days of supply. Essay 2 makes two contributions: theoretically, it is the first effort to connect international trade with inventory performance; empirically, results based on all U.S. manufacturers over a recent nine-year period may provide a benchmark for management when designing global inventory strategy.

In summary, this dissertation comprehensively investigates the impact of global supply chains on inventory performance and financial performance in the context of multinational firms and U.S. domestic manufacturers and hence is expected to enhance our understanding of global supply chain management theory and practices.

The Impact of Globalization on Inventory and Financial Performance: A Firm-Level and Industry-Level Analysis

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Dedication

This dissertation is dedicated to my wife, Yingxia, and my son, Harry. My wife's patience, encouragement, and support over the past four years made it possible for me to complete this dissertation. Harry's birth in May 2008 brought great joys to our life and became a strong motivation for me to focus and be more productive than I could have been.

Acknowledgements

I would like to thank my dissertation chair, Professor Martin Dresner, for providing guidance, direction and support. Martin has been a friend as well as a mentor throughout my Ph.D. study at the University of Maryland. During the last four years, his door has always been open to doctoral students and he has been very responsive to my requests for help. Despite Martin' commitment to so many students and research projects, I am amazed that he has always been able to get back to me very quickly with revisions, comments and advice all over my manuscripts, line by line and word by word. Martin has been willing to help me with every aspect of my academic life, including data collection, software purchase, academic networking, job search, publication, etc. I can not image what my doctoral life would have looked like without Martin's help.

I would also like to thank my dissertation co-chair, Professor Yan Dong. Yan's critical thinking based on his erudition of business and economics literatures has challenged and inspired me to aim high and think outside the box when it comes to dissertation topics and research ideas. Yan's coach and support made it possible for me to lay out a strong foundation for my dissertation even in its early stage.

I am very grateful to Professors Tom Corsi and Sandy Boyson. I have worked closely with Tom and Sandy on a series of research projects for the Supply Chain Management Center since the first day I entered the doctoral program. In fact, it was the supply chain management course I took with them during my MBA study at Robert H. Smith School of Business in 2003 that caused my initial interest in logistics and supply chain management. Especially, I thank Tom for encouraging me to apply to the doctoral

program. Meanwhile, my sincere gratitude goes to Sandy for providing all possible assistance to my research and job search.

I would like to appreciate the scholarly guidance and the generous financial support Professor Bob Windle provided during my doctoral study. Bob has been a wonderful resource whenever I have issues concerning econometric modeling and economic theory. His academic intuition and insights have benefited me a lot in writing papers and this dissertation.

I would like to thank professor Gang-Len Chang for his valuable advice on writing a dissertation and publishing in journals.

I would like to thank professors Curt Grimm, Phil Evers, and Joe Bailey, not only because of their wonderful seminars but also due to their strategic advice and insights on job search and academic publications they provided to me.

I would like to thank Charles Freeman at Center for Strategic and International Studies and Gary Cohen, an experienced executive and currently a faculty member at the Robert H. Smith School of Business for sharing their insights into international business and global supply chains.

I would like to acknowledge the assistance I received from all other key people. John Macdonald, a wonderful peer mentor in the doctoral program, always provided me honest feedback and valuable advice on all aspects of my doctoral life. Mr. Anirudha Roy Chowdhury provided excellent assistance in collecting and processing a large-scale firm-level database. Lastly, my doctoral life would have been less fun without the companion of my fellow doctoral students.

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"Globalization is not a phenomenon. It is not just some passing trend. Today it is an overarching international system shaping the domestic politics and foreign relations of virtually every country, and we need to understand it as such".

Thomas Friedman
The Lexus and the Olive Tree (1999)

"Globalization is much like fire. Fire itself is neither good nor bad.
Used properly, it can cook food, sterilize water and heat our homes.
Used carelessly, fire can destroy homes and forests in an instant".

Keith Porter
Globalization: Good or Bad? (2008)

"The mistake is to see globalization as an either-or proposition. It's not.
The key to finding competitive advantage in this new economic
landscape lies in understanding that the world is both flat and spiky:
Economic activity is dispersing and concentrating at the same time."

Richard Florida
Megaregions: The Importance of Place (2008)

CHAPTER ONE INTRODUCTION

Manufacturing supply chains have been increasingly globalized over the past decades, a trend evidenced by escalating activity levels of international trade (global sourcing and exports) and increasing numbers of foreign subsidiaries. According to the statistics reported by U.S. Annual Survey of Manufacturers, on average, imported materials accounted for about 17% of total cost of materials for all U.S. manufacturing

sectors over the period 1997-2005 while exports of finished goods as a percentage of total value of industry shipments was about 12% over the same period. The Directory of American Firms Operating in Foreign Countries shows that over 4,000 U.S. firms operated more than 63,200 foreign branches, subsidiaries and affiliates in 191 countries in 2007, most of which are public or private manufacturing firms. For example, Ford Motor Company established manufacturing plants in 23 foreign countries, including Canada, Russia, Argentina, China, and Thailand. Global supply chains have benefited multinational firms in many ways, such as reduced materials and labor costs, increased access to foreign resources and markets, and enhanced competitive advantages. However, global operations are not free of difficulties and therefore are not a panacea for all problems facing firms. At a minimum, firms with global supply chains have to deal with surging transportation costs, cross-cultural communications, and more uncertainties across borders. *Industry Week Magazine* reports that "A manufacturing enterprise successfully expands its global supplier base, saving $20 million, only to find that logistics costs had increased by $38 million due to increased trucking expenses" (Stinnes, January 22, 2007). So it is no surprise that VIASYS, a global leader in manufacturing and marketing high-tech medical devices in more than 100 countries, has to research total costs when deciding on a global strategy, including foreign land costs, logistics costs, tax savings, and inventory transit times (Boston Industrial Consulting 2004). Recognizing that inventory flow and timing may be more important than supplier prices and freight costs, supply chain consultants believe that the mission of global supply chain managers is to "correctly place inventory when it should be and where it should be" around the globe because cycle time has a profound impact on firm profit (Craig, January 2004).

1.1 RESEARCH QUESTIONS

Intuitively, globalization is believed to bring both risks and opportunities to inventory management and firm financial performance. However, what is missing in the supply chain management literature is a theoretical framework for *global* supply chain management with explicit empirical testing for the impact of globalization on inventory and financial performance. Little systematic effort has been devoted to unraveling the intertwined relationships among globalization, inventory and financial performance. For example, in the operations management literature, especially for inventory optimization, globalization has not been considered as a specific concern since modelers can simply adjust cost parameters without specifically taking into account the context of globalization. In contrast, in the international business and strategy literature, globalization has been examined as an endogenous operating strategy, such as international geographic diversification (Hitt, Hoskisson & Ireland 1994), and its impact on financial performance has been studied from a wide variety of theoretical lenses, such as industrial economics, competitive advantage, resource-based view, transaction costs, organizational learning, etc. (e.g., Qian & Li 2008, Thomas 2006, Kotabe 2003, Campa 2002, Hitt 1997, Geringer 1989, Porter 1985, and Errunza and Senbet 1984, to list a few). Globalization is not merely an increase in distance for transporting goods but has inherent and unique characteristics which differentiate from operations within national boundaries: risk of foreign exchange rates fluctuation, different cultures and regulations governing the transactions across borders, differential tax treatment, labor and material costs, and uncertainty at border checkpoints.

In this dissertation, using a global supply chain perspective, I set out to address the central question: how does globalization affect inventory and financial performance? I have decided to tackle this question from two perspectives: a micro or firm-level analysis and an aggregate industry-level analysis. From a firm perspective, I am interested in multinational firms with manufacturing plants and distribution facilities dispersed across national borders and ask how globalization, particularly *global intensity*, a measure of international market penetration, and *global extensity*, a measure of geographic expansion of international sales, affect firm inventory performance and financial performance. From an industry perspective, I am interested in the impact of global environment on operations within national borders. Specifically, I ask how global sourcing and exports affect the performance of U.S. manufacturing inventories at all three stages: raw materials, work-in-process, and finished goods inventory. In accomplishing these objectives, I expect to contribute to improving global supply chain management theory and practices.

Involving almost every aspect of human life, especially business, economics, politics, technology, and culture, globalization is a complex and dynamic phenomenon, but also an elusive and vague concept. In this research, I define globalization from a supply chain perspective. By global supply chains, I refer to the sourcing of materials from foreign countries, the establishment of manufacturing plants and distribution centers across national borders, and the serving of customers on a global scale.

The first essay of this dissertation, entitled "The Impact of Globalization on Firm Inventory and Financial Performance", is concerned with how globalization, measured by global intensity and extensity, impact *firm* inventory and financial performance. More

attention is paid to examination of the indirect effect of globalization on financial performance through inventory management. In Essay 2, in order to determine the impact of cross-border inbound and outbound supply chains on inventory performance, I limit my attention to a single economy (the U.S.) and examine how global sourcing and exports affect inventory levels within the U.S. manufacturing sectors. The U.S. manufacturing industry is a good candidate for analysis since there is good variation among industry sectors in terms of reliance on global sourcing and exporting.

1.2 THEORETICAL FRAMEWORK

In related operations, international business and strategy literatures, there appears to exist a number of theoretical lenses which have been used to account for firm inventory behavior and financial performance in a global context.

To examine firm inventory behavior, I will start with the classical inventory models, with the underlying assumption that firms attempt to minimize their total inventory costs by seeking optimal inventory decisions. I then introduce location theory and its modern development – new international trade theory, given the imperfections in product, labor and financial markets around the globe, and the existence of global supply chain networks which make possible for firms to optimally allocate their inventory and other resources along their supply chains. For example, in order to maximize profit, firms may have strong incentives to shift inventory to low-cost countries and regions where labor, warehousing and inventory carrying costs are relatively low.

To understand financial performance of multinational firms, I examine two contrasting lines of reasoning which are commonly employed in the literature to account for the advantages and disadvantages of globalization. Generally, a positive view of the

impact of globalization on financial performance is more likely to resort to resource-based view (RBV) and related knowledge-based view (KBV), market imperfections, and arbitrage opportunities, economies of scale and scope, etc. A negative view of globalization more often emphasizes transaction costs, bureaucracy, diseconomies of scale, learning curve and liability of foreignness (Zaheer and Mosakowski, 1997). In fact, there are always two sides of each issue. For example, the existence of market imperfections in global economy may create many arbitrage opportunities for multinational firms to earn excess returns. However, such returns are not free from risk because globalization increases uncertainties and transaction costs as well. In practice, successful multinational firms may be able to exploit global opportunities while well managing global supply chain risks. Presented below is an overview of relevant theoretical lenses.

1.2.1 Classic Inventory Models

Although classic inventory models are generally built at the product level rather than the firm level where multiple products are often managed simultaneously. Most recent research finds that insights and predictions from the classic inventory models still hold at the aggregate firm level (Roumiantsev & Netessine 2007a). For example, the economic order quantity (EOQ) model aims to balance inventory holding and fixed order costs, and suggests that a firm's optimal order size is positively associated with its demand and fixed order costs, and negatively associated with its inventory holding costs. The classic newsvendor model seeks to determine the optimal order quantity by first determining an optimal customer service level (i.e., stockout rate). Through balancing overage costs (e.g., selling overstocked items at deep discounts and associated inventory

costs) and underage costs (e.g., lost sales and lost goodwill due to stockouts), the solution for a standard newsvendor model suggests that the optimal inventory level is positively associated with the difference between selling price and inventory purchasing cost, equivalent to gross profit margin. The standard safety stock model under stochastic demand and/or supply suggests that the safety stock level is positively associated with the desired customer service level and the standard deviation of demand during the supply lead time, which in turn depends on average lead time and lead time variation. Therefore, I include in the analysis the basic variables suggested by the classic inventory models to measure or proxy demand and supply uncertainties across national borders, such as growth in demand, lead time variation and inventory holding costs.

1.2.2 Location Theory

Dating back to Johann Heinrich von Thünen (1826) and Alfred Webber (1909), location theory is primarily concerned with how to efficiently allocate economic resources and activities across disparate locations. In *The Isolated State*, von Thünen modeled how to optimize the use of agricultural land based on the trade-off of distance-determined transportation costs and the value and characteristics of agricultural products. The Thünen location-rent model laid the foundation of modern location theory. Weber expanded location theory to the location of industrial activities. In *Theory of the Location of Industries*, Weber devised a location triangle geographically formed by a market and two remote raw materials suppliers. A firm's decision is to find the least-cost site for a manufacturing plant within the triangle. Weber's model took into account the trade-off between transportation cost and labor cost, where transportation cost is impacted by the "material index", a ratio between the sum of the weights of all materials used and the

weight of the finished product. If the ratio is less than one, the finished product is considered weight reducing. If the ratio is greater than one, the finished product is considered weight increasing. As a general rule, manufacturing should be located near the market if final products increase bulk and weight; otherwise, manufacturing should be located close to the supplier of raw materials.

Altman (1986) explicitly tested resource endowments and location theory using a case study of Quebec and Ontario, two Canadian provinces relying on coal and iron ore to develop industrial activities at the turn of 20th century. Built on a location model, Nachum, Zaheer & Gross (2008) studied multinational firms' location choices using a data set of over 138,000 investments undertaken by U.S. multinational firms around the globe. They reported that while a host country's geographical proximity to global distribution of knowledge, markets and resources are drivers for multinational firms to locate their activities, proximity to knowledge and markets have much stronger effects on location decisions.

1.2.3 New Trade Theory

Paul Krugman's work on spatial economics has built on and contributed to modern location theory. In his own words, Krugman stated "[I] helped found the so-called 'new trade theory', which is about the consequences of increasing returns and imperfect competition for international trade" (2008). Built on von Thünen's model, Krugman (1991) studied metropolitan locations using models of spatial equilibria where a metropolis produces goods and serves the rural hinterland. Krugman (1992) explored a dynamic model of economic geography examining under what conditions spatial economic equilibria emerge. In this model, "centripetal" forces, such as low

transportation costs, large shares of manufacturing in the economy, and economies of scale, likely lead to the organization of economic activities into "agglomerations," while "centrifugal" forces, such as land rents in city cores, incentives to serve the hinterland, and avoidance of competition, break agglomerations.

In observation of large volumes of "two-way trade" in similar products, new trade theory adds new elements to trade model, such as "increasing returns to scale, imperfect competition and product differentiation", differentiating their models from classical trade theory which focuses on country specialization and comparative advantages (Markusen & Venables 1998, p.183). To suggest an alternative way to view international specialization and trade, Krugman and Venables (1995a) developed a spatial model of trade in which a global economy organizes itself into industrial and agricultural zones on a continuous basis. They further suggested that international specialization may emerge within the manufacturing sector. Krugman and Venables (1995b) studied how globalization affects the location of manufacturing among nations and showed that when transportation costs go down, nations trade and eventually form a "core-periphery" relationship. New trade theory has been used in economics literature to account for activities of multinational corporations. For example, using Longitudinal Firm Trade Transaction Database from the U.S. Census, Bernard, Jensen & Schott (2006) found that prices for the same goods were significantly lower for intra-firm transactions than for arms-length customers, especially when goods were sent to countries with lower corporate taxes and higher tariffs. The transfer price was also affected by foreign exchange rate with respect to the U.S. dollar.

1.2.4 Resource Based View

Economic theory holds that in a free-market economy firms can only make profits determined by industry structure and will not be able to sustain abnormal returns due to competition and new entries. However, the Resource Based View (RBV) of the firm argues that firms can do so if they own and are able to utilize their unique resources. RBV dates back to Penrose (1959) and Barney (1991) whose theories suggest that some firms can gain competitive advantages due to the heterogeneous nature of firms' tangible and intangible assets and resources. Particularly, the resources of firms must have the following four characteristics: valuable, rare, imitable and non-substitutable. Multinational firms may be able to earn abnormal returns in the sense that they can exploit their unique resources, especially their intangible resources, such as patents, technologies, processes, marketing and management skills, and apply them to foreign markets. A knowledge-based view (KBV) is an extension of RBV in that the most precious and productive resource of a firm may be its knowledge base. Firms build their knowledge base through accumulation and sharing of knowledge within organizations and deter imitation by innovation (Kogut & Zander 1992). In a global context, multinational firms with subsidiaries located across different countries may be able to access resource endowments unique to a specific country-specific and expand their knowledge base by contributions from foreign subsidiaries (Kogut & Chang 1991; Morck & Yeung 1991).

1.2.5 Market Imperfections and Arbitrage Opportunities

Market imperfections, also named market failures or distortions, refer to deviations from perfect competition, and occur when the free market mechanism (e.g.,

price) does not function normally due to, for example, lack of market information. Government interventions may be justified, such as price controls, taxes, subsidies, quotas and regulations to overcome these imperfections. Examples of market imperfections include monopolies, positive or negative externalities, and public goods. Even though market imperfections impose high transaction costs, business opportunities may be created for firms that are able to take advantage of such imperfections. For example, firms as first movers may be able to obtain economic rents through early adapting to imperfections (DeGennaro 2005).

Most commonly used in the financial markets, arbitrage means making risk-free returns due to different prices on the same asset. Arbitrage has been applied to stock returns in emerging markets (e.g., Rabinovitch, Silva & Susmel, 2003). In another context, arbitrage refers to the practice of taking advantage of price differences of production factors across markets. Multinational firms are well-positioned to use arbitrage opportunities on a global scale due to their extended global supply chain networks (Slaugther 1995). Global operations, in addition to allowing firms to generate gains from exploiting economies of scale through standardization, may also allow firms to generate arbitrage gains from exploiting differences in operating costs (Ghemawat 2003). For example, Ghemawat (2003) shows that GE Medical Systems located 40 percent of its manufacturing operations in low-cost countries in 2001 to arbitrage cost differences in procurement and manufacturing.

1.2.6 Transaction Costs

Transaction cost economics (TCE) dates back to Coase (1937) and was developed under Williamson (1975 &1985). Over decades, transaction cost economics has become

one of the most frequently used theoretical lenses for examining firm boundary and supply chain outsourcing in the strategy and operations literature. The key notion is that market transactions incur transaction costs, such as information search, coordination, and contract negotiation and enforcement costs, to firms and the transaction cost economizing mode of governance (i.e., vertical integration vs. market outsourcing) depends on environmental uncertainty, asset specificity, and transaction frequency (Williamson 2007). In lieu of multinational firms, the transaction cost argument has been mostly used to explain the choice of modes of foreign market entry, such as wholly-owned vs. joint-ventures and the extent of foreign direct investment (e.g., Brouthers 2007, Madhok 1998, Agarwal & Ramaswami 1992). In this paper, the focus has been the wholly-owned foreign subsidiaries of multinational firms due to the scope of the study. From a TCE perspective, whether foreign subsidiaries contribute to overall firm financial performance may also depend on whether foreign subsidiaries are the efficient organization structure to begin with and the uncertain relationships with their foreign suppliers and customers.

Along this line of logic, existing literature has argued that multinational firms experience escalating transaction costs when globalization reaches high levels (e.g., Geringer, Beamish & DaCosta 1989, Sullivan 1994, Hitt, Hoskisson & Ireland 1994, Hitt, Hoskisson & Kim 1997, and Gomes & Ramaswamy1999). Those costs may include, but are not limited to, communications and monitoring costs, incentive costs to align the management of foreign subsidiaries with the interest of corporate headquarters, and costs dealing with foreign suppliers. For cross-border transactions, preparation of required documentations and waiting at the border check points and ports have significantly increased costs of doing business in a global environment.

1.2.7 Summary

In summary, classic inventory models provide a basic framework for the factors that may affect inventory levels, such as inventory holding costs, supply and demand uncertainties, desired custom service levels, etc. Location theory and new international trade theory suggest that firms may be able to efficiently allocate inventories along their global supply chains. Theoretical lenses, such as RBV, market imperfections, arbitrage opportunities and transaction costs, may help explain the advantages and disadvantages of global operations.

Regarding the impact of globalization on firm financial performance, various theoretical lenses have provided different and even contrasting predictions. Meanwhile, the empirical results in existing literature have presented a mixed picture. In reviewing relevant literature on international business and strategy, it is found that little attention has been paid to inventory. Given that the direct impact of globalization on firm operations is inventory management and that the relationship between inventory and financial performance is complex, it may be promising to unravel the puzzling theoretical predictions and empirical findings from the perspective of inventory management in a global context.

CHAPTER TWO IMPACT OF GLOBALIZATION ON FIRM INVENTORY AND FINANCIAL PERFORMANCE

Given the strategic importance of globalization to manufacturing, our understanding of the impact of globalization on firm inventory seems relatively meager. In fact, there is little empirical research on the impact of globalization on firm inventory performance, let alone an established theoretical basis for globalization in the operations literature. Meanwhile, regarding the impact of globalization on firm financial performance, existing research has presented contrasting theoretical predictions and a mixed empirical picture. Unfortunately, little attention has been paid to inventory management, a critical aspect of global operations. Given the direct impact of globalization on inventory management and the complex relationship between inventory and financial performance, it may be promising to reconcile the contrasting findings in international business and strategy literatures by introducing inventory in the analysis. In this essay, I focus on one important aspect of globalization – manufacturing offshoring (i.e., foreign manufacturing plants and distribution facilities), and set out to provide empirical evidence on how firm manufacturing offshoring drives its inventory and financial performance using a panel dataset comprised of the world's largest public manufacturing firms. More attention will be paid to the indirect effect of globalization through inventory management.

This essay is organized as follows: I first discuss the impact of globalization on firm inventory drawing upon operations literature, and then talk about the impact of globalization on firm financial performance while reviewing related international business and strategy literatures. Next, I present econometric models and describe data

collection and sample statistics. I then present regression results and discuss empirical findings. Finally, I discuss theoretical contributions, managerial implications and research limitations.

2.1 Impact of Globalization on Inventory Performance

Classic inventory theory posits that firms hold inventories in order to buffer against supply and demand uncertainty or smooth production to reduce manufacturing costs (Holt, Modigliani, Muth & Simon 1960). Along a firm's entire supply chain, inventories may perform different functions, such as cycle stock, safety stock and in-transit stock. Rumyantsev & Netessine (2007a) argued that insights from classic inventory models, which were built on a single product level, such as Economic Order Quantity (EOQ) or the Newsvendor Model, still hold at the aggregate firm level for inventory decisions. They also found that factors, such as supply and demand variations, and inventory holding costs, have a significant impact on firm inventory decisions, based on empirical data. Even though globalization has not been explicitly identified as a factor for inventory decisions in the literature, a closer examination of the firm globalization process would reveal its direct or indirect impact on firm decisions. For example, when multinational firms build manufacturing plants and distribution facilities in foreign countries, and sell in foreign markets, they are exposed to higher supply and demand uncertainty across borders.

First of all, globalization may increase supply uncertainty, because supply lines across national borders are more vulnerable to disruptions. In addition, the ripple effects of disruptions may be more severe along the supply chain and may even last longer. Generally, supply lead times across national borders may be longer and of greater

variation. Furthermore, foreign suppliers may be less reliable due to the increased transportation distances, the uncertainties associated with customs clearance, and different business cultures, rules and regulations. A supply chain manager with a U.S. firm commented, "The problem with these long supply lines is they're also highly variable. I mean, it's not just the mean, it's the standard deviation of cycle time" (Manuj & Mentzer 2008a). Greater mean lead times and greater lead time variation will likely increase order quantity and safety stock. Second, firms selling in and to foreign markets may have less knowledge of these markets (compared to their domestic competitors) and hence the forecasting of demand may be less accurate. To compete in foreign markets, firms may have to hold higher inventories to guard against inaccurate forecasts. Third, from a transaction cost perspective, globalization usually incurs higher transportation costs and other transaction costs across borders (e.g., waiting time at border crossings, paper work, etc.). Firms are better off using batch manufacturing and ordering large quantities of inventories, resulting in higher levels of inventories in warehouses and larger sized shipments in-transit.

