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Analysis of Inventory Levels of Canadian Companies

By

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Résumé

La philosophie du juste-à-temps et de la fabrication sans gaspillage a mené les entreprises à la poursuite des politiques pour minimiser les stocks. En même temps, la variété croissante des produits, des niveaux de service à la clientèle plus élevés et l'incertitude de la demandes requièrent beaucoup de stocks. En général, les études qui examinent les entreprises manufacturières aux États-Unis révèlent une diminution du niveau des stocks, mais celles qui enquêtent sur les entreprises américaines du secteur de gros et de détail montrent soit des résultats contradictoires, soit aucune tendance. En plus, les recherches faites sur les entreprises hors de l'économie américaine montrent une baisse marginale pour les entreprises situées dans les grandes économies et aucun impact précis pour les entreprises situées dans des plus petites économies. L'objectif de ce mémoire est d'analyser l'évolution des niveaux de stocks des entreprises canadiennes. Aucune recherche de ce genre n'a été trouvée dans notre revue de la littérature. Les résultats d'une analyse des séries chronologiques sur les données de 420 entreprises cotées en bourse au Canada indiquent que les niveaux de stocks mesurés par le taux rotation des stocks des entreprises canadiennes cotées en bourse ont diminué pour la période de 1987 à 2016. Cette diminution a été trouvée dans le stock net ainsi que dans toutes les trois catégories de stocks - matières premières, travaux en cours, et stocks des produits finis. Les modèles utilisés dans cette étude expliquent entre 70,23% et 78,07% des variations des variables dépendantes. En plus, la corrélation du niveau de stock net avec la marge brute, la taille de l'entreprise, l'investissement dans les immobilisations et la croissance des ventes sont également examinés. Seule la marge brute montre une corrélation positive avec les niveaux de stocks relatifs, tandis que la croissance des ventes et la taille de l'entreprise montrent une corrélation négative avec les niveaux de stocks relatifs. Nous ne trouvons pas de relation statistiquement

significative entre l'investissement dans les immobilisations et les niveaux de stocks des entreprises canadiennes.

Abstract

The just-in-time (JIT) and lean philosophy led companies to pursue policies to minimize inventory. However, increasing product variety, higher customer service levels and demand uncertainty require larger inventories. We hence observe two opposing tendencies. Utilizing relative inventory level measures, previous studies investigating manufacturing sector firms in the U.S. show some level of decline in inventories but those investigating the U.S. wholesale and retail sector firms either give conflicting results or show no trend. In addition, research carried out for firms in non-U.S. economies show a marginal decline for firms in larger economies and no clear cut impact for those in smaller economies. The aim of this thesis is to analyze inventory levels specifically in Canadian companies. No such research has been found in our literature review. Performing a time series analysis on the data of 420 publicly listed firms in Canada, the results indicate that the relative inventory levels of the publicly listed Canadian firms measured in terms of inventory turnover have been declining for the period from 1987 to 2016. The decline has been found for net inventory as well as for the work-in-progress inventories. The models used in the current study explain about 70.23% to 78.07% of the variation in the dependent variables. In addition, the correlation of the net inventory with the gross margin, firm size, investment in fixed assets and growth in sales are also examined. Among these factors, gross margin shows a positive correlation with the relative inventory levels while sales growth and firm size show a negative correlation with relative inventory levels. No statistically significant relation was found between investment in fixed assets and inventory levels of the Canadian companies.

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Content

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List of Acronyms

TI – Inventory turnover for Net inventory

TIRM – Inventory turnover for Raw Materials

TIWIP – Inventory turnover for Work-in-progress

TIFG – Inventory turnover for Finished goods

CaIn – Capital intensity

SG – Sales Growth

Trevenue – Total revenue

IS – Inventory to sales ratio

OEM – Original Equipment Manufacturers

CM – Contract Manufacturers

JIT – Just-in-Time

PMI – Purchasing Managers Index

IA – Inventory to asset ratio

WRDS – Wharton Research Data Services

WIP – work-in-progress

1 Introduction

Inventory management is critical for managing firm's assets in goods based industrial sectors. Inventory holding costs represent about one third of the total of logistics costs (Johnston, 2014). Inventory costs represent the out-of-pocket costs for physically storing the product and the lost investment opportunities due to the capital tied up in them (Cannon, 2008). Excess of stock is seen as a cover up of various underlying operational problems (Cannon, 2008). So, the conventional thinking suggests that it is pertinent to have inventories as minimum as possible to free up capital, reduce costs or resolve operational difficulties.