A few empirical papers related to inventory management in a global context have suggested that inventory levels may have increased with globalization. Hendricks & Singhal (2005) reported that firms experiencing supply chain disruptions (common with long, global supply chains) show 14 percent higher growth in inventory compared to firms without disruptions. Guasch & Kogan (2001) documented that poor infrastructure, inefficient regulation and market inefficiency led to higher inventory levels for firms operating in developing countries. Those findings are substantiated through empirical research based on much larger scale of firm-level data sets (Lai, 2005, 2006a, & 2006b).

In summary, globalization has increased the challenges in managing inventories across borders. From a supply chain risk management perspective, holding more inventories may be one of the effective ways under a firm's control to reduce potential disruptions. In this thesis, therefore, it is expected that globalization is positively associated with firm inventory levels.

2.2 Impact of Globalization on Firm Financial Performance

McKinsey Global Institute reported that globalization can help companies reduce as much as 70 percent of their total costs – 50 percent from job offshoring, 15 percent from business process improvement, and 5 percent from job redesign. Meanwhile, globalized companies may be able to expand into new markets and attract new customers (Farrell 2004). A KPMG survey of senior executives of global manufacturing firms also reveals that "while low cost labor has a role to play, many manufacturers are going global to access a range of opportunities and resources available in different international markets" (KPMG 2006). Globalization may contribute to firm profits largely through two sources: economies of scale and arbitrage opportunities (Ghemawat 2003). Ideally, globalization decisions made by firm management should bring about greater financial returns and eventually maximize firm profits. In practice, however, the benefits of globalization may be overestimated while the costs may be underestimated. For example, distance remains a barrier to the full realization of benefits from globalization, including cultural, administrative, geographic and economic distances between foreign markets and domestic markets, and different industries and products may be affected by those distances to varying degrees (Ghemawat 2001).

In the international business and strategy literature, there are competing rationales for both advantages and disadvantages of globalization and, unsurprisingly, mixed results

regarding the impact of globalization on firm performance. To summarize, six patterns of relationships: i.e., linear positive, linear negative, no relationship, U-shaped, inverted U-shaped, and horizontal S-shaped, have been proposed in the literature and tested through empirical data. While financial performance is most commonly measured by accounting profitability, either return on sales (ROS) or return on assets (ROA), other market-based indicators, such as Tobin's *q*, stock returns and sales growth, have also been adopted in research. While globalization is most commonly measured by foreign sales over firm total sales, other measures have also been used to complement the sales measurement, such as foreign assets over firm total assets, foreign employment over firm total employment, the number of foreign subsidiaries established, the number of foreign countries entered, etc.

Linear Positive

A positive relationship between globalization and firm performance was commonly argued and tested in the early international business literature (e.g., Caves 1971, Grant 1987; Grant, Jammine & Thomas. 1988; Daniels & Bracker 1989; Haar 1989). The underlying logic is that higher globalization leads to higher financial performance primarily due to economies of scale, scope and learning (Vernon 1971, Kogut 1985, Ghoshal 1987, Kim, Hwang & Burgers 1989 & 1993).

Caves (1971) argued that globalization enables firms to exploit market imperfections through utilizing valuable firm assets across borders. Grant (1987) provides four strong reasons for the positive impact of globalization on profitability: (1) increasing returns to intangible assets, such as R&D, technology, advertising, and managerial skills; (2) market power due to international scope; (3) capacity to take risky

projects and earn excess returns due to geographical diversification; and (4) access to more investment opportunities.

Globalization may also enable multinational firms to leverage home-based managerial skills and competencies into foreign regions (Davidson 1983; Papadopoulos & Denis 1988) and take advantage of slack resources (Daniels et al. 1984; Egelhoff 1988). Using ROS, ROA and ROE (return on equity) as alterative performance measures and international sales over firm total sales as a globalization measure, Grant (1987) and Grant, Jammine and Thomas (1988) found a positive impact of globalization on firm financial performance based on data of British-owned manufacturing firms. Other empirical studies in strategy and international business literature showing a positive impact include Vernon (1971), Kim and Lyn (1987), Jung (1991), and Delios and Beamish (1999).

Interestingly, there is a similar interest in the finance literature which focuses on the impact of international diversification on firm value from the perspective of corporate multinationalism. Errunza and Senbet (1981) argued that benefits from global operations may come from (1) imperfections in the product and factor markets, (2) different tax treatment, and (3) imperfections in the financial markets. Using data on U.S.-based multinationals for the period 1968-1977, they found that international involvement (measured by foreign-generated sales, net assets and earnings) leads to higher excess value (the difference between total firm market value and book value of assets, normalized by sales). The positive relationship was further corroborated with new empirical findings for U.S. multinational firms over the period 1970-1978 drawn from COMPUSTAT, while performance was measured by both excess valuation and excess

return, and international involvement was measured by foreign sales percentage, number of foreign subsidiaries, and an Entropy measure of each firm's relative regional holdings, which is defined as: Entropy = $-\sum_{k=1}^{n} S_k * \log S_k$ where, S_k is the ratio of the number of subsidiaries in region *k* to the total number of its foreign subsidiaries.

Kogut (1983) argued, "The primary advantage of the multinational firm, as differentiated from a national corporation, lies in the flexibility to transfer resources across borders through a globally maximizing network." Doukas and Travlos (1988) ascribed the benefits of globalization to (1) the ability to arbitrage institutional restrictions, such as tax and antitrust laws, and (2) the cost savings through joint production in marketing and production. They reported that multinational firms were able to obtain abnormal stock returns and enhance shareholder value when expanding into new foreign geographic markets through acquisitions, based on COMPUSTAT data on U.S. multinational firms over 1975-1983.

More recent arguments for a positive return of globalization have focused on experiential learning. Multinational firms with subsidiaries located across different countries may be able to access unique country-specific resource endowments and hence enhance their knowledge base, capabilities and competitiveness in both domestic and foreign markets (Kogut & Chang 1991; Morck & Yeung 1991; Barkema & Vermeulen 1998; Zahra, Ireland & Hitt 2000).

Linear Negative

For a positive diversification benefit to be realized from globalization, it is argued that three conditions have to be met: (1) less than perfect correlation between asset values across countries, (2) higher costs or barriers for foreign portfolio investment, and (3)

recognition of the diversification by the market (Collins 1990). However, those conditions may not always be satisfied in practice. Therefore, the financial performance of multinational firms may be inferior to that of their domestic counterparts due to excess risks they are taking when engaged in foreign operations. For example, Michel and Shaked (1986) compared performance of 58 U.S.-based multinational manufacturers among Fortune 500 companies with a control group of 43 Fortune 500 U.S domestic firms for the period 1973-1982 and found that U.S. domestic firms have much higher risk-adjusted returns on stocks, measured by market-based measures, such as Sharpe, Treynor or Jensen ratios. They suggested that the market took into consideration higher risks incurred by multinational firms. Collins (1990) compared performance of three groups of U.S. firms over the period 1976-1985: domestic firms, U.S.-based multinational firms with a substantial presence in other developed countries, and U.S-based multinational firms with a substantial presence in developing countries. The comparative results suggested that U.S firms operating in other developed countries do not generate a significantly higher return than U.S. domestic firms, while operating in developing countries does have a significant negative effect on shareholder value. These findings are in line with Brewer's study that globalization, measured by foreign earnings percentage, leads to lower stock returns (Brewer 1981). However, using 420 U.S.-based mining and manufacturing firms, Pantzalis (2001) reported a contrary finding that globalization led to a premium when firms operated in developing economies while global diversification resulted in a value discount when firms operated in developed markets.

Geringer, Tallman and Olsen (2000) argued that the impact of globalization on performance may be unexpected across time periods and found that international diversification strategy, using foreign sales over firm total sales as a proxy measure, had a negative impact on profitability (ROA and ROS) but a positive impact on sales growth based on the analysis of Japanese multinational firms from 1977 to 1993. A possible explanation offered in their study was that Japanese multinational firms may be sacrificing final returns for market growth for the time period studied, so called "buying market share."

Denis, Denis and Yost (2002) argued that the costs of global diversification may outweigh the benefits. Such costs may include coordination costs due to complex organization structure and inefficient cross-subsidization of less profitable business units by a global firm. Managers may even pursue a value-reducing globalization strategy due to self-interest, such as prestige, power and compensation associated with managing a large corporation. Using a sample of over 44,000 firm-year observations over 1984-1997, their study suggested global diversification (measured by foreign sales over firm total sales) is significantly associated reduction in excess value. Christophe (1997) also reported a negative impact of globalization on firm market value (e.g., Tobin's *q*) using U.S. firms from 1978-1996. Christophe and Pfeiffer (1998), using U.S. firm from 1984-1997, and Click and Harrison (2000), using U.S. firms from 1990-1994, provided a similar finding that investors discounted the value of multinational firms in comparison to their domestic counterparties. The fraction of firm sales was a primary measure for globalization in these studies.

U-Shaped

Given both costs and benefits associated with globalization, more and more researchers have modeled a non-linear relationship between globalization and firm performance in their studies in recent years. Research has described a new line of logic, corroborated with empirical evidence, for a U-shaped relationship between globalization and firm financial performance. These authors argue that firms incur lower performance at the initial stage of globalization due to entry barriers and unfamiliarity with foreign markets and will improve performance through learning by doing (Barkema & Drogendijk 2007; Thomas 2006; Ruigrok & Wagner 2003, Lu & Beamish 2001, and Qian 1997). For example, using 164 Japanese small and medium-sized enterprises over 1986-1997, Lu & Beamish (2001) reported that firms' global expansion led to a reduction in profitability (e.g., ROA) primarily due to a liability of foreignness, but greater levels of foreign direct investment are associated with higher performance because firms gained knowledge of the foreign markets and learned from mistakes.

Inverted U-Shaped

In contrast with a U-shaped relationship, an inverted U-shaped has been frequently proposed and verified by empirical studies in both strategy and international business literature, such as Geringer, Beamish & DaCosta (1989), Daniels and Bracker (1989), Sullivan (1994), Hitt, Hoskisson and Ireland (1994), Ramaswamy (1995), Hitt, Hoskisson & Kim (1997), and Gomes and Ramaswamy(1999). This line of logic partially echoes the rationale of researchers who argued for a positive impact of globalization on firm performance. Basically, multinational firms will be able to obtain excess returns at the initial stage due to better utilization of firm resources and managerial skills. However, globalization costs start to exceed benefits when initial slack resources and capacities

have been exhausted and when the complexities and costs of managing cross-border operations exceed these benefits.

For example, using 297 large manufacturing firms obtained from the COMPUSTAT database, Hitt, Hoskisson & Kim (1997) reported that firm performance, measured by ROA and ROS, increased initially with international diversification, measured by foreign sales as a percentage of firm total sales, but started to decline when globalization crossed a threshold. Their argument was that firms were able to benefit from economies of scale, scope and experience initially caused by globalization. However, coordination and distribution costs may escalate due to trade barriers, logistics costs across borders, and cultural differences, exceeding the benefits which may be obtained. Hitt, Koskisson & Ireland (1994) argued that international diversification contributes positively to firm performance up to a point when the management is faced with challenges in efficiently handling the complexity and information asymmetries and in balancing global integration and local responsiveness due to firm overexpansion across the globe. They therefore proposed an inverted U-shaped relationship between globalization and firm performance. Based on a sample of 200 multinational enterprises (MNEs) from the U.S. and Europe in the early 1980s, Geringer, Beamish & daCosta (1989) reported that degree of internationalization is positively associated with financial performance of MNEs until a point when a linear negative association starts to emerge. Note that performance was measured by ROS and ROA and degree of internationalization was measured by sales from foreign subsidiaries over total sales. Gomes and Ramaswamy (1999) argued that overseas growth generated high levels of marginal performance during the initial stages, but beyond an optimum level performance

started to decline due to increasing incremental costs exceeding incremental benefits. They explained that at a later stage of international expansion, firms tend to enter into geographically remote and culturally unfamiliar countries where operating and coordination costs are high. Using U.S. MNEs in manufacturing industries, they reported an invert U-shaped relationship between multinationality, an index measure consisting of foreign sales percentage, foreign asset percentage and number of foreign countries, and firm ROA.

Horizontal S-Shaped

Built on non-linear relationships reported in prior literature, new inquiries into the relationship between globalization and firm financial performance have become more sophisticated. Contractor, Kundu & Hsu (2003) proposed a three-stage theory to explain the complex relationship between globalization (i.e., international geographic expansion) and financial performance, tested through data on service industries across a dozen countries. They argued that at the initial stage of globalization, a relatively shallow negative slope for the relationship between globalization and financial performance is expected due to high upfront costs, liability of foreignness and insufficient economies of scale. At the mid-stage of globalization, however, due to accumulated knowledge about and increasing familiarity with foreign markets, and to sufficient economies of scale, the incremental benefits of globalization may exceed the incremental costs, resulting in a positive slope for the link between globalization and financial performance. Multinational firms are able to arbitrage differences in labor and materials costs, taxation, and product life cycles across nations, and therefore scan market opportunities and gain global market power. However, beyond a certain point of globalization (e.g., operation in a certain

number of countries in their study), the costs of overexpansion, such as coordination and governance costs, may exceed benefits due to diverse cultures and managerial constraints, resulting in a negative slope between globalization and financial performance.

Following a similar logic as laid out in Contractor, Kundu & Hsu (2003), Lu & Beamish (2004) reported a horizontal S-shaped relationship between international expansion and firm performance through various stages of globalization, using a 12-year period of observations for thousands of Japanese firms. To reconcile the contrasting empirical findings in the literature regarding the impact of globalization on financial performance, such as the inverted U-shaped vs. the upright U-shaped relationship, Lu & Beamish argued that the inverted U-shaped pattern is more likely to emerge from samples of well-globalized firms while the upright U-shaped pattern is more likely to appear in samples of newly globalizing firms. At the lower level of globalization, the costs caused by entry barriers and overcoming foreignness may overwhelm the benefits, resulting in a downward slopped relationship between globalization and financial performance. At the mid level of globalization, the costs related to newness and foreignness are reduced through experiential learning while the benefits are fully exploited, resulting in an upward slopped relationship. At the very high level of globalization, another set of costs related to coordination and governance may escalate and are likely to overwhelm the incremental benefits of globalization, leading to a downward relationship again.

No Relationship

Following internationalization theory that a multinational firm can increase its value through utilization of its firm-specific intangible assets, such as R&D, and marketing and managerial skills, which allow the firm to internalize these resources

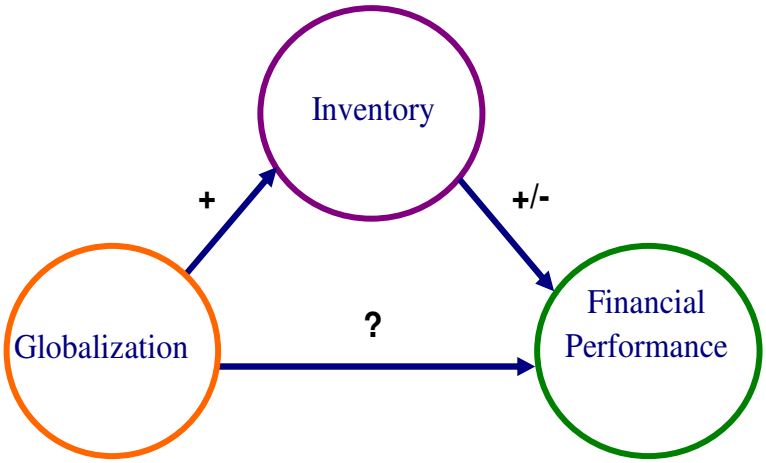
through internationalization and hence gain competitive advantages in foreign countries, Morck & Yeung (1991) argued that multinationalism can add value to firm shareholders only when firms own and are able to utilize their intangible assets, as internationalization theory predicts. International diversification without investment in intangible assets may be considered a liability rather than a value-add. Based on an analysis of 1,644 multinational firms, primarily collected from National Bureau of Economic Research and COMPUSTAT databases, their empirical findings showed that the direct impact of multinationality, measured by the number of foreign subsidiaries established and the number of foreign countries entered, on firm value, measured as Tobin's *q*, was not significant at all. This study thus concluded that empirical evidence provides more support for internationalization theory than international diversification theory or arbitrage opportunities. Buckley, Dunning & Pearce (1984) analyzed the performances (profitability and growth) of a sample of 636 large firms in 1972 and 866 large firms in 1977 collected from the *Fortune* data and reported that multinationality had no significant impact on firm ROA after controlling for size, research intensity, industry and nationality of ownership. Comparing UK domestic firms and UK multinational firms with FDI, Kumar (1984) showed that the degree of foreign operations had no significant influence on profitability or growth of the parent firm.

In summary, existing theories do not provide a definite prediction about the impact of globalization on firm performance and empirical tests have generated a mixed picture. In this thesis, without *a priori* predictions, I intend to unravel the puzzling theoretical predictions and empirical findings from the perspective of inventory management in a global context.

2.3 ESTIMATION MODELS

Given that the possible links among globalization, inventory and financial performance discussed in the existing operations, international business and strategy literatures, a triangular model is proposed in this thesis to study the direct effect of globalization on financial performance and its indirect effect on financial performance through inventory management (see Figure 1).

Figure 1 Research Model



2.3.1 Model for Inventory Performance

Generally speaking, it may be proposed that *firm inventory = f (firm effects, industry effects, time effects)*. According to the existing operations management literature, firm effects may include a few firm-specific characteristics, such as gross margin, cost of capital, capital intensity, strategy and economies of scale (Roumiantsev & Netessine 2007a & b; Gaur, Fisher & Raman 2005; Gaur & Kesavan 2005). Due to the scope of study, globalization is considered a firm-specific strategy in this thesis. Industry effects are important primarily due to the competitive nature and the particular production process of the industry in which the firm is operating. Time effects may be able to

capture changes in productivity and advances in inventory management technologies over time. Therefore, the inventory performance may be modeled as follows:

(1.1) Inventory Level = β_0 + β_1 *Globalization* + β_2 *Gross Profit Margin* + β_3 *Capital Cost* + β_4 *Capital Intensity* + β_5 *Firm Size* + *Industry Effects* + *Time Effects* + ε_1

Inventory Level – Dependent Variable

Following Chen, Frank & Wu (2005), I measure inventory level as days of inventory supply, assuming a 365-day year. Note that inventory days are a relative inventory level rather than an absolute inventory level. Inventory days are closely related to inventory turnover in that both use cost of goods sold to normalize total inventory. In fact, inventory days of supply are obtained if 365 is divided by inventory turns. Therefore, inventory days should be interpreted as an inverse measure of inventory performance. The higher the inventory days, the lower the inventory performance will be. Its measure is straightforward: $Inventory\ Days = 365 * \frac{Total\ Inventory}{Cost\ of\ Goods\ Sold}$ The natural log value is taken to obtain better normality (*LOG_INVT*).

Globalization

The ratio of a firm's sales from foreign subsidiaries to its total sales has been most popularly used as a proxy for globalization level. Reportedly, this measure has many merits: objective, straightforward, simple and accurate due to the fact that sales data are more reliably available to the public. In the existing international business and strategy literature, foreign sales percentage has been the primary measure. Following Grant (1987), Grant, Jammine & Thomas (1988), Geringer, Beamish, & daCosta (1989), Haar (1989), Jung (1991), Sullivan (1994), Sambharya (1995), Riabi-Beikaoui (1996), Tallman & Li (1996), Gomes & Ramaswamy (1999), Geringer, Tallman & Olsen (2000),

Qian (2002), Ruigrok & Wagner (2003), I use foreign sales over total sales as a baseline measure for globalization.

Gross Profit Margin

For the classic newsvendor model, the optimal customer service level corresponds to the ratio of underage cost, i.e., cost of inventory stockouts, to the sum of underage cost and overage cost, i.e., cost of overstocking inventory (Cachon & Terwiesch 2005). Hence, when holding average costs and other factors constant, firms would desire a higher service level and hence a higher inventory level in the presence of a higher underage cost. In the newsvendor model, the cost of inventory stockouts is actually taken as the difference between selling price and purchase price, equivalent to gross profit margin (Roumiantsev & Netessine 2007a). Surveys of retailers revealed that managers tend to trade off inventory turnovers and gross profit margin, suggesting lower inventory turns are likely to be tolerated for products with higher profit margin, resulting in higher inventory levels for the same period (Gaur, Fisher & Raman 2005).They further verified a positive correlation between gross profit margin and inventory levels based on an empirical analysis of 311 U.S. retail firms over 1985-2000. Roumiantsev & Netessine (2007b) also provided empirical evidence from public firms in OECD countries for this positive relationship. Therefore, gross profit margin, commonly measured as (sales – costs of goods sold)/sales, is expected to be positively associated with inventory levels in this thesis.

Cost of Capital

Firm average cost of capital is used to proxy inventory holding costs since firm inventory holding costs are not readily available. Classic EOQ model shows that

inventory order quantity is negatively associated with inventory holding cost. Therefore, it is expected that cost of capital is negatively associated with a firm's average inventory level. Prior empirical research has verified the negative impact of cost on inventory levels (e.g., Roumiantsev & Netessine 2007a). In this dissertation, cost of capital is measured by a firm's interest expenses over its total long-term debts.

Capital Intensity

Capital investment by manufacturing firms includes fixed investment in manufacturing plant and equipment, distribution facilities (e.g., warehouses), and information technologies (e.g., EDI, JIT and real-time tracking). At a minimum, investments in plants and equipment may increase worker productivity and speed the flow of work-in-process inventory; investments in warehouse facilities may increase inventory turns and reduce inventory waste and errors. IT investments are likely to improve communications and inventory visibility along a firm's supply chain. Guar, Fisher & Raman (2005) found that capital intensity at retailers is positively associated with inventory turnover. Therefore, it is expected that capital intensity is negatively associated with inventory levels. Capital intensity is measured as capital expenditure as a percentage of total assets in this study.

Firm Size

Economies of scale may exist for inventory management due to better utilization of labor and to distribution network and transportation capacity/economies (Gaur & Kesavan 2005; Roumiantsev & Netessine 2007a). Moreover, large firms enjoy more power when bargaining with upstream suppliers and downstream customers, and thus may be able to push inventory back to suppliers or forward to customers. In a retailer

setting, Guar & Kesavan (2005) reported a positive correlation between inventory turnover and firm size. Hence, it is expected that firm size is negatively associated with inventory levels measured by days of inventory supply. Sales, assets, and total employment have been used as proxy measures for firm size in the literature. In this dissertation, total employment is used as the baseline measure for firm size.

Industry and Time Effects

Average inventory levels may also correspond to the characteristics of industries. According to North American Industry Classification System (NAICS), industry sectors are classified primarily based on production process and technology, which may affect inventory levels. Product variety, competitive intensity, demand predictability, production processes and procedures (build-to-stock vs. build-to-order), and other characteristics which affect inventory levels may be specific to industries. For example, computer and electronics industries have quick inventory turns and low inventory levels due to short product life cycles and high inventory obsolescence costs. On the other hand, paper and furniture manufacturing may be expected to have higher inventories, *ceteris paribus*. In practice, firm inventory performance may be benchmarked to the average inventory performance of the industry sector to which a firm belongs. Meanwhile, technologies and best-practices in inventory management have advanced over time, such as real-time tracking, EDI, Vendor Managed Inventory, and JIT. Therefore, it is necessary to control for industry sector in this analysis. There are 19 manufacturing industry segments at the 3-digit NAICS code. Industry dummies are included to take into consideration industry characteristics. A time-dependent variable should also be included

if panel data are used to control for productivity and other changes over time. Time dummies are included to account for these time-specific effects.

2.3.2 Model for Financial Performance

According to the strategy and economics literatures, it may be proposed that *firm financial performance = f* (*firm effects, industry effects, time effects*).

Resource-based view (RBV) holds that firm performance may be determined by firm effects, i.e., its internal, firm-specific resources, which are valuable, rare, inimitable and non-substitutable in nature (Barney 1991). Particularly, these resources may include firm financial resources, marketing skills, R&D capabilities, and management strategy. For example, capital intensity and capital structure (i.e., debt level) reflect a firm's financial resources, while a desired inventory level may also be considered part of operational strategy (e.g., Ghosh 2008; Roumiantsev & Netessine 2007b; Hendricks & Singhal 2001; Smith & Warner 1997; Grossman & Hart 1986). Reflecting a firm's international strategy, the degree of globalization has also been extensively examined in the international business and strategy literatures for its impact on firm financial performance (e.g., Lu & Beamish 2004; Contractor, Kundu & Hsu 2003; Qian 2002; Geringer, Tallman & Olsen 2000; Gomes & Ramaswamy 1999; Tallman & Li 1996; Morck & Yeung 1991).

However, according to the structure-conduct-performance paradigm, firm financial performance may be ultimately determined by industry characteristics, such as market concentration and entry barriers (Waldman & Jensen 2006). Industry dummies are included in this study to control for industry-specific impacts on firm financial

performance. Time dummies are also included to control for changes in productivity, technology, macroeconomics and other time-dependent factors omitted in the models. Thus, the financial performance may be modeled as follows:

(1.2) Financial Performance $= \gamma_0 + \gamma_1$ *Globalization* $+ \gamma_2$ *Inventory Level*$+ \gamma_3$ *Inventory Level Squared* $+ \gamma_4$ *Debt Structure*$+ \gamma_5$ *Capital Intensity* $+ \gamma_6$ *Firm Size + Industry Effects + Time Effects*$+ \varepsilon_2$

Financial Performance – Dependent Variable

Following Roumiantsev & Netessine (2007b), Hitt, Hoskisson & Kim (1997), Geringer & Beamish (1989) and others, I use return on net sales (ROS), which is measured by net income over net sales, as the baseline measure for financial performance. Net income is used as a base rather than operating income in the sense that (1) firms should eventually care about the bottom line profitability; and (2) net income reflects many non-operating charges, such as inventory write-offs, inventory financing charges, local tax benefits, and even foreign exchange income or losses. Those charges reflect the characteristics and costs of global operations and thus should be considered for the analysis. In the literature, net return on total assets (ROA) is another popular alternative measure (e.g., Gomes & Ramaswamy 1999, Hitt, Hoskisson & Kim 1997, Lu & Beamish 2004). However, ROS is believed to have an advantage over ROA since assets are recorded at historical book values and depreciation rates vary across countries. In this study, ROS is used as a baseline measure for financial performance while ROA is tested as an alternative measure for financial performance as a robustness check. Note that Hitt, Hoskisson & Kim (1997) reported that ROS and ROA were highly correlated at .91 in their sample.

Inventory

Lai (2005) reported that inventory is negatively associated with a firm's market value, measured by Tobin's *q*. Roumiantsev & Netessine (2007b) found that cash conversion cycle is negatively associated with return on sales (inventory days of supply is one of the three components of cash conversion cycle). They further reported that raw materials inventory in days of supply is consistently negatively associated with return on sales across countries.

However, the classic newsvendor model suggests that the optimal service level, intended to optimize firm profit, is determined by balancing stockout cost and overstock cost. Intuitively, neither an extremely low level of inventory nor an extremely high inventory level benefits a firm since firms will incur losses in either extreme case. Below the optimal inventory level, increasing inventories will improve fill rates and prevent stockout costs, resulting in a positive contribution to firm financial performance. After this optimal inventory level is reached, further increases in inventory will result in overstocking and thus hurt firm financial performance. Interestingly, Chen, Frank & Wu (2005) reported that stocks are valued much higher for relatively lower-inventory firms, but not for firms with the lowest inventory levels. Shah & Shin (2007) also reported a non-linear relationship between inventory and financial performance. Therefore, a curvilinear relationship between inventory level and firm financial performance is expected. Both inventory level and squared term for inventory level are therefore included to model such a curvilinear relationship in my model.

Debt Structure

A firm's performance is believed to be aligned to its capital structure (Ghosh 2008). A direct cost of possessing higher debts is increased interest expenses and debt servicing fees. Higher debt increases a firm's financial risk and exposure to bankruptcy. On the other hand, the Modigliani-Miller Theorem suggests that due to tax deductions on interest expenses, leveraged firms may be able to obtain better returns than non-leveraged firms (see details from standard corporate finance textbooks, e.g., Brealey & Myers 2008 and Bailey 2005). Grossman & Hart (1986) reported that higher levels of debt in a firm's capital structure contribute to higher performance if its management is forced to change its own incentive structure. However, high leverage may be associated with performance declines in the long run due to the possibility that management may be unable to undertake risky projects (Smith & Warner 1979). Majumdar & Chhibber (1999) provided evidence from Indian firms that leverage leads to negative performance. Morck & Yeung (1991) included firm leverage as a proxy for capital structure in their model to explain firm value. Given the mixed results, in this dissertation, debt structure is included in the model without *a priori* prediction of the impact of the debt structure on financial performance. Debt structure is measured as total liabilities as a percentage of a firm's total assets.

Capital Intensity

Capital investments may affect a firm's profitability. Since capital investment helps improve manufacturing productivity, we generally believe that capital intensity may be positively associated with firm financial performance. However, capital investment may hurt a firm's profitability in the short run due to high expenditures and lagged effects over time. For example, Hendricks & Singhal (2001) documented that

among quality award-winners low capital-intense firms improve more in return on sales than do high capital intense firms. In this study, no *a priori* prediction on the impact of capital intensity on financial performance is assumed. Capital intensity is measured by capital investment as a percentage of firm total assets.

Firm Size

Large firms, by definition, generally have more resources than small firms, including managerial skills, business processes, and R&D investment. Large firms also enjoy economies of scale when marketing their products and negotiating with suppliers which may help improve profitability. For example, Roumiantsev & Netessine (2007b) found, on average, larger companies are more profitable than smaller companies. Therefore, firm size may be positively associated with financial performance.

Industry and Time Effects

Industry structure, such as concentration levels and entry barriers, has been most extensively examin\ed in the strategy literature to account for firm financial performance (see Waldman & Jensen 2006 for a comprehensive literature review). In international business literature, possibly due to firms operating in different countries, comparable and meaningful industry structural variables are hard to obtain. Following Lai (2005), Lu & Beamish (2004) and others, I use industry dummies to control for industry effects. Meanwhile, firm financial performance may experience systematic changes over time due to the evolution of technologies, industry and consumer preferences. It is necessary to control for time effects for a time-series dataset.

2.3.3 Econometric Specifications

In terms of econometric specifications, two-stage least squares models (2SLS) are estimated for inventory performance and financial performance. Note that in Equation 1.2, the financial performance model, inventory level is used as an independent variable. However, it is the dependent variable in Equation 1.1, the inventory performance model. Since many of the same exogenous variables are in both equations, inventory level may be considered as an endogenous variable in the financial performance model. Therefore, the predicted values of inventory levels from Equation 1.1 are used in Equation 1.2 to address endogeneity.

Most recent literature has argued for a multi-staged relationship between globalization and financial performance and included globalization, its squared term and cubed term in the regression model in order to capture the multi-staged curve, so called "horizontal S-shaped" relationship (Lu & Beamish 2004; Contractor, Kunda & Hsu 2003). Therefore, I also start with a less restrictive model by including the squared and cubed terms for globalization in my financial model.

To the best of the author's knowledge, this dissertation is the first effort to explicitly introduce inventory levels together with globalization into the existing financial performance model to study the direct and indirect impact of globalization via inventory management. Replacing variables with their corresponding measures as explained above, the original equations may be rewritten as follows:

$$(2.1)\ Inventory\ Level\ (LOG\_INVT) = \beta_0 + \beta_1\ Globalization + \beta_2\ Gross\ Margin + \beta_3\ Capital\ Cost + \beta_4\ Capital\ Intensity + \beta_5\ Firm\ Size + Industry\ Effects + Time\ Effects + \varepsilon_1$$

(2.2) Financial Performance (ROS) = γ_0 + γ_1 Globalization + γ_2 Globalization Squared+ γ_3 Globalization Cubed + γ_4 Predicted LOG_INV+ γ_5 Predicted LOG_INV Squared+ γ_6 Debt Structure+ γ_7 Capital Intensity + γ_8 Firm Size + Industry Effects + Time Effects+ ε_2

In equation (2.1), given that Inventory Days is an inverse measure of inventory performance, a positive and significant β_1 suggests that globalization is associated with higher inventory levels and lower inventory performance, a negative and significant β_1 would suggest that globalization is associated with lower inventory levels and higher inventory performance, and a non-significant β_1 would suggest that there is no sensible relationship between globalization and firm inventory levels.

In equation (2.2), a combination of different signs of γ_1, γ_2 and γ_3 may lend support for one of the six relationships regarding the impact of globalization on financial performance proposed in the existing international business and strategy literatures. For example, a negative γ_1, a positive γ_2 and a negative γ_3 would provide support for a horizontal S-shaped relationship. A negative γ_1, a positive γ_2 and a non-significant γ_3 would support a U-shaped argument. In contrast, a positive γ_1, a negative γ_2 and a non-significant γ_3 would support an inverted U-shaped argument. If γ_1 is significant while neither γ_2 nor γ_3 is significant, a linear relationship between globalization and financial performance may be indicated.

2.4 DATA SOURCES AND SAMPLE STATISTICS

To obtain a more complete picture of global operations and inventory management of manufacturing firms, and to model the inventory and financial performance of multinational firms, a sample of all manufacturing firms (NAICS code from 311111 to 399999) was obtained from the COMPUSTAT database over the period

1987-2007. Initially, 6,425 unique firms were downloaded with 61,691 firm-year observations. However, 338 firms (about 5% of the initial downloads) were excluded from further analysis due to non-reported sales or inventory data for any year during the selected period, resulting in 59,508 firm-year observations with 6,087 unique firms. 3,457 records were dropped from final analysis due to missing values on foreign sales and interest expenses. The final sample contains 56,051 firm-year observations with 6,047 unique firms, although not all firms report in each year of the sample.

Table 1 Globalization, Inventory and ROS over Years Before Winsorization

Year	# of Firms	Foreign Sales Percentage	Inventory in Days of Supply	Median ROS
1987	2797	9.9%	136	2.8%
1988	2704	10.7%	133	3.0%
1989	2647	11.2%	127	2.6%
1990	2631	12.1%	125	2.1%
1991	2704	12.3%	122	1.8%
1992	2888	12.2%	118	2.2%
1993	3031	12.4%	118	2.5%
1994	3149	13.1%	117	3.5%
1995	3394	14.6%	120	3.5%
1996	3445	15.4%	122	3.3%
1997	3390	15.7%	120	3.1%
1998	3331	20.4%	121	2.1%
1999	3202	26.6%	125	2.4%
2000	3005	28.6%	125	2.0%
2001	2808	30.6%	122	-0.5%
2002	2694	31.9%	120	0.0%
2003	2579	33.6%	114	1.5%
2004	2506	35.0%	116	3.0%

2005	2386	35.8%	113	2.9%
2006	2262	36.2%	118	3.7%
2007	1955	37.0%	118	3.8%

Not all firms appear in all years largely due to bankruptcies, mergers and acquisitions. On average, firms have records for nearly ten years with a maximum of 21 years and a minimum of 1 year. Based on raw data collected from the COMPUSTAT database, foreign sales accounted for nearly 20 percent of firm total sales for all firms over 21 years. Since the sample includes both U.S. and non-U.S.-based firms, foreign sales shall be understood as sales generated by subsidiaries located outside of a firm's home country. From Table 1, it is observed that foreign sales as a percentage of firm total sales have been increasing from nearly 10 percent in 1987 to 37 percent in 2007, based on reported foreign sales figure. Average inventory in days of supply showed a declining trend, with 136 days in 1987 and 118 days in 2007. Median net return on sales (ROS) ranged from -0.5% to 3.8%. No clear trend can be observed for ROS while median ROS declined dramatically in the period 2001-2003 probably due to an economic recession.

Since measurement errors and outliers in data may result in biased estimation of parameters, data cleaning methods have been proposed before estimation, including trimming and winsorization (Lien & Balakrishnan 2005). Basically, winsorization is a procedure similar to trimming except that by winsorization observations with the extreme values at both the low and high ends are not thrown away but replaced by the two remaining extreme, cut-off values. Specifically, "to winsorize the data, tail values are set equal to some specified percentile of the data. For example, for a 90% winsorization, the bottom 5% of the values are set equal to the value corresponding to the 5^{th} percentile while the upper 5% of the values are set equal to the value corresponding to the 95^{th}

percentile"(Heckert 2003). As a result, the extreme values are moved toward the centre of the distribution. This technique is sensitive to the number of outliers, but not to their actual values and therefore reduces of the impact of outliers on regression results and provides a reasonable estimate of central tendency for most statistical models.

To reduce the potentially biased impacts of extreme values (outliers) on regression results, in this essay the winsorization process is followed by replacing high extreme values with 90% percentiles and low extreme values with 10% percentiles (see examples in Lai 2006 a & b, Chen, Frank & Wu 2005 & 2007, Gompers, Lerner & Scharfstein 2005). A comparison of mean statistics for all variables before and after winsorization is provided in Table 2. Winsorized values are used for final regression.

Table 2 Mean Statistics of the Full Sample Before and After Winsorization

Variable	**Mean**		**STD**		**Min**		**Max**	
Winsorization	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Globalization	0.20	0.18	0.27	0.23	0.00	0.00	1.00	0.62
ROS	-.38	-.05	1.84	0.21	-14.53	-.57	0.35	0.12
Inventory (days)	174	107	525	58	0.20	34	998	216
Gross Margin	0.28	0.36	0.61	0.16	-4.65	0.13	0.85	0.62
Capital Cost	0.05	0.04	0.03	0.02	0.01	0.02	0.27	0.08
Debt Structure	0.56	0.51	0.43	0.24	0.05	0.17	3.07	0.92
Capital Intensity	0.05	0.05	0.06	0.03	0.00	0.01	0.57	0.11
Employment (in thousands)	6.36	3.21	16.57	4.42	0.007	0.05	113.25	13.64

As for the winsorized sample, on average, foreign sales accounted for 18 percent of firm total sales. This value is in line with foreign sales percentage (about 20 percent) before winsorization. Some firms had no sales from foreign subsidiaries while for a few firms sales from foreign subsidiaries nearly accounted for two-thirds of total sales. Mean

return on sales (ROS) was negative 38 percent with min ROS being -14530 percent, an extremely low value. The winsorized mean of ROS was negative 5 percent with min ROS being negative 57 percent. The median ROS stayed around positive 3 percent across most of the years. The negative value of ROS was largely due to the fact that firms could have large losses caused by write-offs even though sales may be in normal range. However, if firms made profits due to increases in sales, ROS was usually in line with gross profit margin, which is always less than 1.

Mean inventory in days of supply for the before-winsorization sample was 174 days, ranging from nearly 0.20 days to 998 days. Apparently, there are outliers at both the high and low ends which appear to be not reasonable and need to be addressed. In contrast, in the winsorized sample inventory averaged 107 days, ranging from 34 days to 216 days. Gross profit margin rate averaged 28 percent, ranging from negative 465 percent to 85 percent, while in the winsorized sample gross profit margin rate averaged 36 percent, ranging from a low 13 percent to a high 62 percent. Cost of capital for firms over this 21-year period averaged 5 percent, ranging from 1 percent to 27 percent, while in the winsorized sample cost of capital for firms averaged 4 percent, with a minimum of 2 percent and a maximum of 8 percent. Total liabilities accounted for more than half of the total assets, with a maximum value of more than three times total assets while in the winsorized sample leverage ranged from 17 percent to 92 percent. Capital intensity averaged 5 percent in both before- and after- winsorization samples. However, variations differ between two samples. Some firms spent nearly nothing on capital investment while capital expenditure of certain firms accounted as much as 27 percent of the total assets. Firm size in terms of employment varies dramatically. Even though a typical firm had

6,357 employees, the smallest firm only employed 7 workers with the largest 113,245 employees. In the winsorized sample, firm size averaged 3,210 employees ranging from 50 employees to 13,630 employees. In summary, variations of all variables have been significantly reduced in the winsorized sample.

To check for potential multicollinearity, two correlation tables are presented for the inventory and financial performance equations, respectively (Tables 3 and 4).

Table 3 Correlations for the Inventory Model

	Variable	2	3	4	5
2	Globalization	1.00			
3	Gross margin	0.16	1.00		
4	Capital cost	-.17	-.09	1.00	
5	Capital intensity	-.004	-.03	-.12	1.00
6	Firm size	0.35	-.08	-.18	0.15

Note that in Table 3 the correlation values for all independent variables in are relatively low (not exceeding 0.35), indicating that multicollinearity may not be a concern.

Table 4 Correlations for the Financial Performance Model

	Variable	1	2	3	4	5	6	7
1	Globalization †	1.00						
2	Globalization Squared †	0.59	1.00					
3	Globalization Cubed†	0.71	0.74	1.00				
4	Inventory ‡	0.12	0.06	0.09	1.00			
5	Inventory Squared ‡	-.003	0.03	0.01	0.12	1.00		
6	Debt Structure	0.01	-.02	-.005	-.32	-.04	1.00	

7	Capital Intensity	-.004	-.02	-.01	-.02	.002	-.05	1.00
8	Firm Size	0.35	0.15	.26	-.10	-.04	0.24	0.15

(†: Globalization and its polynomial terms all take de-meaned values.
‡: Inventory and its squared term are based on predicted values from Equation 1.1 and de-meaned values)

Due to the expected high correlation between the linear term of globalization, its squared term and its cubed term in the financial performance model, a de-meaned approach is adopted to transform the affected variables by centering the linear term of globalization at its mean and then using squared and cubed de-meaned variable, following Hart & Lence (2004). The same transformation is applied to predicted inventory and its squared term. According to Table 4, however, correlations between globalization, its squared term, and its cubed terms are still at a relatively high level, above 0.7. As a result, I ran Variance Inflation Factors (VIF) tests for all sets of variables. Tests show that each individual VIF score for all independent variables is below 10, a threshold considered a red flag for a serious concern of multicollinearity (Simon 2004). Therefore, multicollinearity may not be a serious concern for this sample. Note that ROS was replaced by ROA for an alterative measure of financial performance in the second stage regression.

2.5 REGRESSION RESULTS

Since the sample contains observations of thousands of firms over a period of time, firm-wise heteroskedasticity and cross-firm correlations may pose econometric problems. In this thesis, robust standard errors are applied to account for heteroskedasticity and contemporaneous correlations, following routine approaches provided by the STATA software.

2.5.1 The Fixed-Effects Models

I start with the original sample without winsorization with a notion in mind that there are outliers in the sample. Results are reported in Table 5.1

Table 5.1 Regression Results for the Fixed Effects Models (No Winsorization)

First-Stage Regression (Inventory Equation 1.1)		**Second-Stage Regression (Financial Performance Equation 1.2)**		
DV	Inventory Day in log term	**DV**	ROS	ROA
IV	Coefficient (std. error)	**IV**	Coefficient (std. error)	Coefficient (std. error)
Constant	4.59*** (.01)	Constant	-.37*** (.03)	0.02*** (.007)
Globalization	0.046*** (.017)	Globalization	-.05 (.05)	-.09*** (.01)
Gross Margin	0.44*** (.006)	Globalization Squared	-1.08*** (.23)	-.18*** (.06)
Capital Cost	-1.03*** (.09)	Globalization Cubed	1.21*** (.30)	0.30 (.07)
Capital Intensity	-.20*** (.06)	Inventory	2.00*** (.06)	0.74*** (.01)
Firm Size	-.0009** (.0004)	Inventory Squared	-1.01*** (.03)	-.25*** (.007)
		Debt Structure	-.27*** (.01)	-.37*** (.003)
		Capital Intensity	0.34*** (.10)	-.16*** (.03)
		Firm Size	0.0003 (.0007)	0.0005*** (.0002)
Year1988	-.02** (.01)		0.08*** (.02)	0.03*** (.006)
Year1989	-.06*** (.01)		0.15*** (.02)	0.06*** (.006)
Year1990	-.08*** (.009)		0.20*** (.02)	0.07*** (.006)
Year1991	-.10*** (.01)		0.23*** (.03)	0.09*** (.006)
Year1992	-.14*** (.01)		0.27*** (.03)	0.11*** (.006)
Year1993	-.15*** (.01)		0.28*** (.03)	0.11*** (.006)

Year1994	-.15*** (.01)		0.31*** (.03)	0.12*** (.006)
Year1995	-.15*** (.01)		0.29*** (.03)	0.12*** (.006)
Year1996	-.16*** (.01)		0.30*** (.03)	0.13*** (.006)
Year1997	-.18*** (.01)		0.33*** (.04)	0.12*** (.006)
Year1998	-.18*** (.01)		0.37*** (.03)	0.12*** (.006)
Year1999	-.18*** (.01)		0.38*** (.03)	0.13*** (.007)
Year2000	-.17*** (.01)		0.35*** (.03)	0.12*** (.007)
Year2001	-.22*** (.01)		0.38*** (.03)	0.10*** (.007)
Year2002	-.24*** (.01)		0.38*** (.03)	0.10*** (.007)
Year2003	-.28*** (.01)		0.56*** (.03)	0.19*** (.008)
Year2004	-.28*** (.01)		0.59*** (.03)	0.21*** (.008)
Year2005	-.30*** (.01)		0.62*** (.03)	0.21*** (.008)
Year2006	-.22*** (.01)		0.61** (.03)	0.20** (.008)
Year2007	-.27*** (.01)		0.57*** (.03)	0.19*** (.008)
Firm effects	Not reported here		Not reported here	Not reported here
# of OBS	56,051		56,051	56,051
# of Firms	6,047		6,047	6,047
Mean # of Years	9.3		9.3	9.3
Adj. R-squared	0.43		0.47	0.45
F-test	286.99 (<.000)		1,148.33 (<.000)	657.04 (<.000)

The results in Table 5.1 show that globalization has a positive and significant coefficient (0.05) on inventory levels. However, the linear term of globalization on ROS is not significant while its squared term has a negative coefficient and its cubed term has a positive coefficient. In the ROA model, the linear and cubed terms of globalization on ROA are both negative and significant while the cubed term is not significant.

Since outliers may generate biased estimation for parameters, I re-run the same fixed-effects models for the 10% winsorized sample. Regression results are reported in Table 5.2.