The advent of Japanese companies in 1960-70s in the North American market had a huge impact on the mindset of the companies with regards to inventory. The just-in-time and lean philosophies were seen as a precursor of the decision to cut down the inventory levels. Western companies were more oriented towards mass production in order to decrease the production and the labor costs by achieving economies of scale. This strategy worked well in the time of economic boom (Shingo, 1989). However, in the time of recession, this strategy appeared to backfire and eat into the company's capital in the form of excess inventory (Shingo and Dillon, 1989). At the same time, the Japanese companies, especially Toyota, still made profits in difficult times (Shingo and Dillon, 1989). This made their western counterparts to take notice of their strategy of lean and just-in-time which advocated the elimination of waste in terms of inventory as well as unproductive work.

The western companies, impressed by this new philosophy of lean systems, started adopting the principles of waste elimination. This led the companies to cut down on their inventories. They tried to imitate the Toyota system of kanban and jidoka to emulate the success of these companies. Some succeeded to a certain extent while others struggled with changing their strategy (Thompson, 1997). However, one thing was clear – the companies were convinced to reduce their inventories levels as much as possible. Along with just-in-time, trends like third-party logistics, information technology, outsourcing and subcontracting have also encouraged companies to undertake inventory reduction (Chen et al., 2007). However, there are also factors such as higher customer service levels, an increase in the variety of product offerings and uncertainty of demands that tend to push the companies towards higher inventory levels (Chen et al., 2007).

Consequently, the question that arises is what happened to the inventory levels of companies. Did they decline or increase with time or was there no trend at all? Numerous academic studies have been done till date trying to answer the above question. A big majority of the research is based on U.S. firms. Many of the studies centered on the U.S. manufacturing sector do show a decline but there are some which state otherwise. Other sectors like wholesale and retail show mixed results across studies. There are few papers examining firms other than those in the U.S. Among these, the general trend is that the firms in larger economies tend to show some decline in inventories. However, no such research has been found in the literature which primarily focuses on Canadian companies. The purpose of this thesis is to perform an empirical analysis of the inventory level of the companies in Canada over time. The investigation takes place in two parts. First, the data on the net inventory level of publicly listed Canadian firms are analyzed to determine whether there is an increasing or decreasing trend or no trend at all. Also, along with net inventory, different types of inventory namely – raw materials, work-in-progress and finished goods, are also examined for inventory time trends. In addition to the above, this research also analyzes the impact of firm size, growth in sales, gross margin and investment in fixed assets on net inventory for publicly listed Canadian companies.

The structure of the thesis is as follows. In the next section, various academic papers related to the examination of inventory trends are discussed. It is followed by the third section covering the proposition of hypotheses for the current study. The fourth section of methodology comprises two sub-sections. The first sub-section provides a brief description of the database and the definition of the variables. The second sub-section deals with the model specification and a precise summary of the various models of time series panel data used for running the statistical tests. The discussion of the results is presented in section five. The last section consists of the conclusions, limitations and a brief note on possible future research.

2 Literature review

Inventory can be defined differently depending upon the field of study (Waller et al., 2014). For financial accounting purposes, inventory is considered to be a part of the current assets as it represents a tangible property that can be transformed into revenue (Waller et al., 2014). From a supply chain perspective, inventory is seen as essential to balance demand and supply (Waller et al., 2014). In short, inventory represents goods or stocks produced or held with the purpose to sell or for maintenance.[1]

As per Waller et al. (2014), inventories can be classified based on the purpose of the stock, based on the production stages and other criteria. The classification based on the production stages is used in this thesis. As per this classification, there are three categories of inventories: raw materials, work-in-progress and finished goods. Raw materials are the inventories that have been stocked for utilization in the production process and do not have a parent material (Waller et al., 2014). They are used as the initial inputs for the production process, e.g. minerals, grains, etc.[2] Work-in-progress inventories are those that are processed into the final product (Waller et al., 2014). Any item in the inventory that is derived from a parent raw material and is not in the final form or output of the production process can be considered as work-in-progress inventory. [3]

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[1] http://dictionary.cambridge.org/dictionary/english/inventory