Table 5.2 Regression Results for the Fixed Effects Models (Winsorized Sample)

First-Stage Regression (Inventory Equation 1.1)		**Second-Stage Regression (Financial Performance Equation 1.2)**		
DV	Inventory Day in log term	**DV**	ROS	ROA
IV	Coefficient (std. error)	**IV**	Coefficient (std. error)	Coefficient (std. error)
Constant	4.22*** (.01)	Constant	-.02*** (.005)	0.03*** (.004)
Globalization	0.15*** (.04)	Globalization	-.06*** (.01)	-.05*** (.01)
Gross Margin	1.34*** (.03)	Globalization Squared	-.17*** (.05)	-.06 (.04)
Capital Cost	-1.37*** (.11)	Globalization Cubed	0.21 (.14)	0.17 (.11)
Capital Intensity	-.36*** (.07)	Inventory	0.40*** (.01)	0.32*** (.006)
Firm Size	-.002* (.0008)	Inventory Squared	-.22*** (.02)	-.19*** (.004)
		Debt Structure	-.16*** (.004)	-.19*** (.004)
		Capital Intensity	0.21*** (.03)	0.20*** (.02)
		Firm Size	0.002*** (.0004)	0.002*** (.0003)
Year1988	-.01 (.009)		0.01*** (.003)	0.01*** (.003)

Year1989	-.04*** (.009)		0.02*** (.003)	0.01*** (.003)
Year1990	-.05*** (.009)		0.02*** (.003)	0.01*** (.003)
Year1991	-.08*** (.009)		0.03*** (.003)	0.02*** (.003)
Year1992	-.11*** (.009)		0.04*** (.003)	0.03*** (.003)
Year1993	-.12*** (.009)		0.04*** (.003)	0.03*** (.003)
Year1994	-.12*** (.009)		0.06*** (.003)	0.04*** (.003)
Year1995	-.11*** (.009)		0.06*** (.003)	0.04*** (.003)
Year1996	-.13*** (.008)		0.06*** (.003)	0.04*** (.003)
Year1997	-.14*** (.008)		0.06*** (.004)	0.04*** (.003)
Year1998	-.14*** (.009)		0.05*** (.004)	0.03*** (.003)
Year1999	-.15*** (.01)		0.07*** (.004)	0.04*** (.003)
Year2000	-.12*** (.01)		0.05*** (.004)	0.03*** (.003)
Year2001	-.17*** (.01)		0.03*** (.004)	0.01*** (.003)
Year2002	-.18*** (.01)		0.03*** (.004)	0.01*** (.004)
Year2003	-.22*** (.01)		0.08*** (.004)	0.05*** (.003)
Year2004	-.22*** (.01)		0.10*** (.004)	0.07*** (.003)
Year2005	-.23*** (.01)		0.11*** (.004)	0.07*** (.003)
Year2006	-.22*** (.01)		0.11** (.005)	0.07** (.003)
Year2007	-.21*** (.01)		0.10*** (.005)	0.07*** (.004)
Firm effects	Not reported here		Not reported here	Not reported here
# of OBS	56,051		56,051	56,051
# of Firms	6,047		6,047	6,047

Mean # of Years	9.3		9.3	9.3
Adj. R-squared	0.73		0.65	0.61
F-test	145.71 (<.000)		189.32 (<.000)	278.60 (<.000)

(Note: *** denotes significance level at 0.01, ** at 0.05 and * at 0.10 for two-tailed tests)

According to Tables 5.1 and 5.2, the 2SLS models show a reasonable level of fit with adjusted R-squared values ranging from 0.43 to 0.73, strongly significant F-tests and the coefficients for the majority of variables with expected signs and high significance levels. The qualitative results for key independent variables are consistent across two samples. Below are discussions of results from the winsorized sample.

For the inventory model, the coefficient for globalization is positive 0.15 and significant at 0.01, suggesting that globalization is positively associated with inventory days. Also, the model shows that gross profit margin is positively associated with inventory levels, consistent with existing literature that firms may be willing to trade off low inventory performance for high profit margins. Cost of capital is shown to be negatively associated with inventory levels, a result in line with the classic EOQ model and economic theory. Capital intensity is negatively associated with inventory levels, suggesting capital investment may help firms reduce inventory. The coefficient for firm size is negative but marginally significant, indicating economies of scale for inventory management may be realized for firms in this sample. Industry fixed effects cannot be captured by the fixed-effects models, due to perfect multicollinearity between firm and industry dummies. Firm fixed effects are considered but not reported here. For time effects, the year dummy for 1987 was omitted as a default. Compared with the default year, each coefficient for all years except 1988 showed a highly significant, negative sign,

indicating average firm inventory levels may have decreased from the 1987 level when controlling for all time-independent factors.

For the ROS model, the coefficient for the linear term of globalization is negative 0.06 and significant at 0.01, the coefficient for its squared term is also negative 0.17 and significant at 0.01, and the coefficient for its cubed term is positive 0.21 but not significant. The results do not support any of the aforementioned six relationships from a statistical point of view; however, globalization may have a general negative impact on firm financial performance due to negative coefficients on both the linear and squared terms and non-significant cubed term. The linear term of predicted inventory is positive 0.40 and highly significant and the squared term of predicted inventory is negative 0.22 and highly significant, suggesting that a non-linear relationship may exist between inventory and financial performance. Particularly, inventories at either too low levels or too high levels may hurt financial performance. Debt structure shows a significant negative effect on ROS, suggesting that high leverage may hurt a firm's financial performance due to interest expenses. Capital intensity shows a positive effect on ROS as generally expected. Firm size has a highly significant, positive coefficient, indicating economies of scale for financial performance may exist as well. As in the inventory model, industry fixed effects cannot be captured by the fixed-effects models, due to perfect multicollinearity between firm and industry dummies. Firm fixed effects are considered but not reported here. For time effects, the year dummy for 1987 was omitted as a default. Compared with the default year, coefficients for all years showed highly significant, positive signs, indicating an upward trend for firm financial performance since 1987 when controlling for all other time-independent factors.

Following Larsen (2008), a residual analysis is conducted to check whether our models fit with the data and random errors are normally distributed with zero mean. A scatterplot of standardized residual with respect to standardized dependent variable (inventory days in log terms) and the histogram of standardized residual is presented in Figure 2. A scatterplot of standardized residual with respect to standardized dependent variable (ROS) and the histogram of standardized residual is presented in Figure 3.

Figure 2 Residual Analysis of Inventory Models – Fixed Effects

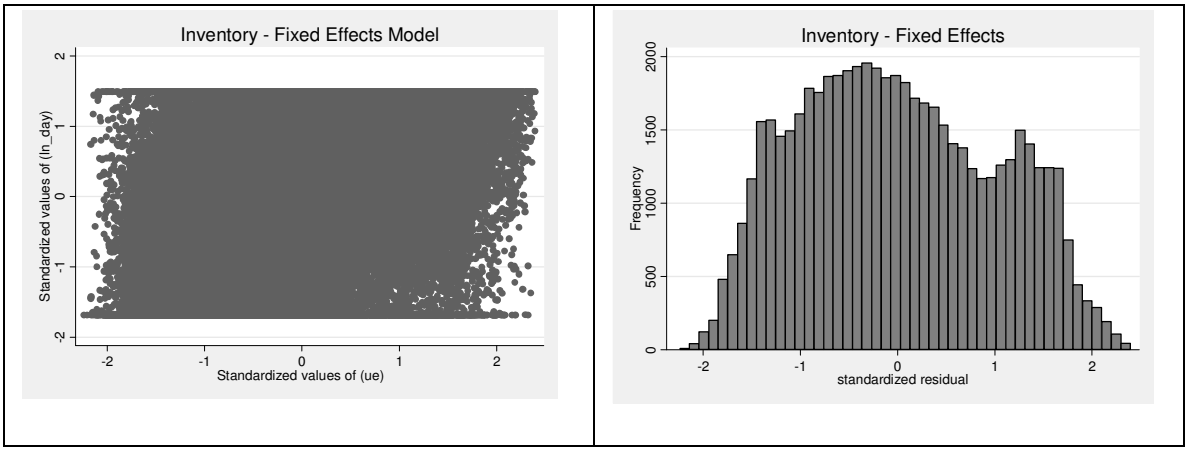
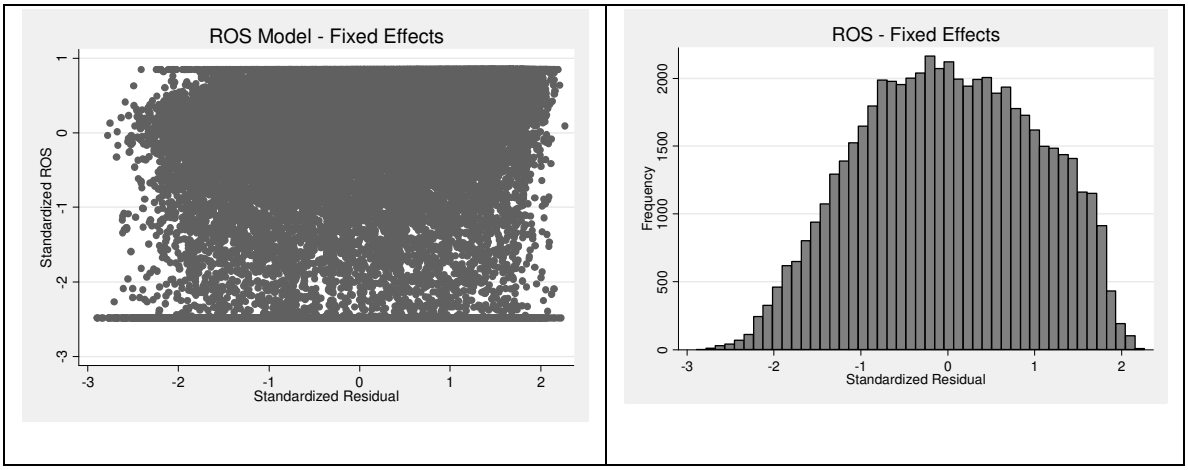


Figure 3 Residual Analysis of ROS Models – Fixed Effects



Based on Figures 2 and 3, the scatterplots of standardized residuals and dependent variables appear to be random without a particular pattern while the histograms show standardized residuals peak at 0 with a largely normal distribution. The residual analyses provide some assurance that the models are appropriate and fit with the dataset.

ROA is used as an alternative measure for financial performance. The qualitative results are in line with those of the ROS model. The coefficient for the linear term of globalization is negative 0.05 and highly significant, while the coefficient for the squared or cubed term is not significant. The linear term of inventory has a highly significant, positive coefficient (0.32) while the coefficient for its squared term is negative 0.19 and highly significant as well. Debt structure shows a negative effect while capital intensity shows a positive effect on financial performance. Economies of scale are also found for firm ROA. Notably, the time effects are very close to those found in the ROS model.

2.5.2 The Random -Effects Models

Since industry dummies can not be captured by the fixed-effects models, random-effects models are also run with industry dummies included. Regression results for the sample without winsorization are reported in Table 6.1 while regression results for the winsorized sample are reported in Table 6.2.

Table 6.1 Regression Results for the Random Effects Models (No Winsorization)

First-Stage Regression (Inventory Equation 1.1)		**Second-Stage Regression (Financial Performance Equation 1.2)**		
DV	Inventory Day in log term	**DV**	ROS	ROA
IV	Coefficient (std. error)	**IV**	Coefficient (std. error)	Coefficient (std. error)
Constant	4.89*** (.04)	Constant	-1.61*** (.07)	-.28*** (.02)
Globalization	0.050*** (.016)	Globalization	0.06 (.04)	-.01 (.01)

Gross Margin	0.439*** (.005)	Globalization Squared	-1.35*** (.23)	-.34*** (.06)
Capital Cost	-.93*** (.09)	Globalization Cubed	1.21*** (.29)	0.39*** (.07)
Capital Intensity	-.28*** (.06)	Inventory	2.58*** (.05)	.65*** (.01)
Firm Size	-.001*** (.0004)	Inventory Squared	-.84*** (.03)	-.20*** (.01)
		Debt Structure	-.28*** (.01)	-.38*** (.003)
		Capital Intensity	-.13 (.10)	-.13*** (.02)
		Firm Size	0.004*** (.0006)	0.002*** (.0002)
Industry311	-.79*** (.06)		0.34*** (.01)	0.65*** (.02)
Industry312	-.41*** (.08)		0.22*** (.02)	0.43*** (.03)
Industry313	-.38*** (.11)		0.26*** (.02)	0.53*** (.04)
Industry314	-.33** (.16)		0.23*** (.03)	0.50*** (.06)
Industry315	-.13** (.07)		0.13*** (.02)	0.26*** (.03)
Industry316	-.16 (.11)		0.14*** (.02)	0.30*** (.04)
Industry321	-.78*** (.10)		0.37*** (.02)	0.70*** (.04)
Industry322	-.59*** (.07)		0.32*** (.01)	0.60*** (.03)
Industry323	-1.08*** (.09)		0.43*** (.02)	0.79*** (.03)
Industry324	-1.02*** (.09)		0.47*** (.02)	0.80*** (.03)
Industry325	-.24*** (.04)		0.04*** (.01)	0.20*** (.02)
Industry326	-.57*** (.07)		0.28*** (.02)	0.56*** (.03)
Industry327	-.51*** (.08)		0.27*** (.02)	0.56*** (.03)
Industry331	-.31*** (.06)		0.23*** (.01)	0.48*** (.02)
Industry332	-.30*** (.06)		0.199*** (.02)	0.41*** (.02)

Industry333	-.16*** (.04)		0.10*** (.01)	0.22*** (.02)
Industry334	-.17*** (.04)		0.05*** (.001)	0.11*** (.01)
Industry335	-.14 (.06)		0.096*** (.01)	0.25*** (.02)
Industry336	-.45*** (.05)		0.26*** (.01)	0.52*** (.02)
Industry337	-.52*** (.09)		0.28*** (.02)	0.54*** (.03)
Year1988	-.02* (.01)		0.09*** (.02)	0.02*** (.006)
Year1989	-.06*** (.01)		0.19*** (.02)	0.05*** (.006)
Year1990	-.08*** (.01)		0.25*** (.02)	0.06*** (.006)
Year1991	-.11*** (.01)		0.29*** (.02)	0.08*** (.006)
Year1992	-.14*** (.01)		0.36*** (.02)	0.09*** (.006)
Year1993	-.15*** (.01)		0.37*** (.02)	0.09*** (.006)
Year1994	-.16*** (.01)		0.40*** (.02)	0.11*** (.006)
Year1995	-.15*** (.01)		0.37*** (.02)	0.11*** (.006)
Year1996	-.16*** (.01)		0.38*** (.02)	0.11*** (.006)
Year1997	-.17*** (.01)		0.42*** (.02)	0.10*** (.006)
Year1998	-.18*** (.01)		0.46*** (.03)	0.09*** (.006)
Year1999	-.18*** (.01)		0.45*** (.03)	0.10*** (.006)
Year2000	-.17*** (.01)		0.42*** (.03)	0.09*** (.007)
Year2001	-.22*** (.01)		0.48*** (.03)	0.07*** (.007)
Year2002	-.24*** (.01)		0.48*** (.03)	0.07*** (.007)
Year2003	-.28*** (.01)		0.69*** (.03)	0.15*** (.007)
Year2004	-.28*** (.01)		0.71*** (.03)	0.17*** (.007)

Year2005	-.30*** (.02)		0.74*** (.03)	0.17*** (.007)
Year2006	-.27*** (.02)		0.72*** (.03)	0.16** (.007)
Year2007	-.27*** (.02)		0.67*** (.03)	0.15*** (.008)
# of OBS	56,051		56,051	56,051
# of Firms	6,047		6,047	6,047
Mean # of Years	9.3		9.3	9.3
Overall R-squared (GLS)	0.29		0.48	0.32
Wald Chi-squared	8,557 (<.000)		38,119 (<.000)	21,718 (<.000)

(Note: *** denotes significance level at 0.01, ** at 0.05 and * at 0.10 for two-tailed tests)

The results in Table 6.1 show that globalization has a positive and significant coefficient (0.05) on inventory levels. However, the linear term of globalization on ROS is not significant while its squared term has a negative coefficient and its cubed term has a positive coefficient. In the ROA model, the linear and cubed terms of globalization on ROA are both negative and significant while the cubed term is positive and significant. The positive impact of globalization on inventory is consistent with findings from the fixed effects models using no-winsorized sample.

Since outliers may generate biased estimation for parameters, I re-run the same random-effects models for the 10% winsorized sample. Regression results are reported in Table 6.2.

Table 6.2 Regression Results of Random Effects Models (Winsorized Sample)

First-Stage Regression (Inventory Equation 1.1)		**Second-Stage Regression (Financial Performance Equation 1.2)**		
DV	Inventory Day in log term	**DV**	ROS	ROA

IV	Coefficient (std. error)	**IV**	Coefficient (std. error)	Coefficient (std. error)
Constant	4.36*** (.03)	Constant	-.18*** (.01)	-.08*** (.007)
Globalization	0.08*** (.01)	Globalization	-.03*** (.01)	-.03*** (.01)
Gross Margin	1.37*** (.02)	Globalization Squared	-.31*** (.05)	-.20*** (.04)
Capital Cost	-1.26*** (.11)	Globalization Cubed	0.24 (.15)	0.19 (.12)
Capital Intensity	-.51*** (.06)	Inventory	.38*** (.007)	.29*** (.005)
Firm Size	-.003*** (.0007)	Inventory Squared	-.08*** (.01)	-.06*** (.01)
		Debt Structure	-.16*** (.004)	-.18*** (.004)
		Capital Intensity	0.27*** (.03)	0.26*** (.02)
		Firm Size	0.005*** (.0003)	0.005*** (.0002)
Industry311	-.45*** (.04)		0.34*** (.01)	0.25*** (.01)
Industry312	-.35*** (.05)		0.22*** (.02)	0.16*** (.01)
Industry313	-.05 (.05)		0.26*** (.02)	0.18*** (.01)
Industry314	-.04 (.06)		0.23*** (.03)	0.17*** (.02)
Industry315	0.08** (.04)		0.13*** (.02)	0.08*** (.01)
Industry316	0.05 (.06)		0.14*** (.02)	0.085*** (.02)
Industry321	-.41*** (.05)		0.37*** (.02)	0.27*** (.02)
Industry322	-.32*** (.04)		0.32*** (.01)	0.23*** (.01)
Industry323	-.68*** (.05)		0.43*** (.02)	0.32*** (.01)
Industry324	-.60*** (.05)		0.47*** (.02)	0.36*** (.01)
Industry325	-.16*** (.03)		0.04*** (.01)	0.05*** (.008)
Industry326	-.31*** (.04)		0.28*** (.02)	0.21*** (.01)

Industry327	-.26*** (.05)		0.27*** (.02)	0.20*** (.01)
Industry331	-.007 (.04)		0.23*** (.01)	0.17*** (.01)
Industry332	-.07* (.04)		0.199*** (.02)	0.15*** (.01)
Industry333	0.02 (.03)		0.10*** (.01)	0.07*** (.003)
Industry334	-.09*** (.03)		0.05*** (.001)	0.02*** (.007)
Industry335	0.05 (.04)		0.096*** (.01)	0.07*** (.01)
Industry336	-.16*** (.03)		0.26*** (.01)	0.19*** (.01)
Industry337	-.25*** (.05)		0.28*** (.02)	0.20*** (.01)
Year1988	-.01 (.009)		0.01*** (.003)	0.01*** (.003)
Year1989	-.04*** (.009)		0.02*** (.003)	0.01*** (.003)
Year1990	-.05*** (.009)		0.02*** (.003)	0.01*** (.003)
Year1991	-.08*** (.008)		0.03*** (.003)	0.02*** (.003)
Year1992	-.11*** (.008)		0.04*** (.003)	0.03*** (.003)
Year1993	-.12*** (.008)		0.04*** (.003)	0.03*** (.003)
Year1994	-.13*** (.008)		0.05*** (.003)	0.04*** (.003)
Year1995	-.12*** (.008)		0.05*** (.003)	0.04*** (.003)
Year1996	-.13*** (.008)		0.05*** (.003)	0.04*** (.003)
Year1997	-.14*** (.008)		0.05*** (.003)	0.03*** (.003)
Year1998	-.14*** (.009)		0.04*** (.003)	0.02*** (.003)
Year1999	-.15*** (.009)		0.06*** (.003)	0.04*** (.003)
Year2000	-.13*** (.009)		0.04*** (.004)	0.02*** (.003)
Year2001	-.17*** (.0096)		0.02*** (.004)	0.003 (.003)

Year2002	-.19*** (.0096)		0.02*** (.004)	0.005 (.003)
Year2003	-.22*** (.097)		0.07*** (.004)	0.04*** (.003)
Year2004	-.22*** (.0098)		0.09*** (.004)	0.06*** (.003)
Year2005	-.24*** (.0099)		0.097*** (.004)	0.06*** (.003)
Year2006	-.22*** (.01)		0.098** (.004)	0.06** (.003)
Year2007	-.21*** (.01)		0.093*** (.004)	0.06*** (.003)
# of OBS	56,051		56,051	56,051
# of Firms	6,047		6,047	6,047
Mean # of Years	9.3		9.3	9.3
Overall R-squared (GLS)	0.27		0.15	0.19
Wald Chi-squared	6,695 (<.000)		7,042 (<.000)	10,173 (<.000)

As shown in Table 6.2, for the inventory model, the coefficient for globalization is positive 0.08 and significant at 0.01, suggesting that globalization is positively associated with inventory days. Also, the model shows that gross profit margin is positively associated with inventory levels; cost of capital is negatively associated with inventory levels; capital intensity is negatively associated with inventory levels; and economies of scale for inventory management exist, as reported in the fixed effects models. The industry dummy for the miscellaneous industry coded 399 was omitted as default in the inventory model. Most industry effects are significant and negative. The time dummy for the year of 1987 was omitted as default in the financial performance model. The coefficients for all years except 1988 are significant and negative.

For the ROS model, the coefficient for the linear term for globalization is negative 0.03 and highly significant, for its squared term is negative 0.31 and highly significant, but for its cubed term is not significant. The results show the same pattern as in the fixed-effects model. The linear term for predicted inventory is positive 0.38 and highly significant and the squared term of predicted inventory is negative 0.08 and highly significant, suggesting a non-linear relationship between inventory and financial performance, a finding consistent with the fixed-effects model. Debt structure and capital intensity show significant negative effects on ROS, as reported in the fixed effects model. Note that industry effects and time effects are generally positive and significant across all industry sectors and years.

Following the fixed effects model, the same residual analysis is performed to the random effects models. Results with respect to inventory and ROS are presented in Figure 4 and Figure 5, respectively.

Figure 4 Residual Analysis of Inventory Model - Random Effects

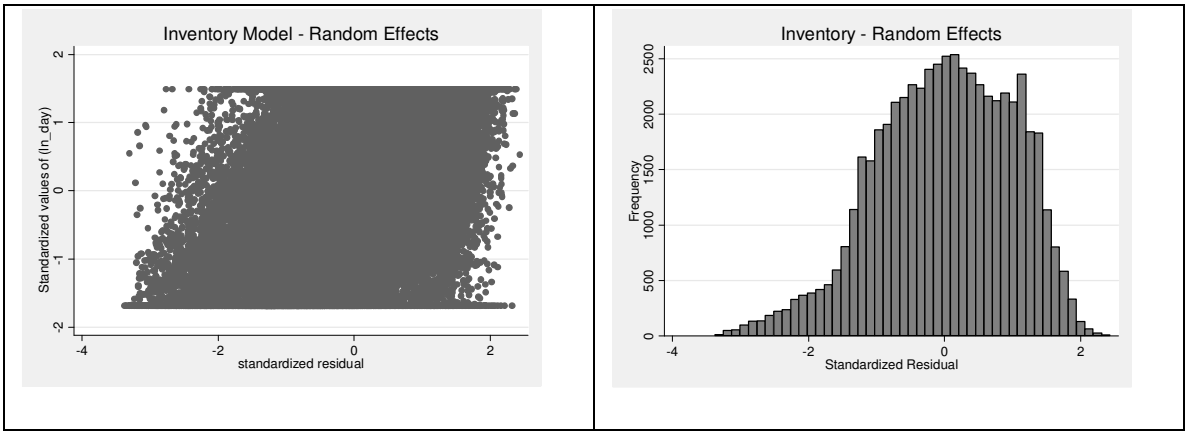
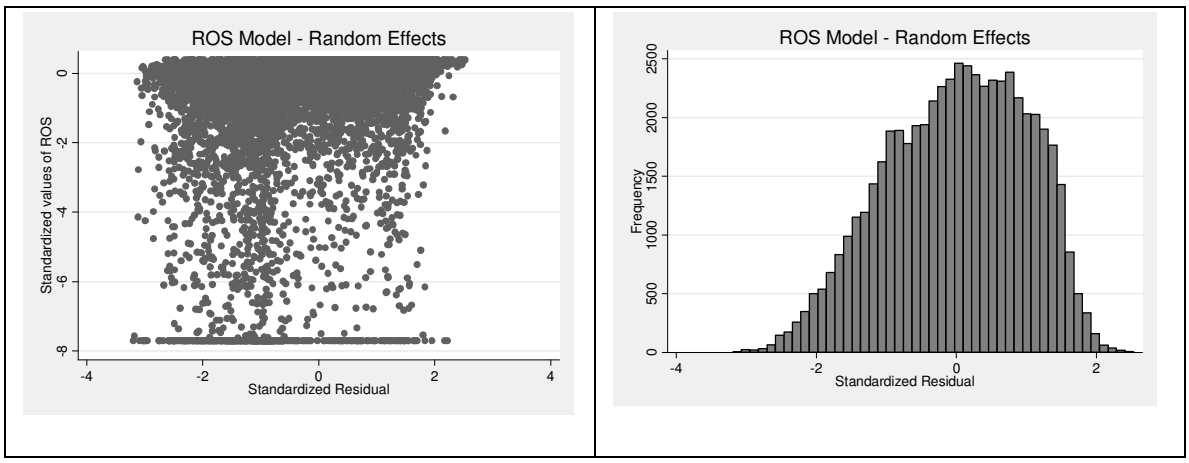


Figure 5 Residual Analysis of ROS Models – Random Effects



Based on Figures 4 and 5, the scatterplots of standardized residuals and dependent variables appear to be random without a particular pattern while the histograms show standardized residuals peak at 0 with a largely normal distribution. The residual analyses provide some assurance that the models are appropriate and fit with the dataset.