[2] http://www.referenceforbusiness.com/management/Int-Loc/Inventory-Types.html

[3] http://www.referenceforbusiness.com/management/Int-Loc/Inventory-Types.html

Goods obtained at the end of the production or assembly and ready to be sold to the customers are called finished goods (Waller et al., 2014). Net inventory can be described as a summation of goods procured externally, goods produced internally as well as materials and supplies purchased for manufacturing.[4] Some authors also use the term total inventory for net inventory. As per Rajagopalan et al. (2001), it is generally considered inappropriate to use inventory in the terms of monetary value alone to examine inventory behavior over time. They further state that the output of an industry varies over time and inventory varies with the output of that industry. Hence, a decline in output could lead to a decline in inventory thus not giving a clear picture of the inventory trends. Therefore, most studies reviewed in the succeeding part of the literature review use some form of relative measures of inventory. However, few studies do use absolute inventory levels. Jain et al. (2014) use average quarterly inventories and Amihud et al. (1989) utilize average annual inventories as their dependent variable. Robb et al. (2012) also use the year-end inventories of the firms as their dependent variable.

The relative inventory measures used in the studies analyzed as a part of the literature review are inventory turnover, inventory ratios, inventory days, inventory to asset ratio, and inventory to sales ratio. Inventory turnover (TI) is defined as the ratio of the cost of goods sold to the total or net inventory measured in monetary value (Gaur et al., 2005). Some studies like Rajagopalan et al. (2001), Cheng et al. (2012) and Boute et al. (2003) employ inventory ratios as their dependent variable. Inventory ratio is defined as the ratio of the inventory to the value of shipments (Rajagopalan et al., 2001). Inventory to sales ratio (IS) is defined as the ratio of the total or net inventory to annual sales (Shah et al., 2007). Few studies like Mishra et al. (2013)

[4] HEC online library – Osiris user guide
https://proxy2.hec.ca:3090/version-2016628/Search.QuickSearch.serv?_CID=1&context=35TZCN8NR6T9HQ1

and Lieberman et al. (1999) use the inverse of inventory to sales ratio as their dependent variable. The third measure, inventory days is defined as the product of the net inventory and number of days in a year divided by the cost of goods sold (Chen et al., 2005). Inventory to assets ratio is defined as the total or net inventory to total assets in a year (Chen et al., 2005). The total assets in the above ratio could be substituted with fixed or current assets or capital investment which all form subsets of the inventory to assets ratio (Blazenko et al., 2003).

Numerous academic research has been carried out to ascertain whether inventories have actually decreased or not. The two main approaches taken by various researchers is either to analyze the aggregate sector level behavior or to perform the same by utilizing firm level data. In the first sub-section, the five major studies on this topic are analyzed in detail. Then, in the second sub-section, studies inspecting the factors impacting inventory trends are reviewed. All the papers covered in the two sub-sections are centered on the U.S. economy or U.S. firms. In the third sub-section, studies examining the inventory trends of companies in non-U.S. economies, including China, Germany, etc., are taken into consideration.

2.1 Five major studies – U.S.

The five most cited studies concerning the topic of this thesis are listed in Table 1. In this table, we indicate the authors in the first column, the data source in the second column, time-period of the respective study in the third column, dependent variable and sector in the last two columns of the table. Many of the later studies take the work of these authors as a reference to build their methodology and utilize several of the variables used in these studies.

Authors	Data	Timeline	Dependent Variable	Sector
Rajagopalan and Malhotra (2001)	U.S. Census Bureau – 20 sectors	1961 – 1994	Inventory Ratios	Manufacturing
Gaur et al. (2005)	Financial reports - 311 publicly listed firms	1987 – 2000	Inventory turnover	U.S. retail
Swamidass (2007)	S&P Compustat – 1200 firms	1981 – 1998	Total inventory to sales	U.S manufacturing
Chen et al. (2005)	WRDS Compustat – 7433 firms	1981 – 2000	Inventory days, Inventory to asset ratios	U.S - manufacturing
Chen et al. (2007)	WRDS Compustat – 1662 firms	1981 – 2004	Inventory days, Inventory to asset ratios	U.S – retail & wholesale

Table 1 – Major studies centered on the U.S. Adapted from (Cannon, 2008)

Rajagopalan and Malhotra (2001) investigate 20 industries in the manufacturing sector using data from the U.S. Census Bureau for the period 1961-1994. Making use of inventory ratios and data for all the three types of inventory, i.e. raw materials, work-in-progress and finished goods, they find that the total inventory measured in terms of inventory ratios declined with time with a greater decrease in the pre-1980 period compared to post-1980. They also conclude that among the various types of inventories, the raw materials and work-in-progress inventory ratios showed a decline in the majority of the industries. However, the finished goods inventory ratios did not show a specific trend due to mixed results. Work-in-progress showed the sharpest decline among all the classifications of inventory. Similar results were found by Chen et al. (2005) who use firm level data of public listed U.S. companies in the manufacturing sector from WRDS (Wharton Research Data Services) compustat. They use inventory days which is defined as the average number of days for the inventory to turn over and is computed through the product of inventory and the number of days in a year divided by the cost of goods sold (Chen et al. 2005). Using the interest rates, GDP growth, inflation rate and Purchasing Managers Index (PMI) as explanatory variables, the results showed a decline in inventory days for total inventory across the study period. Also, a larger decline was observed in work-in-progress inventory days and a smaller but significant decline in raw materials inventory days. No trend was observed for finished goods inventory. To counter check their results, Chen et al. (2005) perform the same tests using inventory to asset ratio as a proxy for inventory. The decline in inventory to asset ratio was found to be more drastic than for inventory days.

Relating raw materials inventory with interactions with suppliers, work-in-progress inventory with internal operations and finished goods inventory with customer interaction, Chen et al. (2005) suggest that the manufacturers have improved upon their efficiency in terms of internal operations and communication and working with their suppliers. However, they attribute the lack of decline in finished goods inventories to increasing product varieties and higher levels of customer service expectations. These factors could have nullified the impact of JIT on finished goods inventories.

Overall, work-in-progress inventories have shown the maximum improvement for the majority of the firms included in their study. Using the same set of variables, Chen et al. (2007) perform a similar analysis on 1662 publicly listed firms in the retail and wholesale sector of the

U.S. for the period from 1981 to 2004. The only difference here is that the authors only consider total inventory for their test. The inventory days for the wholesale sector companies declined from 73 days in 1981 to 49 days by 2004. This results in an average of 3% decline per year. The retail sector companies had inventory days of 72.6 days in 2004; a mere 12-days decline from 1981.(Chen et al., 2007)

On detailed observation of the test results of Chen et al. (2007), it was found that the inventory days increased in the initial years and remained unchanged until 1995. The decline begins to appear post-1995. However, the overall period is trendless for the retail sector firms. Similar results were observed for tests having inventory to asset ratios as the dependent variable. Among the 21 sub-sectors in wholesale, except for two, all the sub-sectors show a decline in inventory measured in terms of inventory to assets ratio, whereas most of the 14 sub-sectors in retail did not show any decline. Chen et al. (2007) attribute the lack of decline in the retail sector to the reasoning that the firms were more concerned with higher service levels and larger product varieties.

Gaur et al. (2005) undertake another in-depth analysis of the U.S. retail sector. They utilize inventory turnover as a proxy for inventory along with capital intensity, sales surprise and gross margin as explanatory variables. The inventory turnover (TI) is defined as the ratio of the cost of goods sold to the total inventory in monetary value (Gaur et al., 2005). Capital intensity is described as a measure of investments in warehouses, IT, logistics and inventory management systems and sales surprise is defined as a measure of the degree of difference between the actual sales and the forecasts (Gaur et al., 2005). The regression results of Gaur et al. (2005) suggest that the overall inventory turnover showed a downward trend over time implying that the relative inventory levels have been increasing for the sample firms as a whole. But nearly 38% of the firms show an increase in inventory turnover implying a decline in their relative inventory levels. Also, the inventory turnover was negatively correlated with the gross margin and positively correlated with the sales surprise and capital intensity. Gaur et al. (2005) contend that the overall worsening of inventory trends may be partly attributed to the increased product varieties, shorter life cycles of products and longer lead time for products due to global outsourcing.

In order to get a more in-depth view of inventory in manufacturing within the framework of financial performance, Swamidass (2007) takes a unique approach. He argues that the reason for the ambiguous results for inventory trends found in the literature, i.e. some studies showing a decline in inventory and others proving the opposite, is because the firms within a given industry are treated as a homogenous lot. Thus, he prefers to investigate the inventory behavior of the firms distinguished by their financial performance. He takes a sample of 1,200 firms from the S&P Compustat data and divide them into three groups of top performers, middle and bottom performers on a financial basis. To establish a clear distinction between all the firms, they are ranked on their financial performance and the average inventory of the top 10% firms are compared with the middle 10% and the bottom 10% firms.