ROA is also used as an alternative measure for financial performance in the random-effects model. The qualitative results are almost the same as those of the ROS model. Specifically, globalization is found to have an overall significant effect on ROA with a significant, negative coefficient (-.03) for the linear term, a significant, negative coefficient (-0.20) for the squared term, but a non-significant coefficient for the cubed term. The coefficient of inventory in linear term is positive (0.29) and highly significant and for its squared term the coefficient is negative (-0.06) and highly significant, suggesting a non-linear relationship between inventory and financial performance.
In addition, coefficients for control variables, such as debt structure, capital intensity and firm size, all show the expected signs.

While the results for key independent variables appear to be close across the fixed-effects and random-effects models using both winsorized and non-winsorized samples, Hausman specification tests suggest that the fixed effects models are generally favored over the random effects models for the current dataset due to highly significant Hausman test scores. Since extreme values may distort regression results, the same models are tested using samples winsorized at 1% and 5% as well. It turns out that the qualitative results with respect to the impact of globalization on inventory and financial performance are robust to different winsorization methods used to treat extreme values.

However, it should be noted that the degree of globalization has been measured in various ways in the literature. It is no surprise if different measures of globalization may have contributed to the mixed findings in the literature. Besides foreign sales over total sales, other complementary measures have been used in the literature as well, such as foreign assets over total assets (Ramaswamy 1993, Geringer, Beamish & daCosta 1989), foreign employment over total employment (Kim, Hwang & Burgers 1989), the number of geographic regions or foreign countries a firm entered (Kogut 1985, Ramaswamy 1993, Hitt, Hoskssion & Ireland 1994, Lu & Beamish 2004), and a composite index based on some or all aforementioned measures (Sullivan 1994, Ramaswamy, Krock & Renforth 1996, Contractor 2003).

2.6 A CROSS-SECTIONAL ANALYSIS

Many measures for globalization in the existing literature, such as sales (assets, employment) from foreign subsidiaries over total sales (assets, employment), may be alone the line of global *intensity*, reflecting the depth and the extent to which a multinational firm penetrates into and relies on foreign markets. Only a few other

measures, such as the total number of foreign countries entered and foreign subsidiaries established, may be called a rough measure of global *extensity*, reflecting the breadth of globalization. To ensure that the results are less sensitive to various measures for globalization, in this thesis I adopt a two-dimensional measure of globalization – global *intensity* and *extensity* – and include both measures in the regression models to examine the impact of globalization on inventory and financial performance. While global *intensity* is measured by foreign sales over firm total sales, global *extensity* is defined as dispersion of foreign sales, which can be measured by the reciprocal of geographic concentration of foreign sales. Following the Herfindahl Hirschman Index (HHI) measure, foreign sales concentration may be defined as

$$Foreign\ Sales\ Concentration = \sum_{k=1}^{K} [\frac{Sales\ \ from\ Foreign\ Country_k}{Firm\ Total\ International\ Sales_i}]^2$$ (k is country index); Therefore, $$Global\ Extensity = 1/\sum_{k=1}^{K} [\frac{Sales\ \ from\ Foreign\ Country_k}{Firm\ Total\ International\ Sales_i}]^2 .$$

2.6.1 Mean Statistics for the Cross-Sectional Sample

The recent year of 2006 was selected for cross-sectional analysis. Since not all firms reported their foreign sales by country, to capture global extensity, only 1,141 manufacturing firms are included. The sample statistics is reported in Table 7.

Table 7 Mean Statistics for the Cross-Sectional Sample

Variable	**Mean**		**STD**		**Min**		**Max**	
Winsorization	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Global Intensity	0.36	0.31	0.31	0.25	0	0.01	1.00	0.62
Global Extensity	2.16	1.98	1.58	1.03	1.00	1.00	11.23	6.36
Inventory Days	158	103	206	58	2	34	998	216

ROS	-.43	-.04	2.09	0.21	-12.98	-.57	.31	0.12
Gross Margin	0.32	0.38	0.59	0.16	-4.27	0.13	0.79	0.62
Capital Cost	0.04	0.04	0.03	0.02	0.01	0.02	0.20	0.08
Debt Structure	0.54	0.48	0.47	0.24	0.06	0.20	3.02	0.92
Capital Intensity	0.05	0.04	0.04	0.04	0.01	0.00	0.57	0.32
Employment (000)	6.75	3.77	10.06	4.82	0.07	0.05	113.25	13.64

On average, international sales accounted for 31 percent of firm total sales, a measure of global *intensity* in the winsorized sample. The average foreign sales percentage was 36.2 percent for all firms that reported sales data in 2006 in the non-winsorized sample (also shown in Table 1). The average global *extensity* index was 1.98, ranging from 1 to 6.36 in the winsorized sample while average extensity was 2.16 in the non-winsorized sample. Since the *extensity* index is a reciprocal of the international sales geographic concentration level, the concentration level corresponding to an *extensity* score of 1.98 in this sample was 0.51, with a minimum of 0.16 and a maximum of 1.00. The average firm inventory level was 158 days in the non-winsorized sample ranging from 2 to 998 days while the average firm inventory level was 103 days in the winsorized sample. The average return on sales in the non-winsorized sample was negative 43 percent while in the winsorized sample was negative 4 percent. Note that the median ROS was positive 4 percent. In the winsorized sample, average gross profit margin rate is 38 percent which high margin firms marked up by 92 percent and some firms sold products at less than 2 percent. Note that the non-winsorized sample had a gross profit margin of 32 percent.

In the winsorized sample, on average, debt accounted for approximately half of a firm's total assets with some firms being highly leveraged. The cost of debt was 4% on average, ranging from 2 percent to 8 percent. Also, capital investment only accounted for 4% of total assets, ranging from less than 1 percent up to 11 percent. The average workforce was 3,770 workers per firm, ranging from 50 workers to over 13,000 employees.

2.6.2 Regression Results of the Cross-Sectional Sample

In this alternative model, globalization is operationalized by *global intensity and extensity.* In addition, the product term of *global intensity* and *extensity* is included to account for a potential interactive effect because the impact of global intensity may also depend on the degree of sales dispersion (i.e., *extensity*) and vice versa. Therefore, the econometric model is specified as follows:

$$(3.1)\ Inventory\ Level\ (LOG\_INV) = \beta_0 + \beta_1\ Global\ Intensity + \beta_2\ Global\ Extensity + \beta_3\ Global\ Intensity\ \text{X}\ Extensity + \beta_4\ Gross\ Margin + \beta_5\ Capital\ Cost + \beta_6\ Capital\ Intensity + \beta_7\ Firm\ Size + Industry\ Effects + \varepsilon_1$$

$$(3.2)\ Financial\ Performance\ (ROS) = \gamma_0 + \gamma_1\ Global\ Intensity + \gamma_2\ Global\ Extensity + \gamma_3\ Global\ Intensity\ \text{X}\ Extensity + \gamma_4\ Predicted\ LOG\_INV + \gamma_5\ Predicted\ LOG\_INV\ Squared + \gamma_6\ Debt\ Structure + \gamma_7\ Capital\ Intensity + \gamma_8\ Firm\ Size + Industry\ Effects + \varepsilon_2$$

Similar to the model applied to the full sample, 2SLS model is estimated in this cross-sectional sample. Predicted inventory levels from the first stage (Equation 3.1) are used in the second stage (Equation 3.2). In Equation 3.2, inventory and its square term are centered at mean to reduce multicollinearity. Since the introduction of interaction term may also cause high correlations, global intensity, global extensity and their

interaction term are de-meaned as well. VIF tests show that all VIF scores are below 4 across both models, indicating that multicollinearity may not be a serious concern. Correlations are presented in Table 8.

Table 8 Correlation Table for the Cross-sectional Sample with Winsorization

	Variable	1	2	3	4	5	6	7	8	9
1	Global Intensity	1.00								
2	Global Extensity	0.42	1.00							
3	Intensity X Extensity	0.06	0.25	1.00						
4	Gross Margin	0.08	-.01	-.01	1.00					
5	Capital Cost	-.14	0.03	-.01	-.15	1.00				
6	Capital Intensity	0.02	0.07	-.04	-.13	0.04	1.00			
7	Firm Size	0.15	0.17	0.02	-.15	0.32	0.17	1.00		
8	Debt Structure	-.02	0.03	-.02	-.37	0.25	0.04	0.32	1.00	
9	Inventory	0.14	0.02	-.06	0.41	-.28	-.30	-.40	-.48	1.00
10	Inventory Square	-.05	-.11	-.02	0.13	-.07	-.02	0.03	0.04	0.12

(Note: correlations are based on de-meaned values of affected variables.)

According to Table 8, all correlation values are generally moderate (less than 0.5). Together with VIF test scores, multicollinearity may not pose a serious concern.

Regression results based on a2SLS estimation are presented in Tables 9.1.

Table 9.1 Regression Results for Cross-Sectional Analysis (Winsorized Sample)

	Inventory Model	Financial Performance Model
DV	LOG_INV	ROS

IV	Coefficient (std. error)	Coefficient (std. error)
Constant	4.29*** (.07)	-1.29*** (.09)
Global Intensity	0.14** (.06)	-.03*** (.01)
Global Extensity	0.005** (.002)	-.006 (.004)
Intensity X Extensity	-.02* (.01)	-.0007 (.0015)
Capital Intensity	-1.71*** (.59)	0.38*** (.11)
Firm Size	-.007*** (.001)	0.003*** (.001)
Capital Cost	-.68*** (.13)	
Gross Margin	1.19*** (.09)	
Debt Structure		-.23*** (0.08)
Predicted Inventory		0.08*** (.01)
Predicted Inventory Squared		-.09*** (.03)
Industry311	0.06 (.09)	0.04** (.02)
Industry312	-.18** (.09)	0.08*** (.02)
Industry313	0.09 (.21)	0.02 (.03)
Industry314	-.35** (.16)	0.17*** (.05)
Industry315	-.06 (.09)	0.05** (.02)
Industry316	0.20* (.13)	0.01 (.03)
Industry321	-.08 (.17)	0.04 (.03)
Industry322	-.08 (.09)	0.05*** (.02)
Industry323	-.22*** (.06)	0.05* (.03)
Industry324	-.14 (.11)	0.04 (.03)

Industry325	-.04 (.06)	0.01 (.01)
Industry326	-.04 (.10)	0.01 (.02)
Industry327	-.16* (.09)	0.07*** (.02)
Industry331	-.07 (.09)	0.03* (.016)
Industry332	-.02 (.09)	0.04** (.02)
Industry333	-.10* (.06)	0.04*** (.01)
Industry334	-.15*** (.06)	0.02** (.01)
Industry335	0.01 (.08)	0.029* (.016)
Industry336	-.08 (.07)	0.03** (.01)
Industry337	-.26* (.15)	0.06** (.03)
# of OBS	1,141	1,141
Adj. R-squared	0.31	0.33
F-tests	19.64 (<.000)	21.02 (<.000)

(Note: *** denotes significance level at 0.01, ** at 0.05 and * at 0.10 for two-tailed tests)

As shown in Table 9, both the Inventory and ROS models have R-squared values above 0.30 with highly significant F-tests, a reasonable fit given the nature of cross-sectional dataset.

In the inventory model, the coefficient for global intensity is 0.14, significant at 0.05, suggesting *global intensity* is positively associated with inventory level. This result is consistent with the analysis of the panel dataset. The coefficient for *global extensity* is 0.005, significant at 0.05, suggesting global extensity may have a positive effect on inventory level. Interestingly, the interaction term between global intensity and extensity is negative (-.02) and significant at 0.10, suggesting that when both intensity and

extensity are increased, the positive impact on inventory levels may be offset to some extent. This non-intuitive finding seems difficult to interpret from a theoretical viewpoint.

Also, the inventory model shows that the coefficients of control variables generally have expected signs. For example, the effect of gross profit margin is positive, consistent with existing literature that firms may be willing to trade off low inventory performance with high profit margins. The coefficient for capital cost is negative, indicating that higher costs may reduce inventory holdings. The coefficient for capital intensity is negative, suggesting capital investment may help firms reduce inventory. Inventory level is also shown to be negatively associated with firm size, suggesting there may exist economies of scale for inventory management, consistent with existing inventory literature.

In the ROS model, the coefficient for global intensity is -.03, significant at 0.01, suggesting that global intensity is negatively associated with financial performance. However, the coefficients for global extensity and the interaction term between global intensity and extensity are not found to have significant impact on financial performance for this sample. Note that control variables in the ROS model demonstrate expected effects on financial performance. Predicted inventory level and its squared terms are both significant, indicating a likely non-linear relationship between inventory and financial performance. Capital intensity seems to improve financial performance while high leverage may lead to lower financial performance. Firm size has a highly significant, positive coefficient, indicating the existence of economies of scale.

The same residual analysis is performed with respect to inventory and ROS and results are presented in Figure 6 and 7, respectively.

Figure 6 Residual Analysis of Inventory Model – Cross-sectional Sample

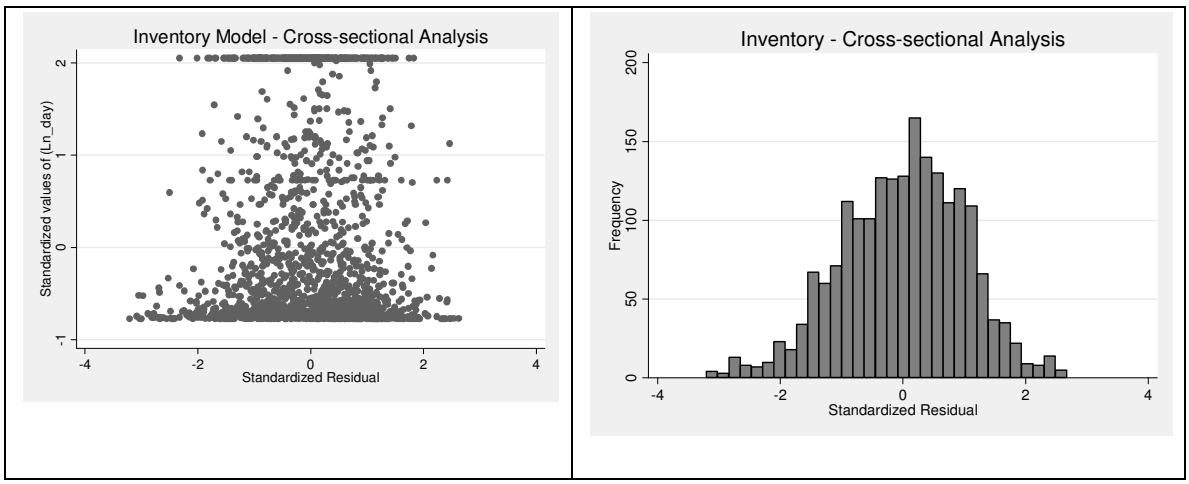
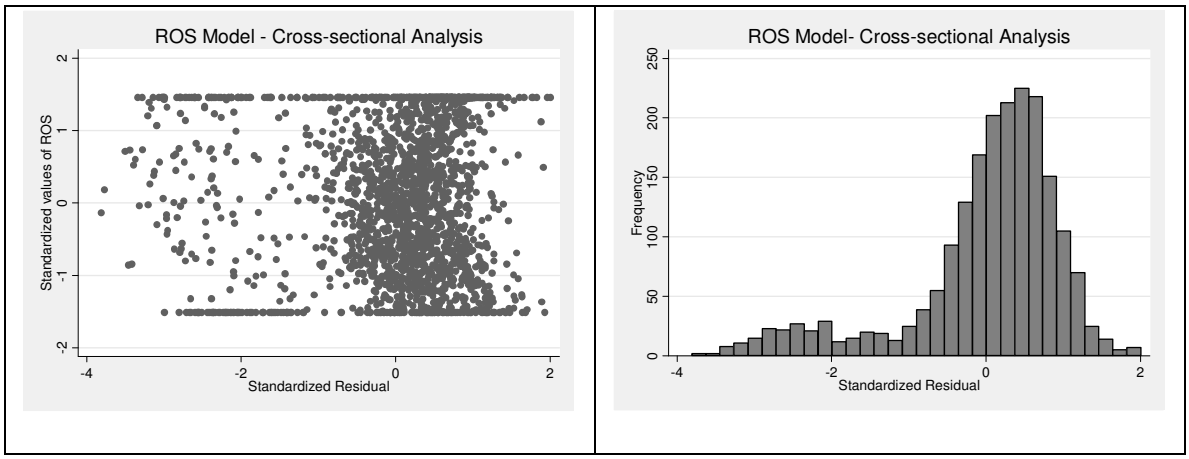


Figure 7 Residual Analysis of ROS Model – Cross-sectional Sample



Based on Figures 6 and 7, the scatterplots of standardized residuals and dependent variables appear to the random and do not imply a particular pattern. The histogram of inventory is normally distributed with zero mean. However, the histogram of ROS is approximately normally distributed but with a long tail to the lower values. Overall, residual analyses indicate that the models are appropriate and fit with the dataset.

For a robustness check, the same set of regressions is run using the non-winsorized sample. Results are presented in Table 9.2

Table 9.2 Regression Results of Cross-sectional Analysis (Non-Winsorized Sample)

	Inventory Model	**Financial Performance Model**
DV	LOG_INV	ROS
IV	Coefficient (std. error)	Coefficient (std. error)
Constant	3.85*** (.21)	-1.29*** (.09)
Global Intensity	0.09* (.05)	-.02** (.01)
Global Extensity	0.005* (.003)	-.003 (.005)
Intensity X Extensity	-.05** (.02)	-.0009 (.0018)
Capital Intensity	-1.43*** (.59)	0.57*** (.15)
Firm Size	-.005*** (.001)	0.003* (.002)
Capital Cost	-.92*** (.13)	
Gross Margin	1.26*** (.09)	
Debt Structure		-.37*** (0.10)
Predicted Inventory		0.06*** (.02)
Predicted Inventory Squared		-.12*** (.03)
Industry311	0.14* (.08)	0.03 (.03)
Industry312	-.13 (.11)	0.07*** (.03)
Industry313	0.11 (.23)	0.02 (.03)
Industry314	-.39** (.18)	0.21*** (.04)
Industry315	-.05 (.08)	0.04** (.02)
Industry316	0.16* (.09)	0.02 (.04)

Industry321	-.09 (.20)	0.05 (.04)
Industry322	-.07 (.06)	0.06** (.03)
Industry323	-.26*** (.09)	0.04** (.02)
Industry324	-.16 (.13)	0.05* (.03)
Industry325	-.09* (.06)	0.01 (.01)
Industry326	-.14 (.10)	0.02 (.03)
Industry327	-.27* (.09)	0.07* (.04)
Industry331	-.07 (.09)	0.04** (.02)
Industry332	-.04 (.09)	0.05** (.02)
Industry333	-.08 (.06)	0.05*** (.02)
Industry334	-.11** (.06)	0.03** (.02)
Industry335	0.01 (.09)	0.02 (.02)
Industry336	-.08 (.09)	0.03* (.02)
Industry337	-.24 (.18)	0.08** (.04)
# of OBS	1,141	1,141
Adj. R-squared	0.28	0.29
F-tests	17.58 (<.000)	19.33 (<.000)

According to Table 9.2, the coefficients of key independent variables are largely in line with those shown regressions using the winsorized sample. For example, both global intensity and extensity are positively associated with inventory level; however, they are marginally significant for the non-winsorized sample. The interaction term of global intensity and extensity is negative and significant, consistent with the winsorized

sample result. In terms of impact on financial performance, global intensity has a negative impact but less significant than it was in the winsorized sample. Other variables are also demonstrating similar impacts as in the winsorized sample.

2.7 IMPACT OF GLOBALIZATION ON FINANCIAL PERFORMANCE WITHOUT CONSIDERING INVENTORY

Most recent strategy and international business literatures have shown that the relationship between globalization and financial performance is horizontal-S shaped. For example, Contractor, Kundu & Hsu (2003) proposed a three-stage theory to explain the complex relationship between globalization (i.e., international geographic expansion) and financial performance, tested through data on service industries across a dozen countries. They collect data on 204 firms spanning 11 major service sectors, such as advertising, air transport, hotel, market research and publishing, over the period 1983-1988. In their model, financial performance is measured as return on global total sales (ROS) and globalization, the degree of "multinationality" in their term, is measured by a composite index, an eigenvector-weighted foreign sales over total sales, foreign employment over total employment, and number of foreign offices over total number of firm offices. Therefore, their globalization index ranges from 0 to 3.

Their model is specified as follows: ROS = *f (firm size, globalization, globalization squared, globalization cubed, sector dummies, US-based dummy).* As shown in the regression analysis, the total number of observations is 606 and a pooled ordinary least squared estimation is performed. Regression using a subset of dataset shows that the coefficient of globalization is negative, the coefficient of squared globalization is positive and the coefficient of cubed globalization is negative, suggesting

a horizontal-S shaped relationship existing between globalization and financial performance. They explained that the slope is negative at Stage 1 due to liability of foreignness, positive at Stage 2 due to arbitrage benefits and economies of scale and scope, and negative again at Stage 3 due to rocketing coordination costs caused by over-expansion.

Lu & Beamish (2004) also reported a horizontal S-shaped relationship between international expansion and firm performance through various stages of globalization, using data on 1,489 Japanese firms over the period 1986-1997. They argued that the relationship between internationalization ("geographic diversification" in their term) and firm performance is negative at low levels of geographic diversification due to "liability of newness and foreignness", positive at medium levels due to learning and exploitation effects and development of new capabilities, and negative at high levels of geographic diversification due to costs associated governance and coordination. Firm performance is measured by return on assets (ROA) and Tobin's *q*, a ratio between firm market values and book value of assets. Internationalization is measured by a composite of two counts: the number of overseas subsidiaries in a given year, and the number of countries a firm had overseas subsidiaries in a given year. The composite index is achieved as follows: first, the number of overseas subsidiaries in a given year is divided by the maximum number of overseas subsidiaries in the sample; second, the number of foreign countries in a given year is divided by the maximum number of foreign countries in the sample; third, the simple average of these two ratios is computed as the internationalization index. The final score ranges from 0 to 1. Their model is specified as follows:

Financial performance = f (internationalization, internationalization squared, internationalization cubed, exchange rate, R&D intensity, advertising intensity, firm size, product diversity index, debt-to-equity ratio, export intensity, internationalization X R&D intensity, internationalization X advertising intensity).