Performing a time series analysis of inventory to sales ratio against time with no other control variables, the result of Swamidass (2007) showed no specific overall trend for the entire data set. However, on taking a closer look at the result at each level, it is found that the top 10% and middle 10% firms showed a downward trend or improvement in the inventory to sales ratio whereas the bottom 10% showed an increase or worsening of this ratio. Also, for the period 1981 – 1990, the overall trend is negative but for the period from 1991 – 1998, the top 10% showed no significant trend. The middle 10% showed a downward trend whereas the bottom 10% firms showed an increase in the ratio (Swamidass, 2007). In addition to the above, his results suggested that the gap between the top 10% firms and the bottom 10% firms tends to grow with time. Though the study is interesting, doubt can be cast over the results as no control variables have been taken into consideration, whereas other studies showed that the control variables can have an impact. Also, the results obtained by comparing just the top and bottom 10% firms cannot be generalized for the entire sector or industry. Nevertheless, it gives a different perspective for looking at the inventory behavior.

Based on the five papers discussed above, it could be concluded that the U.S. manufacturing sector showed a decline in inventories for both sector-level and firm-level analysis. All the three papers on the manufacturing sector – Rajagopalan et al. (2001), Chen et al. (2005) and Swamidass (2007) more or less agree with some sort of decline in inventories. This decline is more profound in the period prior to 1990. Rajagopalan et al. (2001) performing a sector level analysis and Chen et al. (2005) performing a firm level study, both indicate a decline in raw materials and work-in-progress inventories and no trend for finished goods inventory. Also, the work-in-progress category showed the highest improvement among all the categories of inventory. The wholesale sector too has shown a substantial decline in Chen et al. (2007) but the retail sector is trendless or showing signs of worsening of inventories in Chen et al. (2007) and Gaur et al. (2005) respectively.

2.2 Factors impacting inventory trends

The above five papers focused on the inventory trend across time as the main subject of analysis. However, many academicians prefer to focus their analysis on one specific aspect of business like – globalization, investments in IT, implementation of JIT and lean systems and many others and study their impact on the inventories. Below is a generic diagram (Figure 1) of various factors impacting the firm inventory levels.

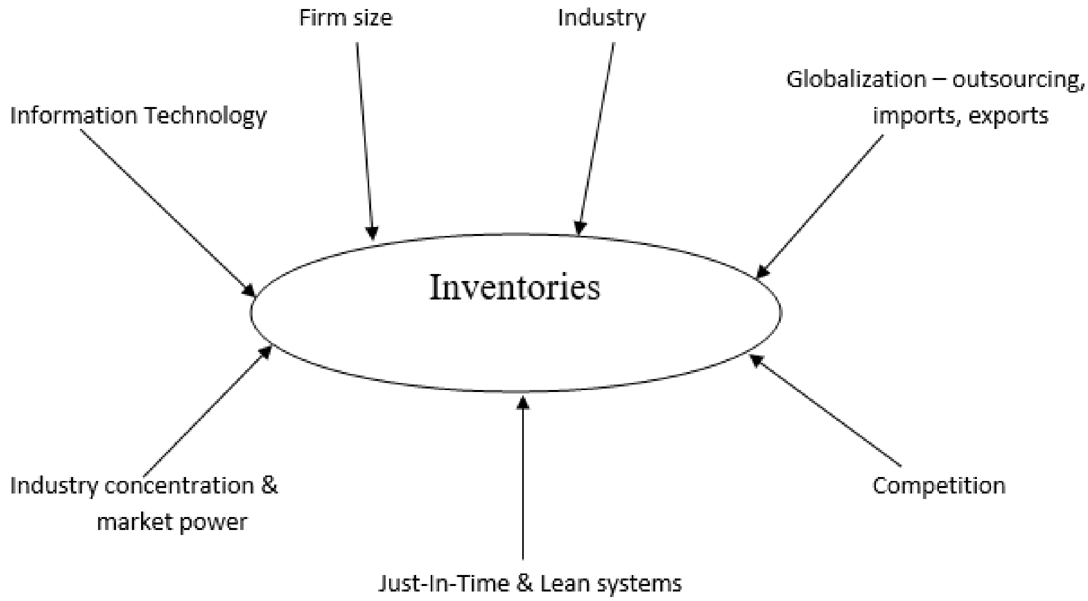

Figure 1 – Factors impacting inventory behavior. Adapted from De Leeuw et al. (2011)

Moving further, the seven factors mentioned in the Figure 1 and their impact on inventories are analyzed in the studies listed in the Table 2 to get more insights on inventory trends. The discussion of the literature in this section is organized around these seven factors. Each of them will be discussed in a separate subsection. Table 2 contains a mix of studies from U.S. and non-U.S. economies. In this table, we indicate the authors in the first column, the data source in the second column, time- period of the respective study in the third column, dependent variable and sector in the last two columns of the table.

Authors	Data	Timeline	Dependent Variable	Sector
Johnston (2014)	S&P Compustat – 126 firms	1982 – 2012	Inventory turnover, Inventory to	Retail – U.S.

			asset ratio	
Cannon (2008)	S & P Compustat – 244 firms	1991 – 2000	Inventory turnover	Manufacturing – U.S.
Cheng et al. (2012)	U.S. Census Bureau – 165 sectors	2003 – 2008	Inventory ratios	Manufacturing – U.S.
Blazenko et al. (2003)	U.S. – publicly listed firms; S&P Compustat	1976 – 1995	Inventory to invested capital ratio	Across industry – U.S.
Demeter and Matyusz (2011)	IMSS 4 – International Manufacturing strategy survey. 711 firms	February 2005 to march 2006	Inventory days	Manufacturing – 23 countries
Demeter (2003)	IMSS 2 – International Manufacturing strategy survey. 444 firms	1996 – 1997	Inventory turnover	Manufacturing – 23 countries
Huson and Nanda (1995)	Questionnaire & S&P Compustat – 55 firms	1980 – 90	Inventory turnover	Manufacturing – U.S.
Vergin (1998)	Fortune 500 (Compact disclosure guide) – 427 firms –	1986 – 1995	Inventory turnover	95% manufacturing, rest retail, mining etc.

Han et al. (2008)	Sector level – U.S. Census Bureau	2002 – 2005	Inventory days	U.S. manufacturing
Jain et al. (2014)	U.S. Compustat & U.S. customs – 177 firms	2007 – 2010	Inventory investment	U.S. – retail & Wholesale firms
Lieberman et al. (1999)	Suppliers & part manufacturers – Surveys	1993	Sales/ average inventory	U.S. & Canada automobile sector
Kros et al. (2006)	Research Insight Database – 316 firms	1994 – 2004	Inventory turnover	Automobile, electronics and aeronautics – U.S.
Amihud and Mendelson (1989)	S&P Compustat Database – 1,601 firms	1968 – 1986	Average inventory and inventory variance	U.S. Manufacturing
Irvine (2003)	Sector level – U.S. Dept. of Commerce Bureau of Economic analysis	1967 – 1999	Inventory to sales ratio	U.S. – Manufacturing, retail, wholesale
De Leeuw et al. (2011)	Interviews & Surveys –		Inventory days	U.S. - Automobiles

	dealers & management – 119 interviews			
Mishra et al. (2013)	S&P Compustat, CSRP – Centre for Research in Security Price, Information Week journal. 197 firms	2000 – 2009	Sales to Inventory ratio	U.S. – Manufacturing, Retail, Mining, wholesale, Transportation, construction etc.
Shah et al. (2007)	Sector level data – BEA from Dept. of Commerce (U.S.)	1960 – 1999	Inventory to sales ratio	U.S. – Manufacturing, retail, Wholesale
Dehning et al. (2007)	S&P CompuStat – 123 firms	1994 – 2000	Inventory turnover	U.S. manufacturing
Boute et al. (2003)	National Bank of Belgium – 15 sectors of manufacturing	1979 – 2000	Inventory ratios	Manufacturing, Retail, wholesale - Belgium
Shan et al. (2013)	Wind financial database – 1286 firms	2002 – 2009	Inventory/ operating cost	9 industries - China
Robb et al. (2012)	ISI emerging market database	1990 – 2008	Inventory to cost of cost sold	Manufacturing - China

	– 294,914 firms			
Kolias et al. (2011)	Financial reports – 566 firms	2000 – 2005	Inventory turnover	Retail-Greece
Obermaier (2012)	Sector level – German Central Bank	1971 – 2005	Inventory / sales	Manufacturing, Wholesale & Retail - Germany
Lieberman et al. (1999)	Financial reports – 52 automobile firms	1965 – 1991	Inventory/ sales	Automobile sector - Japan

Table 2 – Other U.S. and non-U.S. studies. Adapted from (Cannon, 2008)