Note that, average exchange rate is based on US dollar to yen rate in a given year. R&D intensity is R&D expenses over sales, advertising intensity is advertising expenses over sales, firm size is measured by log term of sales, export intensity is expressed as a percentage of total sales exported, and product diversification is product line sales based Herfindahl index.

The model is estimated using the random effects model. Results show that the coefficient of internationalization is negative, the coefficient of internationalization squared is positive and the coefficient of internationalization cubed is negative, suggesting a horizontal-S shaped relationship between internationalization and financial performance.

To ensure the comparability of my current models with these two most recent models and also highlight the contribution after including inventory in the model, I also re-run the previous models for the panel dataset while only dropping inventory and its squared term. Results for fixed effects and random effects models are reported in Tables 9.3.

Table 9.3 Regression Results of the ROS Models without Inventory

DV	ROS	
Models	**Fixed Effects**	**Random Effects**
IV	Coefficient (std. error)	Coefficient (std. error)

Constant	0.05*** (.004)	-.03*** (.009)
Globalization	-.04*** (.01)	-.002 (.01)
Globalization Squared	-.21*** (.05)	-.38*** (.05)
Globalization Cubed	0.36** (.15)	0.56*** (.15)
Debt Structure	-.20*** (.004)	-.20*** (.004)
Capital Intensity	0.12*** (.02)	0.13*** (.02)
Firm Size	0.002*** (.0003)	0.005*** (.0003)
Year1988	0.005 (.003)	0.0056* (.003)
Year1989	0.007** (.004)	0.007** (.0035)
Year1990	0.002 (.004)	0.02 (.0035)
Year1991	-.0009 (.004)	-.001 (.0035)
Year1992	-.001 (.004)	-.001 (.0035)
Year1993	-.001 (.004)	-.0017 (.003)
Year1994	0.01*** (.004)	0.009*** (.003)
Year1995	0.01*** (.003)	0.01*** (.003)
Year1996	0.007** (.003)	0.005 (.003)
Year1997	0.004 (.004)	0.0004 (.003)
Year1998	-.002 (.004)	-.008** (.004)
Year1999	0.01*** (.004)	0.003 (.004)
Year2000	0.001 (.004)	-.006 (.004)
Year2001	-.04*** (.004)	-.05*** (.004)
Year2002	-.04*** (.004)	-.05*** (.004)

Year2003	-.004 (.004)	-.01*** (.004)
Year2004	0.02*** (.004)	0.01*** (.004)
Year2005	0.02*** (.004)	0.01*** (.004)
Year2006	0.03*** (.004)	0.02** (.004)
Year2007	0.03*** (.004)	0.02*** (.004)
D311		0.11*** (.01)
D312		0.09*** (.02)
D313		0.15*** (.03)
D314		0.15*** (.04)
D315		0.12*** (.02)
D316		0.12*** (.03)
D321		0.13*** (.02)
D323		0.12*** (.02)
D324		0.13*** (.02)
D325		-.03*** (.01)
D326		0.10*** (.02)
D327		0.12*** (.02)
D331		0.13*** (.02)
D332		0.12*** (.14)
D333		0.08*** (.01)
D334		0.01 (.009)
D335		0.07*** (.01)

D336		0.12*** (.01)
D337		0.14*** (.02)
Firm Effects	Not reported here	Not reported here
# of OBS	56,135	56,135
# of Firms	6,050	6,050
Average Years	9.3	9.3
Overall R-squared	0.35	0.15
F-tests	153.99 (<.000)	
Wald chi-squared		4771 (<.000)

A residual analysis is also performed. Results with respect to inventory and ROS models are reported in Figures 8 and 9, respectively.

Figure 8 Residual Analysis of ROS Model without Inventory – Fixed Effects

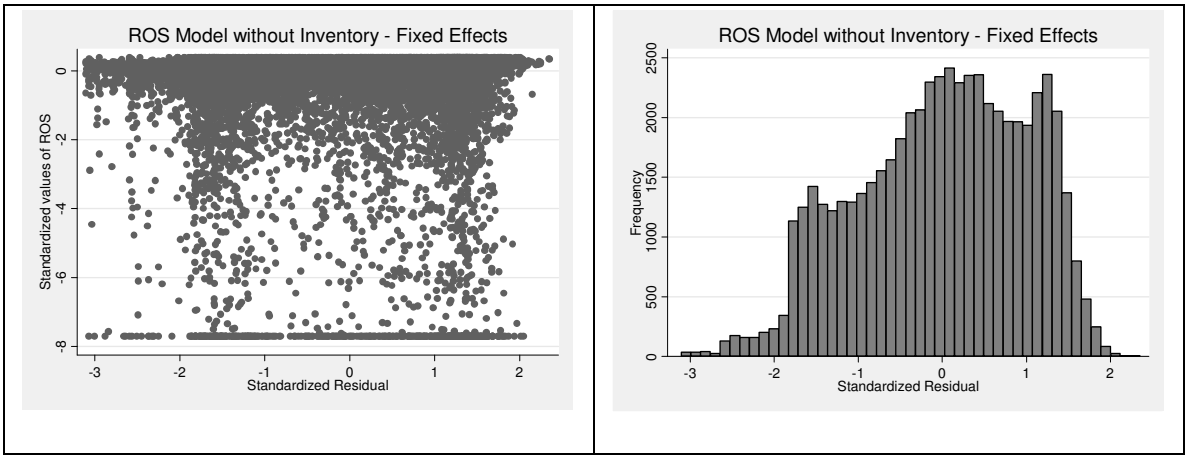
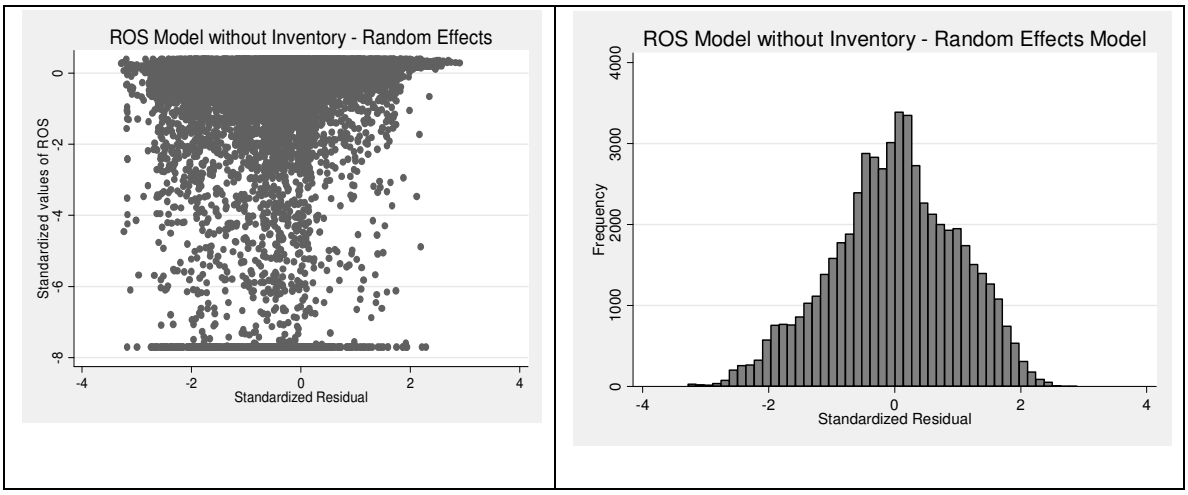


Figure 9 Residual Analysis of ROS Model without Inventory – Random Effects



Figures 8 and 9 show that scatterplots of standardized residuals and dependent variables appear to be random without a particular pattern and that histograms of standardized residuals are normally distributed centering at zero. The residual analysis suggests that the models are appropriate and fit with the dataset.

According to Table 9.3, the coefficient of the cubed term of globalization is positive and highly significant, suggesting a sigmoid relationship between globalization and financial performance. The finding is largely in line with results reported by Contractor, Kundu & Hsu (2003) and Lu & Beamish (2004). However, the coefficient of the squared term of globalization is negative and significant in this research, while the coefficient of globalization squared was positive and significant in Contractor, Kundu & Hsu (2003) and Lu & Beamish (2004) across most models.

Interestingly, in the models with inventory included, the cubed term of globalization is not significant at all neither in the fixed effects models nor in the random effects models. When inventory is excluded, the cubed term becomes positive and highly significant across all models. The different impact of globalization on financial performance may be due to the role of inventory. When inventory increases with

globalization, as shown in the inventory model, inventory costs may contribute negatively to firm financial performance. Therefore, taking into account inventory becomes critical when studying the impact of globalization on firm financial performance.

2.8 DISCUSSION OF REGRESSION RESULTS

Regression results from an analysis of the 21-year panel dataset and a cross-sectional examination show that globalization, measured by global *intensity* and *extensity*, may likely increase firm inventory levels. Meanwhile, globalization may also lead to reduced financial performance in general. While the inventory finding is understandable given that holding more inventories may be an effective tool within a firm's control to manage the increasing risks associated with global supply chains, the performance finding may not seem intuitive. After all, globalization has become a common theme among modern enterprises and multinational firms have been in active operations around the global for decades.

The results may be explained that due to increasing transaction costs and operating costs for global activities, coupled with decreasing arbitrage opportunities, multinational firms may not be able to enhance financial returns by increasing the degree of globalization. For example, with an increasing number of foreign markets, firm bureaucracy increases and the demand for information technology investments escalates in order to achieve better monitoring and coordination. Foreign operations may expose firms to different cultures and values in the workplace, requiring investments in new management practices. Financial risks can increase, for example, through foreign exchange risks. Economies of scale and scope may not be easily obtained when facing localized customer preferences. Our conversations with industry experts suggest that the

financial outcome of a global strategy may also depend on location of activities and execution of strategies. In fact, some evidence in research has highlighted the importance of locations of multinational firms in driving firm value (Olsen & Elango 2005).

Even though the findings in the study are not intended to suggest that top executives of multinational firms are making unwise decisions, it may be a reality that motivations for manufacturing firms to increase their global operations may also include, but are not limited to, pressure from Wall Street, domestic competition, the bandwagon effect of being global, and compensation and self-fulfillment for senior executives, as Denis, Denis & Yost (2002) pointed out. But why do firms over-expand? Contractor, Kundu & Hsu (2003) argued that globalization may be a discrete decision and the degree of globalization may not be constantly monitored. Overexpansion may serve as a long-term strategy to take market share from a firm's competitors.

Another plausible explanation provided in the literature is that multinational firms may be willing to sacrifice short-term profitability in exchange for greater market-based performance, such as growth in market share and performance of stocks. For example, studies reported that globalization contributes positively to sales growth (i.e., Geringer, Tallman and Olsen 2000) and Tobin's *q*, a stock-based measure (i.e., Lu & Beamish 2004).

2.9 CONCLUSIONS

Using a sample of global manufacturing firms over a 21-year period, this study examines the direct impact of globalization on firm financial performance and, more importantly, the indirect impact through inventory management. Regression results suggest that globalization, as measured by *global intensity* and *extensity*, may have a

positive impact on firm inventory levels and a negative impact on firm financial performance.

2.10 THEORETICAL CONTRIBUTIONS AND MANAGERIAL IMPLICATIONS

This study is among the first efforts to empirically test how global operations of multinational manufacturing firms may affect their overall inventory performance. Existing operations literature on inventory management has not paid enough attention to the richer global context. This thesis fills the literature gap through an explicit examination of globalization on inventory performance based on a large scale dataset.

This study is also the first effort to examine the indirect effect of globalization on financial performance through inventory management. The non-linear relationship between inventory and financial performance may provide a new perspective for researchers to understand the conflicting relationships between globalization and financial performance in existing strategy and international business literature.

This study contributes to construction of global supply chain management theory by providing a two-dimensional measure of globalization: *global intensity* (market penetration) and *global extensity* (geographic expansion) and directly testing both measures on inventory and financial performance in a manufacturing context.

Our empirical finding that globalization may not have contributed to firm financial performance as expected may seem to be surprising to management. However, it may still serve as a reminder to firm decision makers that it is complex and challenging to manage global operations, especially inventory management along the extended supply chain across national borders. Since there is no easy solution, only firms that balance the

risks and opportunities can survive and succeed in a competitive, global business environment.

2.11 LIMITATIONS AND FURTHER RESEARCH STEPS

I realize that this current research is subject to several limitations. Admittedly, firm globalization is a complex phenomenon beyond any single quantitative measure. Various quantitative measures have been used in the literature to proxy the degree of firm globalization. In this essay, globalization is examined from the perspective of foreign subsidiaries of multinational corporations. Due to data availability, only international sales figures are used to operationalize firm globalization. Even though a two-dimensional measure, global intensity and extensity, is proposed and tested in the cross-sectional analysis, obviously, other measures may be used to capture other aspects of globalization, such as foreign assets deployed, foreign employment and foreign investment committed. In particular, the qualitative component of globalization may be used to extend current research, even though it may be harder to measure, and relevant data may be less available for access. For example, the opportunities and risks of globalization perceived by decision makers of multinational firms may be different, even though the globalization level may be the same by certain quantitative measures. After all, it is mangers that respond to situations and act in daily operations. A two-dimensional measure of globalization shall be applied to the panel dataset for the immediate next step. In the future, research shall be expanded to gain a better understanding of the specific mechanisms multinational firms use to manage their inventory in foreign countries and across borders.

By the same token, firm financial performance is not limited to accounting profitability, even though accounting profitability may be one of the basic and critical indicators. One the one hand, market-based performance indicators may be tested, such as growth in market share and stock performance, in comparison with profitability indicators. On the other hand, the qualitative component of performance may be also captured in the future research, such as quality of earnings, viability of long-term profitability, relationships with local supply chain partners, etc.

Last but not least, the impact of globalization on inventory and financial performance has been tested using data of larger, public manufacturing firms in this study. It is not known whether smaller, private manufacturing firms behave differently. A more comprehensive study including those private firms may yield more interesting insights.

CHAPTER THREE IMPACT OF INTERNATIONAL TRADE ON U.S. MANUFACTURING INDUSTRIES

3.1 INTRODUCTION

There is a common belief in the inventory literature that a firm's inventory will need to increase if the firm's supply chain increases in length and complexity. Assuming that a firm wishes to maintain its service levels, the increased inventory levels can be attributed to greater needs for safety and cycle stock. In recent years, many U.S. manufacturing firms have expanded their global operations, as evidenced by a growth in U.S. imports and exports. Since global operations generally imply longer and more complex supply chains, one would expect that U.S. manufacturing inventories should have increased as well. However, there is evidence of an overall *declining* trend in certain components of inventories (i.e., raw materials and work-in process inventories) in most U.S. manufacturing sectors that parallel increases in U.S. trade activities (Rajagopalan & Malhotra 2001, Chen, Frank & Wu 2005). This "inventory paradox" has been attributed to factors such as the use of advanced technologies (e.g., inventory tracking) and inventory-reducing process changes (e.g., JIT) in the literature (e.g., Keane & Feinberg 2007, Zhu & Kramer 2002). But the technology explanation for declining inventories may fail under rigorous statistical analysis (Brynjolfsson & Hitt 2000). For example, Rajagopalan & Malhotra (2001) compared inventory trends pre- and post- 1980 to determine the impact of post-1980 technologies but did not find that inventory levels in the post-1980 period significantly improved over the pre-1980 period, casting doubt on the impact of the technologies. A U.S. Bureau of Economic Analysis report claimed that

"Buffer stock behavior has been virtually unaffected by managerial changes" (Hirsch 1996).

In practice, global operations have been an increasing trend among U.S. manufacturers. According to a PRTM (2008) survey, among the 300 largest companies surveyed, manufacturing activities and 38 percent of final assembly have already been globalized. By 2010, more than half of the total operations will be offshored. Meanwhile, global sourcing remains a strategic endeavor for U.S. manufacturers to reduce material costs. The PRTM survey also showed that 30 per cent of the respondents will deploy company resources in foreign supplier locations while implementing supplier training and increasing frequency of on-site audits. Interviews with company executives and industry experts indicated that in the era of global supply chains, management of manufacturing inventories has been a key task facing executives at the U.S. manufacturing firms sourcing and selling on a global scale. Deployment of the right level of inventory at the right time and the right place has been always a challenge. Industry leaders are also those firms who have successfully managed their inventories on a global scale. For example, one of the advantages that Dell Computers has over its competitors is its low inventory. In fact, Dell's inventory in days of supply averages about one week while the median inventory level is 33 days for the computer manufacturing industry (Hoovers 2009).

In this research, I propose an alterative explanation for this inventory paradox based on location theory. Generally speaking, much like firms confined to a domestic supply chain, U.S. firms with an international presence have to balance two tasks when they come to inventory management in a global supply chain: (1) increase inventory to buffer from supply uncertainties across national borders and possible disruptions and

maintain a desired service level to be competitive in the market; (2) reduce inventory to curb costs and improve firm profitability to sustain businesses. In addition, firms are able to benefit from low costs of materials and labor. But they also need to pay close attention to supply chain risk management due to greater uncertainty and the higher likelihood of disruptions. As a result, firms tend to increase inventory levels with increasing levels of globalization. But, when globalization reaches a certain point, firms may have well-established global supply chain networks, including foreign manufacturing plants and distribution centers, global logistics network, and have experienced good relationships with foreign suppliers and third-party logistics providers. Given the pressure of escalating inventory costs associated with globalization, U.S. firms may allocate inventories to low cost countries and regions, such as foreign trade zones, along their global supply chains thus reducing U.S. domestic holdings of inventories. Therefore, international locations become viable channels for inventory allocation and could contribute to the declining trend in U.S. domestic inventory.

Despite the increasing globalization of firm supply chains, little theoretical and empirical effort has been attempted to connect international trade with U.S. domestic inventory levels over time and across industries. In addition, empirical research on U.S. manufacturing inventories lacks systematic explanations of inventory heterogeneity across sectors and at different stages along supply chains. In this research, I ask two questions: how do cross-border inbound supply chains (i.e., global sourcing), and outbound supply chains (i.e., exports), affect the performance of inventories at all three stages: raw materials, work-in-process, and finished goods? Specifically, I investigate

how global supply chains, measured by the intensity of international trade, affect inventory behavior across industries, using evidence from U.S. manufacturing sectors.

3.2 INTERNATIONAL TRADE AND MANUFACTURING INVENTORIES

3.2.1 Theoretical Basis

Classic inventory theory, positing that roles of inventories may include buffering supply chain uncertainties and smoothing production, remains the starting point for understanding inventory behavior. Depending on the position along a supply chain, inventories may function as cycle stock, safety stock and in-transit stock. Rumiantsev & Netessine (2007a) argued that insights from classic inventory models, which were built on a single product level, such as Economic Order Quantity (EOQ) or the Newsvendor Model, still hold at the aggregate firm level for inventory decisions. They also found that factors identified by classic inventory models, such as supply and demand variations, and inventory holding costs, have a significant impact on firm inventory decisions, based on their empirical analysis of firms. Globalization, defined as imports and exports in this essay, is expected to have an impact on supply and demand uncertainty and therefore may affect cycle stock and safety stock.

Grossman and Rossi-Hansberg (2006) argued that in the era of global supply chains, firm tasks are performed in disparate locations and the core of international trade has shifted from the Ricardian "wine-for-cloth" model to increased offshoring of production processes, notably through intra-firm trade. Formerly, goods were often produced from start to finish in one location, plant, city or country and firms exchanged finished goods for other finished goods with other locations. These days, thanks to revolutionary progress in transportation, communications and product design technology,

production is often organized on a global scale, taking advantage of differential factor prices across remote locations. New trade theory is founded upon this paradigm of international trade, and also provides a theoretical basis for research on how firms allocate resources, such as inventory, across disparate locations.

Using confidential firm transaction level trade data obtained from the Bureau of Economic Analysis, Bernard, Jensen & Schott (2005) documented a profile of U.S. multinational firms and reported that (1) U.S. firms are exporting a greater number of products to a larger number of countries; (2) intra-firm trade dominates U.S. imports and exports; and (3) globally engaged firms contribute a significant portion to U.S. employment. In a follow-up study, they analyzed how country and product characteristics and their interactions have impacted intra-firm trade (Bernard, Jensen, Redding & Schott 2007). Bardhan & Jaffee (2004) noted that firms are motivated to use imported intermediate inputs from foreign affiliates instead of domestic arms length supply, resulting in vertical production integration across borders. More strikingly, they found that transportation costs have not been a barrier to high-tech intermediate imports since 1997, using detailed trade data for computer and electronic products.

In summary, even though economic literature on international trade has not addressed the inventory issue, *per se*, a common theme emerges that manufacturing processes have been allocated across disparate locations, primarily through intra-firm trade (e.g., Melitz 2003; Eaton & Kortum 2002).

Based on classical inventory models and location theory, this research argues that there may exist two offsetting effects of international trade on domestic inventory levels: increasing and decreasing effects.

3.2.2 Increasing Effects of Trade on Domestic Inventories

To ensure a continuous flow of raw materials through production lines, with global sourcing U.S. manufacturers may have to keep higher levels of inventory to offset supply uncertainties, higher transportation costs, and delay costs due to frequent transactions at border crossings. Global supply lines are more vulnerable to disruptions and global sourcing may result in longer and more variable lead times, due to many unexpected events, such as delays caused by inclement weather or inefficient customs clearance systems (Rajeev & Narendar 2005). Since the negative effects on the entire supply chain may be severe, holding higher inventory remains a risk management tool under a firm's control. For example, to guard domestic manufacturing plants from disruptions, U.S. manufacturers may have to hold more raw material inventories. This point was echoed in Rajagopalan & Malhotra (2001) who suggested that imports may have contributed to an increase in U.S. domestic raw materials inventory.

Holding more inventories may also make economic sense from a transaction cost perspective in a global context. Given the fixed transaction costs related to exports; e.g., documentation, inspection, clearance, terminal handling, etc. (Anderson van Wincoop 2002; Djankov & Pham 2007), there may be more batching as firms increase their export intensity. Empirical evidence from Belgium shows that higher levels of finished goods inventory are associated with higher export ratios (Boute et al. 2006).

3.2.3 Decreasing Effects of Trade on Domestic Inventories

As U.S. firms engage increasingly in foreign trade, they may be able to more efficiently allocate their inventories among countries, thereby decreasing U.S. inventories. For example, U.S. firms may choose to hold more inventories outside the U.S. if

inventory holding costs are lower in the foreign countries, especially in the free trade zones overseas.

As location theory predicts, it is expected that when the costs of input factors vary across countries, U.S. firms may be able to reduce not only manufacturing costs, but also inventory costs, by offshoring inventory operations to less expensive locations. One important component of inventory cost is warehousing, which may include the fixed costs of constructing a warehouse, purchasing warehouse equipment, and installing inventory management technologies, as well as variable inventory operating costs, including labor, order processing, maintenance, inventory financing costs, and inventory taxes. Often, the fixed costs of establishing a warehouse, and the ongoing inventory operating costs, are lower in locations offshore than in the U.S. Therefore, U.S. firms may be able to lower inventory costs by reducing domestic inventories and allocating more inventories overseas, while maintaining the same level of domestic shipments. Note that even if total supply chain inventories increase due to longer supply chains, there could be a decrease in domestic inventories and overall inventory costs due to location decisions.

The decision to offshore inventories is a reasonable choice in the presence of global sourcing, especially when plants and facilities in strategically located foreign locations have already been established. These foreign locations can serve either as procurement centers, with the locational advantages of proximity to raw material supplies, as manufacturing facilities holding work-in-process, or as finished goods warehouses which directly support export or domestic markets. Meanwhile, re-allocation of inventories is in fact an arbitrage activity based on differential tax treatment. For example,

Bernard, Jensen & Schott (2006) reported that U.S. multinational firms can transfer goods at lower prices to countries with lower corporate taxes and higher tariffs. The transfer price may also be affected by the changes in foreign exchange rates with respect to the U.S. dollar.