2.2.1 Firm size

Johnston (2014) utilizes a similar set of variables as Gaur et al. (2005) along with the firm size and net margin as additional explanatory variables. The results of Johnston (2014) showed that the inventory turnover increased on average by 0.28% annually ignoring firm size. However, by taking firm size into account, the inventory turnover showed a decrease from 1982 to 1994, implying an increase in the relative inventories and then a small increase in TI from 1998 to 2001 pointing towards a decline in the relative inventories. There is no long-term trend for the selected retail firms. This result is in line with Chen et al. (2007) who find a decline only around 1995. In contrast, Gaur et al. (2005) conclude an overall worsening of the inventory levels with no exception in any of the years under study. However, Johnston's results for Inventory to assets ratio (IA) showed a continuous decline over the whole period of 30 years. He prefers TI over IA as the impact on IA could be biased due the fact that IA could be improved by decreasing the investments in inventories but increasing assets in the form of retail outlets, distribution centers and transport equipments. Vergin (1998) takes a sample of 427 companies from the list of the Fortune 500 companies and found that the inventory turnover improved for eight consecutive years before a drop in 1995. Inventory turnover for firms making industrial products increased, whereas it decreased for firms engaged in consumer goods. The results of Cannon (2008) also showed a decline in the relative inventory level for a sample of 244 manufacturing firms with inventory turnover (IT) as the dependent variable and capital intensity, firms' employee base as proxy for the firm size and time as independent variables.

Thus, as seen above it can be noted that the firm size does have a significant impact on the inventory. However, the results are somewhat contradictory and confusing. Johnston (2014) points towards a worsening of the inventory trend in retail, whereas Vergin (1998), which includes a sample of top performers across sectors and Cannon (2008) show signs of improvement. First, it could be that the dependent variable for inventory or even the variables used to estimate the firm size could be impacted by the choice of other explanatory variables considered in these studies and behave differently under the influence of a different set of independent variables.

2.2.2 Globalization

Some academicians argue that many of the original equipment manufacturers (OEMs) source part or most of their products from contract manufacturers (CMs) which could result in a redirection rather than a reduction of inventories (Han, Dresner & Windle, 2008). The OEMs could be just pushing the entire excess inventories on their suppliers and contractors. Also, contracting leads to longer lead times in turn resulting in larger safety stocks. Cheng et al. (2012) favor sector-level data rather than individual firm-level data given that in most cases both OEMs and contract manufacturers are in the same sector.

As per Cheng et al. (2012), outsourcing can have two opposite impacts. Globalization can lead to cheaper raw materials and lower production costs. However, an increase in the distance generally results in longer lead times and a higher risk due to natural calamities necessitating higher safety stocks. Their analysis shows that outsourcing leads to a reduction of raw materials and finished goods inventories but not for work-in-progress inventory. They conclude that contract manufacturers can pool production across many OEMs, thus achieving economies of scale by inventory pooling which in turn helps in reducing safety stock. Han et al. (2008) try to find out the impact of globalization on inventory in the form of import and export ratios for individual sectors. The import ratio is defined as the ratio of imported raw materials to the total purchases per sector (Han et al., 2008). The export ratio is defined as the ratio of the exported finished goods to the total sales within the sector (Han et al., 2008).

The results of Han et al. (2008) show that the inventory costs are positively correlated with the import and export ratio. An increase of 10% in imports leads to an increase of 2.16 days of inventory. Similarly, increasing exports by 10% results in augmenting the inventory days by 2.05 days. While Han et al. (2008) concentrate on the impact of global operations in terms of imports and exports on inventory, Jain et al. (2014) investigate the impact of global sourcing in terms of imports and supplier diversification on inventory. They deduce a positive relationship between global sourcing and inventory investment and a negative relationship between supplier dispersion and inventory investment. A 10% increase in global sourcing would lead to an 8.8%

higher investment in inventories for the sample firms despite reduced costs of inventory. However, a larger dispersion of the supplier base reduces the dependency and uncertainty for the firms resulting in lower inventory investments.

Cheng et al. (2012) and Jain et al. (2014) support that contract manufacturing and higher supplier diversification cause reduction in inventories. However, Han et al. (2008) contradict it by showing that a higher level of globalization results in higher inventory investments.

2.2.3 JIT & lean systems

There is another set of academicians who make a comparison between lean and non-lean companies or take a sample of self-proclaimed JIT firms to show the impact of the principle of waste elimination on inventories. Demeter and Matyusz (2011) use the 4th edition of the IMSS (International Manufacturing Strategy Survey) to compare between 171 lean and 84 non-lean companies from across 23 countries, including 25 from Canada. The findings of Demeter and Matyusz (2011) suggest that lean companies showed significantly smaller inventory days across various types of inventory compared to non-lean ones. However, within lean firms too, there was a significant difference in the impact on inventories based on the production systems and order type. The choices of production system, i.e., whether modular or dedicated lines, impacted work-in-progress inventory the most. The higher the ratio of dedicated lines, the lower is the work-in-progress inventory. Secondly, the order policy has a profound impact on the inventory of raw materials and finished goods. Demeter et al. (2011) show that make-to-order had a strong positive correlation to raw materials inventory while assemble-to-order is negatively associated with it. On the other hand, make-to-stock results in higher inventory days for finished goods inventory.