U.S. international trade data show that U.S. intra-firm trade (imports and exports) with Canada and Mexico accounts for nearly 50 percent of total U.S. trade with these countries (USITC 2007). U.S. manufacturing firms can procure materials from both of these countries and store materials in foreign local warehouses if there are cost and/or service advantages to doing so. Shipments may be sent from foreign warehouses to the U.S. only when required by U.S. manufacturing plants. For example, large quantities of intermediate products may be exported to the Mexican Maquiladora sector for processing, and then imported back to U.S. for final assembly.

3.2.4 MANUFACTURING INVENTORIES

According to U.S. Annual Survey of Manufactures, "manufacturing activities involves the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembly of component parts of manufactured products is considered manufacturing except in the case of construction" (U.S. Census Bureau 2008, MA-1000 Instructions). In particular, manufacturing activities include production, fabricating and processing, assembling from purchased components, maintenance of plant and equipment, receiving and shipping, warehousing and storage, etc. Any stocked materials or goods owned by a manufacturing plant are called manufacturing inventories. Holding inventories may be able to help manufacturers to

buffer against demand and supply uncertainties and reduce costs through economies of scale, such as bulk buying, batch production and shipping.

Manufacturing inventories can break down into three components by the stage of fabrication: raw materials inventory, work-in-process inventory and finished goods inventory. Raw materials inventories refer to any stored raw materials, parts, components or fuels which are directly purchased from the suppliers but have not been put into the production or assembly process. For example, for a computer manufacturer, raw materials inventories may include chips, diodes, mother boards, power cords, hard drives, cases, and many other items supplied by vendors; for a grape juice producer, raw materials inventories may include fresh grapes, sugar, other ingredients, container and labels. Finished goods inventories are more straightforward and they mean completely finished products which are ready to ship out of the manufacturing plants to customers or warehouses. Work-in-process inventories may include partially transformed materials, partially assembled components, or partially finished products which need further processing and are not ready to ship out.

3.3 FORMULATION OF HYPOTHESES

The existence of both increasing effects and decreasing effects from trade on domestic inventory holdings suggests a possible non-linear relationship between these variables. At lower levels of trade, it is reasonable to expect that U.S. domestic inventories may increase with imports and exports due to the need to carry additional inventories to secure trade flows and customer service requirements. At higher levels of trade, it is reasonable to expect that firms are able to reallocate inventories and store more goods in low cost locations. To the extent that allocative efficiencies may only be

realized once a certain level of global activity is reached, it is hypothesize that the overall impact of international trade on U.S. manufacturing inventories is an inverted-U shaped (illustrated in Figure 10).

Figure 10 Hypothesized Relationship between Trade and Inventory

3.3.1 Raw Materials Inventory

As inputs into firm production, raw materials are at the first stage of a firm's supply chain and transported inbound to manufacturers. Due to a function of raw materials inventory as a cushion between suppliers and domestic manufacturers, it is reasonable to expect that the decision on how much raw materials inventory to carry may be affected by the degree of global sourcing. Based on the discussion above, it is hypothesized:

H1: U.S. domestic raw materials inventory increases with import intensity but at a decreasing rate until an inflection point is reached and then begins to decrease.

3.3.2 Finished Goods Inventory

As an output of the production process, finished goods inventory is at the last stage of a firm's supply chain and is transported outbound from a manufacturer. Since

finished goods inventory functions as a cushion between manufacturers and their customers (i.e., distributors and retailers), it is believed that finished goods inventory may be affected by export activities, and thus it is hypothesized:

H2: U.S. domestic finished goods inventory increases with export intensity but at a decreasing rate until an inflection point is reached and then begins to decrease.

3.3.3 Work-in-Process Inventory

Located at the middle stage of the production process, work-in-process inventory (WIP) connects inbound and outbound supply chains. The primary functions of WIP inventory are to guard against machine maintenance and failures, and to provide a cushion for setup changes and other events in the manufacturing process (Bai 1995). WIP inventory may also serve as an indirect cushion against disruptions of raw materials supply and shortages of finished goods supply. Intuitively, WIP inventory may be most affected by a firm's internal factors, such as production technology, labor efficiency, and plant design and least affected by global factors, such imports and exports. However, to the extent that WIP inventory may be affected by global supply chains, two hypotheses are formulated regarding the impact of imports and exports, respectively:

H3a: U.S. domestic WIP inventory increases with import intensity but at a decreasing rate until an inflection point is reached and then begins to decrease.

H3b: U.S. domestic WIP inventory increases with export intensity but at a decreasing rate until an inflection point is reached and then begins to decrease.

3.4 ESTIMATION MODELS

Existing literature has suggested that manufacturing inventory levels may be a function of industry-specific characteristics and macroeconomic factors, such as gross

margin, cost of capital, capital intensity, and economies of scale (Han, Dresner & Windle 2008; Roumiantsev & Netessine 2007 a & b; Gaur, Fisher & Raman 2005; Rajagopalan & Malhotra 2001). In this essay, a relevant global variable is included in the existing models in order to study the impact of international trade on domestic inventory levels at all three stages of production.

The following models are proposed to test the hypotheses on raw materials inventory (*RAW_DAY*), finished goods inventory (*FG_DAY*), and work-in-process inventory (*WIP_DAY*), respectively.

$$RAW\_Day = \beta_0 + \beta_1 IMPORT + \beta_2 IMPORT\_SQUARED + \beta_3 COST + \beta_4 INFLATION + \beta_5 GROWTH + \beta_6 MARGIN + \beta_7 UTILIZE + \beta_8 PLANT + \beta_9 DURABLE + \beta_{10} TIME + \varepsilon_1 \quad (1)$$

In Equation 1, a positive β_1 together with a negative β_2 would lend support for H1.

$$FG\_Day = \beta_0 + \beta_1 EXPORT + \beta_2 EXPORT\_SQUARED + \beta_3 COST + \beta_4 INFLATION + \beta_5 GROWTH + \beta_6 MARGIN + \beta_7 UTILIZE + \beta_8 PLANT + \beta_9 DURABLE + \beta_{10} TIME + \varepsilon_2 \quad (2)$$

In Equation 2, a positive β_1 together with a negative β_2 would lend support for H2.

$$WIP\_Day = \beta_0 + \beta_1 IMPORT + \beta_2 IMPORT\_SQUARED + \beta_3 EXPORT + \beta_4 EXPORT\_SQUARED + \beta_5 COST + \beta_6 INFLATION + \beta_7 GROWTH + \beta_8 MARGIN + \beta_9 UTILIZE + \beta_{10} PLANT + \beta_{11} DURABLE + \beta_{12} TIME + \varepsilon_3 \quad (3)$$

In Equation 3, a positive β_1 together with a negative β_2 would lend support for H3a, and a positive β_3 together with a negative β_4 would lend support for H3b.

Macroeconomic factors and industry specific characteristics are controlled as suggested by existing inventory and economics literatures.

Industry Average Cost of Capital (COST)

The classic Economic Order Quantity (EOQ) model suggests that the optimal inventory order quantity is negatively associated with the cost of capital. The real interest rate is usually a good indicator of the cost of capital. One early economic paper indicated

that at the U.S. national aggregate level, a one percentage point increase in the interest rate would reduce inventory investment by about $2 billion (Akhtar 1983). Recently, Chen, Frank & Wu (2005) argued that inventory levels should drop when the real interest rate rises because financing inventory becomes more expensive. In their models, interest rates showed a significant, negative impact on work-in-process and finished goods inventories.

Inflation Rates (INFLATION)

A popular indicator for measuring inflation faced by producers is the Producer Price Index (PPI). It reflects inflation pressure due to the rising costs of raw materials. Intuitively, when inflation is increasing, firms may save purchasing costs by making early purchases of raw materials. However, we do not have an *a priori* reasoning about the direction of the impact of inflation on work-in-process or finished goods inventories. Note that in some of the models in the Chen, Frank & Wu study (2005), inflation appeared to have a significant, positive impact on raw materials inventory while significant, negative impact on work-in-process and finished goods inventories.

Sector Real Growth (GROWTH)

In this study, the total value of shipments is captured as manufacturing output, which is in fact realized demand. When sector output grows faster, inventories are depleted faster. Production may not catch up with demand, resulting in a downward effect on inventory levels at all stages. Rajagopalan and Malhotra (2001) found a negative impact of output growth on inventory.

Gross Profit Margin Rate (MARGIN)

Industry gross profit margin can be estimated by subtracting all employment related expenses from total value added. The gross margin rate is obtained by dividing gross margin by total value of shipments. Gaur et al. (2005) argued that retailers may trade off slower inventory turns with high margin rates and reported a negative correlation between gross margin and inventory turns in their model. Since inventory days are inversely related with inventory turns, we would expect a positive correlation between gross margin and inventory in days of supply. Roumiantsev & Netessine (2007a) reported a positive relationship between gross margin and inventory days in their empirical study.

Plant Capacity Utilization Rate (UTILIZE)

Published by the U.S. Census's Survey of Plant Capacity, plant capacity utilization rate captures how a plant is utilized compared to its maximum capacity. The rate reflects the greatest output level that a plant could sustain on a realistic work schedule. A higher utilization rate may indicate that demands higher than anticipated were realized in the previous period, and that firms need to expand production to catch up with demand. Since work-in-process inventory is likely to be affected by the capacity of a manufacturing plant, it is expected that the plant capacity utilization rate may have an impact on WIP inventory. Without an *a priori* theoretical prediction, plant utilization rate is also included as a control variable in the raw materials and finished goods inventory models.

Industry Average Plant Size (PLANT)

To capture a possible economies of scale effect, the average plant size per industry is included. Generally, larger manufacturing plants gain some efficiency in

inventory operations and hence industries with larger plants may have lower inventory levels.

Durable Goods Sector vs. Nondurable Goods Sector (DURABLE)

Unlike many other consumer goods, durable goods may often be stocked for long time periods without depreciating a substantial value. In addition, durable goods transportation generally demands batching to fully utilize transportation capacity. Therefore, it is reasonable to expect that inventory levels are higher in the durable goods sectors than in the nondurable goods sectors, *ceteris paribus*.

Time Trend (TIME)

Empirical findings from existing literature suggest that U.S. manufacturing inventory levels have declined over the past decades, possibly due to productivity improvement, the use of new technologies, and to advanced inventory management techniques introduced over time (e.g., Rajagopalan & Malhotra 2001; Chen, Frank & Wu 2005). Therefore, a time trend variable is introduced to control the changes over time in the analysis.

3.5 DATA COLLECTION AND METHODOLOGY

3.5.1 Data Collection

The unit of observation is a three-digit North American Industrial Classification System (NAICS) industry. Data on industry inventories and other operations, including value of shipments, labor costs and value added, were collected from the Census of Manufacturers and the Annual Survey of Manufacturers conducted by the U.S. Census Bureau for the period 1997-2005. Accordingly, all economic indicators and industry characteristics included in the analysis are aggregates of plant-based data, complemented

by the industry producer price index from the Department of Labor, manufacturing plant utilization rate from the U.S. Census Bureau's Survey of Plant Capacity, and the number of plants per industry from U.S. Census's County Business Pattern. Industry cost of capital is collected from New York University Finance Professor Damodaran's educational website (Damodaran 2007). Industry import and export data are derived from the input-output (I-O) tables published by the U.S. Bureau of Economic Analysis. In particular, import data by industry are derived from the *Use* table while export data by industry are derived from the *Make* table.

Note that there are 21 three-digit sectors for U.S manufacturing according to the NAICS classification system. The U.S. Bureau of Economic Analysis, however, regroups some sectors in its Input-Out tables. For example, food and beverage (311) and tobacco products (312) are grouped together under 311FT. Textile mills (313) and textile product mills (314) are combined into 313TT. Apparel (314) and leather products (315) are joined together under 315AL. Transportation equipment (336) is divided into two sub-sectors: motor vehicles, and auto bodies and parts (336MV), and other transportation equipment (336OT), including aerospace products, ship and boat building, and military armored vehicles. Regrouping results in 19 industry sectors, out of which 8 are durable goods sectors and 11 are nondurable goods sectors according to the classification provided by the U.S. Economic Classification Policy Committee (ECPC), comprised of Bureau of Economic Analysis, Bureau of Labor Statistics, Census Bureau and Office of Management and Budget (see details in Table 10).

Table 10 NAICS Manufacturing Sectors

NAICS Code	Meaning	Durable or Nondurable

311FT	Food, beverage & tobacco	Nondurable
313TT	Textile mills & textile product mills	Nondurable
315AL	Apparel & leather	Nondurable
321WP	Wood products	Durable
322PM	Paper products	Nondurable
323PS	Printing & related support activities	Nondurable
324PE	Petroleum & coal products	Nondurable
325CH	Chemicals	Nondurable
326PR	Plastics & rubber products	Nondurable
327NM	Nonmetallic mineral products	Durable
331PM	Primary metals	Durable
332FM	Fabricated metals	Durable
333MM	Machinery	Durable
334CE	Computer & electronic products	Durable
335EE	Electrical equipment & appliances	Durable
3361MV	Motor vehicles & parts	Durable
3364OT	Aerospace, ship & other transport equipment	Durable
337FU	Furniture	Durable
339MS	Miscellaneous manufacturing	Durable

(Source: U.S. Bureau of Labor Statistics, http://www.bls.gov/ces/cessuper.htm)

3.5.2 Measures of Variables

Inventory in Days of Supply

All inventory levels are normalized to days of supply, calculated as the multiples of 365 days and the respective inventory ratios. We calculate inventory ratios at all three stages as raw materials inventory days (*RM_DAY*), work-in-process inventory days (*WIP_DAY*), and finished goods inventory days (*FG_DAY*), using the same method that

Rajagopalan and Malhotra (2001) employed in their study of U.S. manufacturing inventories. Specific formulas are listed as follows:

$$RM\_DAY = \frac{365}{\frac{Total\ Cost\ of\ Materials}{Raw\ Materials\ Inventory}} = 365 * \frac{Raw\ Materials\ Inventory}{Total\ Cost\ of\ Materials}$$

$$WIP\_DAY = \frac{365}{\frac{Materials Cost + 0.5 * ValueAdded}{WIP\ Inventory}} = 365 * \frac{WIP\ Inventory}{Materials Cost + 0.5 * ValueAdded}$$

$$FG\_DAY = \frac{365}{\frac{Materials Cost + ValueAdded}{Finished\ Goods\ Inventory}} = 365 * \frac{Finished\ Goods\ Inventory}{Materials Cost + ValueAdded}$$

Trade Intensity

In this analysis, imports include all raw materials and intermediate goods imported by a manufacturing sector, and exports include all final products exported by that sector. Since published import and export data are product-based, while inventory data are plant-based, reconciliation is needed to reduce the mismatch. Note that NAICS-based industry codes have significantly improved the match between industry and product over prior SIC codes. In analyzing the U.S. content of imports, Leamer (2006) developed a mechanism to allocate imports of materials among industry sectors based on a *similarity* assumption: It is assumed that imported materials for each industry are used in the same proportion as the U.S.-made intermediate inputs for each industry. Fortunately, the latter proportion is available in the *Use* table of the U.S. BEA I-O tables. For this study, the total of imported raw materials used by each industry is obtained by allocating product-based imports of goods and materials across industry sectors according

to each industry's proportional use of U.S. domestic intermediate inputs. Therefore, Import Intensity (*IMPORT*) can be further obtained as follows:

$Import\ Intensity = \frac{Industry\ Imports\ of\ Raw\ Materials}{Industry\ Total\ Costs\ of\ Materials}$ where industry total costs of materials includes both domestic and imported purchases of raw materials.

By the same logic, allocation of exports of finished goods among industry sectors is based on the proportional contribution of each industry to total industry output. This proportion is available in the Make table of the U.S.BEA I-O tables. Once exports by industry sector are obtained, Export Intensity (*EXPORT*) can be operationalized as follows: $Export\ Intensity = \frac{Industry\ Exports\ of\ Finished\ Goods}{Industry\ Total\ Value\ of\ Shipments}$ where industry total value of shipments includes both domestic shipments and exports.

Industry Cost of Capital (COST)

Professor Damodaran 's website tracks and provides cost of capital for dozens of industry sectors based on their debt and equity cost information for thousands of public firms over a decade. When the three-digit sectors are at a more aggregate level than professor Damodaran's classification, I use an industry output weighted average of cost to compose an aggregate cost at the three-digit level.

Inflation Rates (INFLATION)

Annual inflation rates by industry are calculated based on industry-specific producer price index (PPI) published by the U.S. Department of Labor.

$Inflation_t = \frac{PPI_t - PPI_{t-1}}{PPI_{t-1}}$.

Sector Real Growth Rates (GROWTH)

Industry total value of shipments is used to calculate sector growth rates. To obtain real growth rates and achieve comparability over time, all shipment values are deflated using the GDP deflator in 1997 constant dollars. The real growth for the year of 1997 is also obtained using total value of shipment for 1996. This variable is measured as follows: $Real\ Growth_t = \frac{IndustryShipment_t - IndustryShipmet_{t-1}}{IndustryShipmet_{t-1}}$

Industry Average Plant Shipment (PLANT)

Total value of shipments per plant in each industry is used to measure the plant size. $Average\ Plant\ Shipment = \frac{Deflated\ Values\ of\ \ Industry\ Shipments}{Industry\ Total\ \ Number\ of\ \ Plants}$

Industry Gross Profit Margin Rate (MARGIN)

Industry gross profit margin is measured by total value of shipments less the total of materials costs and labor costs. Therefore,

$$Gross\ Profit\ Margin\ Rate = \frac{Total\ Value\ of\ \ Shipments - Cost\ of\ \ Materials - Labor\ \ Expenses}{Total\ Value\ of\ \ Shipments}$$

Time Trend (TIME)

Since the data set covers the period 1997-2005, following Chen, Frank & Wu (2005), a time trend is obtained by considering 1997 as year 1 and 2005, the last year in the dataset, as year 9, instead of using time dummies.

3.5.3 Sample Statistics

Mean statistics of the pooled sample is provided in Table 11.

Table 11 Mean Statistics of Pooled Sample

Variable	Mean	STD	MIN	MAX
RM Inventory Day	29.55	9.45	6.55	51.46

FG Inventory Day	15.22	5.62	3.44	29.53
WIP Inventory Day	16.04	19.79	3.53	114.20
Import Intensity	0.17	0.09	0.07	0.53
Export Intensity	0.12	0.09	0.01	0.38
Cost	0.08	0.02	0.06	0.14
Inflation	0.02	0.06	-.23	0.47
Growth	0.01	0.08	-.47	0.47
Utilization	0.71	0.07	0.52	0.88
Margin	0.32	0.07	0.14	0.46
Average Plant Shipment ($000)	19,553	20,130	2,274	86,094

According to Table 11, over the 9-year period, among three components of industry inventories, the industry raw materials inventory level was highest, averaging nearly 30 days and ranging from about 7 days to 51 days across industry sectors. Industry finished goods inventory was lowest, averaging15 days and ranging from 3 days to 30 days. However, even though average WIP inventory was relatively low (16 days), its variation was greatest among all three types of inventories, ranging from 4 days to 114 days. Average import intensity was 17 percent, with some industries sourcing as low as 7 percent of total costs of materials while other industries relying on imports more than half of materials. Average export intensity was 12 percent, with some industries exporting as low as 1 percent of finished goods while other industries exported as high as 38 percent of total output to foreign markets. Industry average cost of capital was 8 percent, ranging from 6 percent to 14 percent. Industry annual PPI-based inflation rates averaged 2 percent,

with large variations, ranging from negative 23 percent to positive 47 percent. Sector annual real growth rates averaged 1 percent with very large variations, ranging from negative 47 percent to positive 47 percent. Plant capacity utilization rates averaged 71 percent with small variations, ranging from 52 percent to 88 percent. Industry gross profit margin rate averaged 32 percent, ranging from 14 percent to 46 percent. Industry plant size averaged $19.55 million in 1997 constant dollars, with large variations, ranging from a bit over $2 million to $86 million.

3.5.4 Trend of Industry Real Output

The trend in industry total output (in terms of 1997 dollars) over the 9 year period is presented in Figure 11.

Figure 11 Total Value of Shipments across Industries Over 1997-2005

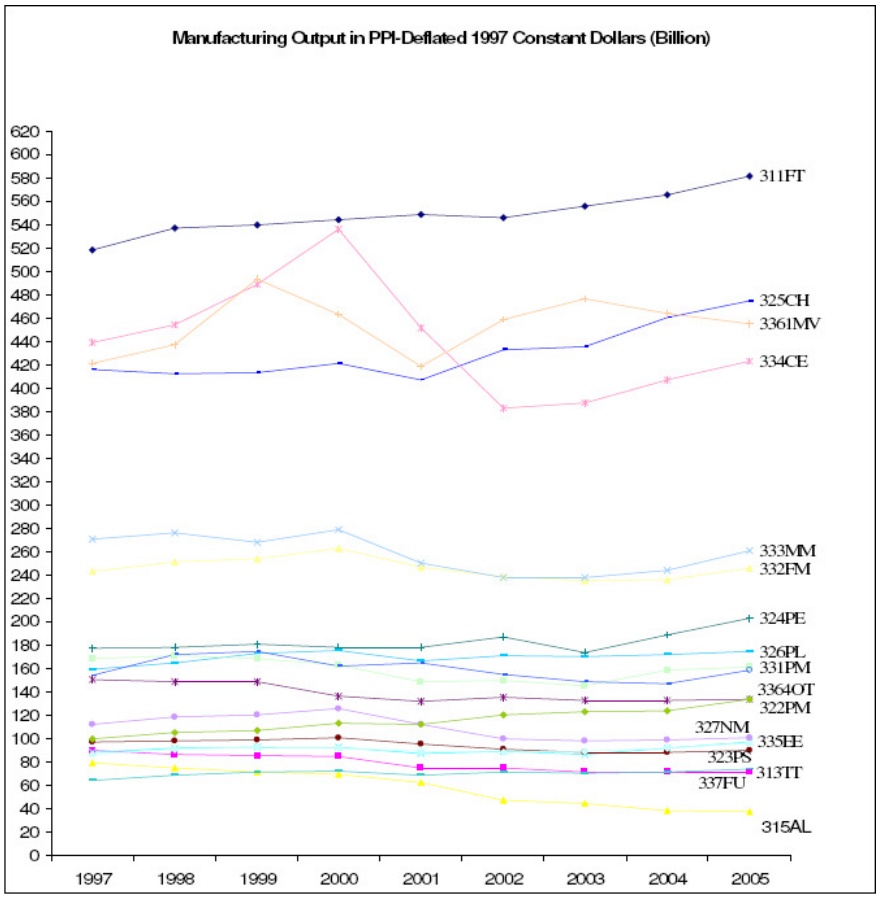


Figure 11 shows a mixed picture across industry sectors. The food and tobacco sector (311FT) appeared to be the only industry showing a steady but smooth upward trend over the entire 9-year period. On the other hand, the apparel and leather industry (315AL) appeared to be the only industry showing a consistent downward trend over the entire period. All other industries experienced ups and downs. For example, most industries experienced a downturn in 2001 and 2002, in coincidence with the "9.11" terrorist attack and the economic recession. However, since 2003, manufacturing output has shown a strong rebound in many sectors, such as chemicals (325CH), computer & electronics (334CE), petroleum & coal (324PE), and machinery (333MM).

3.5.5 Correlations of Variables

A correlation table for the pooled sample using all sectors and years is presented in Table 12.

Table 12 Correlation Table for the Pooled Sample

	VAR	1	2	3	4	5	6	7	8	9	10
1	*Import*	1.00									
2	*Import Squared*	0.83	1.00								
3	*Export*	0.28	-.10	1.00							
4	*Export Squared*	0.33	0.06	0.74	1.00						
5	*Cost*	0.15	0.05	0.33	0.18	1.00					
6	*Inflation*	0.28	0.35	-.12	-.04	-.12	1.00				
7	*Growth*	0.24	0.29	-.18	-.15	-.01	0.34	1.00			
8	*Utilize*	0.15	0.30	-.42	-.31	-.02	0.18	0.31	1.00		
9	*Margin*	-.35	-.39	0.19	0.05	0.30	-.15	-.04	-.31	1.00	
10	*Plant*	0.59	0.44	0.35	0.21	0.03	0.17	0.17	0.25	-.23	1.00
11	*Time*	0.16	0.07	0.01	0.03	-.43	0.25	0.02	-.34	0.08	0.01

Due to the polynomial specification of import intensity and export intensity, high correlations between the linear and squared terms may be expected. A de-meaned approach is adopted to transform the affected variables. Note that the correlation between demeaned *Import Intensity* and its squared term is .83 and that between demeaned *Export Intensity* and its squared term is .74. To check whether multicollinearity might become a concern, a Variance-Inflation-Factor (VIF) test is conducted. The test shows that VIF scores for all independent variables are below 2, except for *Import Intensity* and its squared term in the Raw Materials Inventory model where VIF scores were 6.28 for *Import Intensity* and 5.03 for its squared term. Since these scores are still below 10, a threshold considered a red flag for a serious concern for multicollinearity (Simon 2004), it is believed that multicollinearity may not be a serious problem for the sample.

3.6 REGRESSION RESULTS

To consider industry-wise heteroskedasticity and cotemporary correlation across industries, an estimator with a panel corrected covariance matrix is applied to all models, following Beck & Katz (1995) and Johnson (2004). In particular, a panel-corrected standard error model may be estimated if robust standard errors are desired for each industry based on the assumptions that standard errors may vary across industry sectors and each industry's observations may be correlated with those from other industries in a given time period. The sample contains observations for 19 industries over 9 years, resulting in 171 observations no missing values. Regression results for Equations 1, 2 and 3 are presented in Table 13.

Table 13 Regression Results for All Three Models

Model	Raw Materials Inventory	Finished Goods Inventory	Work-in-Process Inventory

DV	*RM_DAY*	*FG_DAY*	*WIP_DAY*
IV	Coefficient	Coefficient	Coefficient
Constant	58.77*** (6.97)	52.23*** (4.02)	73.05*** (10.98)
Import Intensity	81.99*** (13.48)		2.87 (17.62)
Import Intensity Squared	-198.66*** (43.53)		-89.19* (48.14)
Export Intensity		57.88*** (3.61)	171.19*** (12.53)
Export Intensity Squared		-332.67*** (17.81)	1136.83*** (90.90)
Cost of Capital	-42.17** (20.70)	-65.65*** (16.14)	-197.52*** (47.64)
Inflation Rates	10.27 (7.07)	8.37 (8.15)	9.78 (12.13)
Sector Growth	-12.76** (5.58)	-6.23* (3.90)	16.58 (15.42)
Gross Profit Margin	64.19*** (4.45)	7.40*** (2.42)	-32.87*** (8.03)
Plant Utilization Rate	-8.19 (7.62)	0.04 (3.91)	-38.98*** (13.20)
Average Plant Size	-10.72*** (0.42)	-7.10*** (0.43)	-2.74*** (0.63)
Durable Dummy	5.79*** (0.59)	-1.95*** (0.33)	-0.53 (1.01)
Time Trend	-0.76*** (0.15)	-0.29** (0.12)	-1.50*** (0.28)
N	171	171	171
Adjusted R-squared	0.74	0.52	0.80
F-tests	48.72 (<.000)	19.19(<.000)	58.66(<.000)

As shown in Table 13, all three models appear to be a good fit for the sample data. Adjusted R-squared values range from 0.52 to 0.80 with highly significant F-tests. Below are details of the results for each of the three models.

3.6.1 Raw Materials Inventory

The raw materials inventory model shows that the coefficient for the linear term of import intensity is 81.99 and significant at 0.01 while the coefficient for the squared term of import intensity is -198.66 and significant at 0.01, suggesting an inverted U-shaped relationship may exist between import intensity and raw materials inventory, lending support for *H1*. A post-estimation analysis shows raw materials inventory reaches its highest level when import intensity increases to 20.6 percent, beyond which raw materials inventory may start to decrease. Note that import intensity ranges from 7 percent to 53 percent across sectors. This post hoc analysis provides further support for *H1* that an inverted U-shaped relationship may exist between global sourcing and raw materials inventory levels.

Notably, a negative and significant time trend (*TIME*) is found and suggests that raw materials inventory has declined by 0.76 days on average per year over the period 1997-2005. This declining trend is consistent with findings reported by Rajagopalan & Malhotra (2001) and Chen, Frank & Wu (2005). The coefficient for cost of capital (*COST*) is -41.17 and significant at the 0.05 level, indicating that higher costs may reduce inventory holdings, as the EOQ model shows and economic theory predicts. The coefficient for sector real growth rates (*GROWTH*) is -12.76 and significant at the 0.05 level, indicating that fast growing industries tend to have lower levels of raw materials inventory. The coefficient for industry gross profit margin rate (*MARGIN*) is 64.19 and highly significant, indicating industries with higher margin rate may be likely to hold more inventories, perhaps due to their willingness to tolerate slow moving inventories, as Guar, Fisher & Raman (2005) suggested. The coefficient for industry average plant size

(*PLANT*) is -10.72 and highly significant, indicating economies of scale for inventory management may exist at the plant level. The durable sector dummy (*DURABLE*) has a positive and significant coefficient of 5.79, indicating that industries in the durable sector hold nearly 6 days more in raw materials inventory than do nondurable sectors when controlling for other factors. Note that inflation rates (*INFLATION*) and plant capacity utilization rates (*UTILIZE*) do not appear to be significant factors in determining raw materials inventory levels.

3.6.2 Finished Goods Inventory

From Table 13, the finished goods inventory model shows that the coefficient for the linear term of export intensity (*EXPORT*) is 57.88 and significant at 0.01 while the coefficient for the squared term of export intensity is -332.67 and significant at 0.01, suggesting an inverted U-shaped relationship may exist between export intensity and finished goods inventory, lending support for *H2*. A post-estimation analysis shows finished goods inventory reaches its highest level when export intensity is at 8.7 percent, beyond which finished goods inventory may begin to decline. Note that export intensity ranges from 1 percent to 38 percent for the sample. This post hoc analysis provides further support for *H2*.

Even though a negative and significant time trend (TIME) is found, the magnitude of the coefficient is relatively small (0.29), suggesting that finished goods inventory has declined on average by 0.29 days per year during the period of analysis. This small change in finished goods inventory is consistent with related findings reported by Rajagopalan & Malhotra (2001) and Chen, Frank & Wu (2005) that finished goods inventory has remained stable over time in a majority of industry sectors.

The coefficient for industry cost of capital (*COST*) is -65.65 and highly significant, suggesting that higher costs of capital may pressure industries to hold less inventory, a finding predicted by the Classic Inventory Models and related empirical research. The coefficient for gross profit margin rate (*MARGIN*) is 7.40 and highly significant, suggesting industries with higher margins may tolerate higher inventory levels, a finding consistent with the existing literature (e.g., Gaur, Fisher & Raman 2005). The coefficient for average plant size (*PLANT*) is -7.10 and highly significant, indicating economies of scale for management of finished goods inventory at the plant level.

Interestingly, in contrasting with the positive coefficient for the durable goods sector dummy (*DURABLE*) in the raw materials inventory model, a negative and significant coefficient (-1.95) for the durable goods sector dummy is found in the finished goods inventory model, indicating industries in the durable goods sectors tend to hold nearly 2 days less in finished goods inventory supply than do industries in the nondurable goods sectors. Since neither literature nor theory is readily available for this non-intuitive finding, a further investigation along the durable vs. nondurable goods divide line may be warranted.

Note that coefficients for inflation rate (*INFLATION*) and plant capacity utilization rate (*UTILIZE*) are not significant.

3.6.3 Work-in-Process Inventory

From Table 13, the work-in-process inventory model shows a mixed picture of the impact of import and export intensity on WIP inventories. The coefficient for the linear term of import intensity is positive but not significant while the coefficient for the squared term of import intensity is negative and significant. This pattern is difficult to

interpret but may suggest an overall negative relationship between import intensity and WIP inventories. Therefore *H3a* is not supported for the full sample. The coefficients for the linear and squared terms of export intensity are both positive and highly significant, suggesting that a possible exponentially positive (the right part of a U-shape) may exist between export intensity and WIP inventory. Therefore, *H3b* is *not* supported either.

Notably, the coefficient for the time trend (*TIME*) is -1.50 and highly significant, suggesting that WIP inventory has decreased at one and half days per year on average. The declining trend is greater and more significant in WIP inventory than in raw materials and finished goods inventory levels, a finding consistent with that reported by Rajagopalan & Malhotra (2001) and Chen, Frank & Wu (2005).

Also note that the coefficient for plant capacity utilization rate (*UTILIZE*) is negative 38.98 and highly significant, suggesting a 10 percent increase in plant capacity utilization may reduce WIP inventory by approximately 4 days. Note that plant capacity utilization rate is not significant in the raw materials or in the finished goods inventory models, but it is reasonable to believe that plant capacity utilization, which reflects the internal operations of a manufacturing plant, may have more impact on WIP inventory. The coefficient for cost of capital (*COST*) is -197.52, suggesting a 10 percent increase in inventory cost may lead to a nearly 20 percent reduction in WIP inventory. This *COST* coefficient is greater in both magnitude and significance for the WIP inventory model than for the raw materials and the finished goods inventory models. This may suggest that inventory holding costs may become a more serious concern when WIP inventory is managed. The coefficient for gross profit margin (*MARGIN*) is -32.87 and highly significant, a finding in sharp contrast with the findings in the raw materials and finished

goods inventory models. This finding is hard to interpret given that existing literature has focused on the impact of gross profit margin on either finished goods inventory or total firm inventory and little attention has been paid to WIP inventory. The coefficient for average plant size is -2.74 and significant at 0.01, suggesting economies of scale in managing WIP inventory may also exist at the plant level. However, the coefficients for inflation rates and sector growth rates are not significant. Whether industries manufacture durable goods or nondurable goods seems to make no difference in terms of WIP inventory levels.

3.7 DURABLE GOODS VS. NONDURABLE GOODS SECTORS

Intuitively, one would expect that inventory management may be different in the durable goods sectors compared to the nondurable goods sectors due to the fact that durable goods can last longer without losing their initial function or value. As well, the nature of durable goods may facilitate batching.

However, regression results for Equations 1, 2 and 3 reported in Table 12 show a mixed picture as to whether the durable sectors have reacted differently to globalization in terms of inventory allocation. Specifically, the durable goods sector dummy (*DURABLE*) shows a positive and significant sign (5.79) for raw materials inventory, a negative and significant sign for finished goods inventory (-1.95) and no effect for WIP inventory. For a robustness check, the same set of regressions is run using subsets of the original data – durable goods and nondurable goods.

3.7.1 Durable Goods Sector

Since there are 11 manufacturing industries as durable goods sectors among all the 19 manufacturing industries, resulting in 99 observations for further analysis. Results are presented in Table 14.

Table 14 Regression Results for Industries in the Durable Goods Sector

Model	Raw Materials Inventory	Finished Goods Inventory	Work-in-Process Inventory
DV	*RM_DAY*	*FG_DAY*	*WIP_DAY*
IV	Coefficient	Coefficient	Coefficient
Constant	90.94*** (6.52)	56.12*** (3.54)	-4.87 (17.49)
Import Intensity	156.66*** (19.02)		138.29*** (50.58)
Import Intensity Squared	-292.83*** (86.44)		-1290.50*** (330.47)
Export Intensity		67.28*** (23.15)	133.56*** (16.99)
Export Intensity Squared		-348.42*** (27.69)	1639.11*** (157.73)
Cost of Capital	-64.58*** (25.76)	-82.75*** (18.03)	-123.08* (68.12)
Inflation Rates	11.45 (23.45)	28.13 (20.96)	31.40 (54.92)
Sector Growth	-15.74** (6.91)	-13.77* (4.72)	9.84 (23.78)
Gross Profit Margin	43.21*** (4.49)	18.29*** (4.68)	48.62*** (15.97)
Plant Utilization Rate	-26.52*** (6.50)	12.17* (7.24)	-46.55** (21.23)
Average Plant Size	-16.57*** (0.87)	-10.92*** (0.59)	-11.81*** (2.38)
Time Trend	-0.66*** (0.20)	-0.31* (0.16)	-1.61*** (0.53)
N	99	99	99
Adjusted R-squared	0.81	0.66	0.83

F-tests	47.11 (<.000)	21.86(<.000)	45.18(<.000)

As shown in Table 14, all three models appear to be significant with highly significant F-tests and relatively high R-squares, ranging from 0.66 to 0.83.

For the raw materials inventory model, the coefficient for import intensity is 156.66 and highly significant while the coefficient for the squared term of import intensity is -292.83 and highly significant. A post-estimation analysis suggests that the raw materials inventory level changes from an increasing trend to a decreasing trend at the import intensity of 26.7 percent. This finding suggests that an inverted U-shaped relationship may exist between import intensity and raw materials inventory level, lending support for *H1*.

For the finished goods inventory model, the coefficient for export intensity is 67.22 and highly significant while the coefficient for the squared term of export intensity is -348.42 and highly significant. A post-estimation analysis suggests that the finished goods inventory level changes from an increasing trend to a decreasing trend at the export intensity of 9.6 percent. This finding suggests that an inverted U-shaped relationship may exist between export intensity and finished goods inventory level, lending support for *H2*.

For the WIP inventory model, the coefficient for the linear term of import intensity is 138.29 and highly significant, while the coefficient for the squared term of import intensity is -1290.50 and highly significant. A post-estimation analysis suggests that WIP inventory level changes from an increasing trend to a decreasing trend at the import intensity of 5.4 percent. This finding suggests a possible inverted U-shaped relationship between import intensity and WIP inventory levels, thus lending support for

H3a. The coefficients for the linear and squared terms of export intensity are both positive and highly significant, suggesting an exponentially positive (the right side of U shape) may exist between exports and WIP inventory. This finding does not provide support for *H3b*.

As generally expected, the coefficients for cost of capital (*COST*) are all negative and highly significant, the coefficients for gross profit margin (*MARGIN*) are all positive and highly significant, and the coefficients for industry average plant size (*PLANT*) are all negative and highly significant, and the time trend (*TIME*) has shown a negative sign across all three models. The coefficients for sector growth (*GROWTH*) are negative and significant in both the raw materials and finished goods inventory models, but not significant in the WIP inventory model. Interestingly, plant utilization rate (*UTILIZE*) is shown to have different effects on the different types of inventories. While plant utilization rate appears to have a significant, negative effect on both raw materials and WIP inventories, it has a significant, positive effect on finished goods inventory. Inflation rates are not significant in any of the models.

3.7.2 Nondurable Goods Sector

Since there are 8 manufacturing industries as nondurable goods producers among all the 19 manufacturing industries, resulting in 72 observations for analysis. Regression results are presented in Table 15.

Table 15 Regression Results for Industries in the Nondurable Goods Sector

Model	Raw Materials Inventory	Finished Goods Inventory	Work-in-Process Inventory
DV	*RM_DAY*	*FG_DAY*	*WIP_DAY*
IV	Coefficient	Coefficient	Coefficient

Constant	16.95** (8.63)	61.70*** (6.00)	55.60 (4.71)
Import Intensity	33.91* (18.85)		-17.99*** (5.91)
Import Intensity Squared	-138.37** (62.16)		15.62 (11.35)
Export Intensity		-10.31 (31.21)	233.72*** (37.21)
Export Intensity Squared		-793.33*** (153.98)	1070.07*** (202.42)
Cost of Capital	-33.62* (19.14)	-51.19* (31.20)	-36.37* (16.62)
Inflation Rates	1.80 (7.16)	-1.17 (2.63)	3.72*** (1.40)
Sector Growth	-4.49 (7.08)	0.32 (3.92)	8.46*** (2.53)
Gross Profit Margin	35.81*** (7.97)	-14.03*** (1.51)	-37.55*** (7.47)
Plant Utilization Rate	28.38*** (8.69)	-21.92*** (5.48)	-17.85** (4.10)
Average Plant Size	-4.71*** (0.93)	-3.04*** (0.48)	-1.37* (0.76)
Time Trend	-0.35* (0.20)	-0.40*** (0.14)	-.51*** (0.09)
N	72	72	72
Adjusted R-squared	0.74	0.87	0.83
F-tests	23.47 (<.000)	54.09(<.000)	33.26(<.000)

Table 15 shows that all three models are significant with highly significant F-tests and relatively high R-squares, ranging from 0.74 to 0.87.

For the raw materials inventory model, the coefficient for import intensity is 33.91 and marginally significant while the coefficient for the squared term of import intensity is -138.37 and significant at the 0.05 level. A post-estimation analysis suggests that raw materials inventory level changes from an increasing trend to a decreasing trend at the import intensity of 12.3 percent. This finding suggests that an inverted U-shaped

relationship may exist between import intensity and raw materials inventory, lending support for *H1*.

For the finished goods inventory model, the coefficient for the linear term of export intensity is *not* significant while the coefficient for the squared term of export intensity is -793.33 and highly significant. The expected inverted U-shaped relationship is *not* found, thus *H2* is *not* supported for the nondurable goods sectors.

For the WIP inventory model, the coefficient for the linear term of import intensity is -17.99 and highly significant, and the coefficient for the squared term of import intensity is *not* significant. Therefore, support is *not* found for *H3a*. The coefficients for the linear and squared terms of export intensity are both positive and highly significant, suggesting an exponentially positive (e.g., the right side of U shape) may exist between exports and WIP inventory. This finding does not provide support for *H3b*.

Consistent with prior findings, the time trend (*TIME*) has a significant, negative coefficient for raw materials, finished goods and WIP inventory models. Cost of capital (*COST*) has a negative effect on inventory holdings. Average plant size (*PLNAT*) has a significant, negative coefficient, indicating economies of scale for inventory management may exist for the nondurable sectors.

There are also a few mixed results. The inflation rates (*INFLATION*) demonstrated a significant, positive coefficient for WIP inventory (a finding consistent with the general idea that industries may be willing to hold more inventories in an inflationary environment), but not for raw materials or finished goods inventories. Surprisingly, sector growth rate (*GROWTH*) has a positive effect on WIP inventories.

Prior logic is that fast growing industries may draw down inventories more quickly given the same production level. Gross profit margin (*MARGIN*) is found to have a positive effect on raw materials inventory, while a negative effect is found for both finished goods and WIP inventories, in contrast to the finding for the durable goods sectors. Also notably, the effect of plant capacity utilization (*UTILIZE*) is shown to be negative on both finished goods and WIP inventories as expected, but positive on raw materials inventory.

3.7.3 Summary

A comparison of results from the regression analyses of the durable goods sectors, nondurable goods sectors, and the full sample reveal some interesting findings and may warrant further investigation.

In terms of the inflection point of raw materials inventory level with regard to import intensity, a level of 20.6 percent for import intensity is found for the full sample, while a level of 26.7 percent for import intensity is found for the durable goods sectors, and a level of 12.3 percent for the nondurable goods sectors. Compared to the full sample result, the import intensity corresponding to the inventory inflection point for the durable goods sectors is higher than for the nondurable goods sectors. Also, the magnitudes of the coefficients for the linear term of import intensity and its squared term in the durable goods sectors appear to be greater than for the nondurable goods sectors. The comparative pattern for finished goods inventory across all three samples is less obvious. In terms of the inflection point of finished goods inventory level with regard to export intensity, a level of 8.7 percent for export intensity is found for the full sample. The export intensity inflection point is slightly higher at 9.6 percent for the durable goods sectors. The inverted U-shaped pattern does not emerge from the nondurable goods

sectors. Also, the magnitudes of corresponding coefficients for export intensity and its squared terms appear to be slighter greater for the durable goods sectors. These findings may indicate that industries in the durable goods sector respond more dramatically to both cost and risk pressure due to globalization when it comes to inventory management.

3.8 CONCLUSIONS

U.S. domestic manufacturing inventories decreased in the period 1997-2005 at all three stages of production. Overall, international trade appears to have significant impacts on U.S. domestic inventories, especially on raw materials and finished goods inventories, but this impact is nonlinear. Our sample shows that at the low levels of import and export activities, international trade may increase inventory levels as the concern for supply risk may dominate managerial decisions. At high levels of global activities, managers may choose to allocate inventories to low-cost foreign locations in order to reduce inventory holdings in the U.S. To the extent that allocative efficiency may only be realized when a certain level of global activity is reached, the relationships between import intensity and raw materials inventory levels and between export intensity and finished goods inventory levels are shown to be inverted-U shaped.

3.9 CONTRIBUTIONS AND MANAGERIAL IMPLICATIONS

Theoretically, this study is the first effort to connect international trade with domestic manufacturing inventories and the first attempt to apply New Trade Theory and Location Theory to account for inventory management. Given the fact intra-firm trade among global manufacturing firms has become increasingly important in international trade between countries, our findings on the relationship between international trade and domestic inventory levels contribute to inventory management by extending the analysis

to a global context and under a new perspective. Empirically, this is the first study which provides a comprehensive examination of U.S. manufacturing inventory performance at all three stages: raw materials, finished goods and work-in-process inventories. While empirical studies of U.S. manufacturing inventories in the existing operations management literatures have been descriptive in nature without a systematic examination of industry specific factors, this study not only captures the trend of inventory levels but also provides explanations for inventory heterogeneity across industries using trade activity, macroeconomic factors, and other industry specific factors as independent variables.

Given the current trend towards globalization, our findings may help inventory researchers establish a meaningful connection between trade activity and domestic inventory levels. Meanwhile, our empirical findings provide a benchmark picture of industry inventory using full U.S. manufacturing data and may provide management a benchmark when designing and implementing global inventory strategy through balancing holding inventory and offshoring inventory via international trade.

3.10 LIMITATIONS AND FURTHER RESEARCH STEPS

This study is subject to several major limitations. First, data on imports of raw materials and exports of finished goods by industry are estimated figures based on a *similarity* assumption. It is assumed that the use of imported materials for each industry is in the same as the proportion as the use of U.S.-made intermediate inputs for each industry, and that the proportion of exported finished goods among industry sectors is the same as the proportional contribution to total industry output. Even though this assumption has been applied in prior studies (e.g., Leamer 2006), industry actual imports

and exports may be different from the estimates. Therefore, the magnitudes of measured effects may differ from the actual effects. Future research using actual import and export data for each industry, such as an aggregation of firm-based Longitudinal Research Data (LRD), may be able to verify the results and improve the measures reported in this study. Second, further investigation of the behavior of WIP inventory is needed given mixed global effects shown in the current study. Intuitively, WIP inventory may be more affected by the internal operations of manufacturing plants. Therefore, variables related to plant processing and manufacturing technologies may be collected for future studies. Third, the allocative effects of imports and exports on U.S. domestic inventories are proposed based on New Trade Theory and Location Theory. However, it may be very helpful to investigate corresponding inventory behavior of major U.S. trade partners, such as Canada, Mexico and China. In particular, evidence on how inventory is managed in overseas warehouses or by foreign suppliers may be able to enhance the understanding of global effects on U.S. domestic inventories. Last but not the least, a deep examination of specific manufacturing industries may reveal more insights into inventory management. For example, computer and automobile manufacturing industries have more complex supply chain on a global scale. Tracking operations of leading firms in those industries is not only possible but also very helpful in investigating how global supply chains and inventory management may differ across industries.

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