Demeter, using the same strategy as above, divides a list of 444 companies from IMSS – 2 survey into firms with and without manufacturing strategy and finds no significant correlation between inventory turnover and manufacturing strategy (Demeter, 2003). Thus, a conflicting result is obtained from two surveys. IMSS-4 was compiled in a more recent period and is considered to have more authentic data compared to IMSS-2 as the latter was conducted at the initial stages. So there are chances of recording inappropriate responses in earlier version. Also, for IMSS-4, Demeter does filter out a large number of small and medium-sized companies and includes only large scale firms for analysis. Demeter argues that the reason to exclude small and medium firms is that most of them do not have the resources or capital to invest in lean production for effective inventory management.

Huson and Nanda (1995) take a sample of 55 U.S. manufacturing firms based on newspaper articles related to JIT implementation and mailed them a questionnaire to obtain the details including commencement date of JIT implementation. They obtain the information on inventories, number of employees, unit margins and earnings per sales from the financial statements of these firms published in S&P Compustat. The results suggested an average increase of 24% in the inventory turnover in the period after the JIT implementation. Also, there was a decrease in employee per sales dollar of approximately 34% by the end of the study period pointing towards improved labor productivity. The findings of Fullerton et al. (2001) indicate that firms had a substantial reduction in inventory levels post implementation of JIT. A greater reduction was found in work-in-progress and raw material inventory while there was substantially less decline in finished goods inventory. This is in line with the findings of Rajagopalan et al. (2001) and Chen et al. (2005). Almost all the papers focusing on JIT implementation like Fullerton et al. (2001), Huson et al. (1995) and Demeter et al. (2011)

unanimously agree that the implementation of just-in-time principles does lead to a decline in inventory levels.

2.2.4 Industry

Some researchers prefer to select a particular industry/s like automobile or aeronautics where the impact of JIT (just-in-time) is considered to be profound instead of the whole manufacturing sector for their analysis. Based on the survey of tier-1 suppliers to assemblers in the U.S. and Canada automobile industry, Lieberman et al. (1999) find a negative correlation for work force training and customer communication with inventory levels. Plants which had their workforce trained in a formalized improvement process had almost half the level of inventory compared to those plants where there was no emphasis on process improvement at the production lines. Another significant outcome was that the plants which had closer and more frequent communication with customers had lower inventories than those who did not (Lieberman et al., 1999).

There was no significant difference in the inventory levels of Japanese-owned plants and plants owned by the U.S.-based automobile companies. In fact, the regression results of Lieberman et al. (1999) showed that the Japanese plants had higher inventories in terms of finished goods and work-in-progress compared to the average inventory of their U.S. and Canadian counterparts. The authors suggest that the Japanese firms may have decided to have larger inventories to adapt to the conditions in North America with lower real estate prices and longer transport distances compared to Japan.

Kros et al. (2006) focus on the inventory of the supplier firms in the automobile, aeronautics and electronics industry. Their analysis showed that for the electronics industry, the inventory ratios for raw materials and work-in-progress improved over the period but the finished goods and total inventory ratios worsened. For aeronautics, there was not much change in any of the inventory ratios. Surprisingly, the suppliers in the automobile industry as well did not show any significant changes in the inventory ratios. Kros et al. (2006) also make a comparison between Original Equipment Manufacturers (OEM) and their suppliers for all the three industries. They do not find any similarities in terms of trends in the inventory ratios of OEMs and their suppliers for all the three industries. The reason as per Kros et al. (2006) could be that the inventories were not eliminated but rather moved upstream from OEMs to their suppliers. Another point to be noted is that this study was done in the latter part of the 1990s, long after the concept of JIT was widely accepted. It might be a possible explanation that these firms and their suppliers, especially in the automobile segment, may have implemented JIT long ago and by the time of the commencement of this study the elimination of excess inventory had already reached saturation. Hence, no trend is seen in the inventory ratios here.

De Leeuw et al. (2011) on the other hand, focus on the inventories downstream at the dealers and retailers side belonging to the U.S. automobile industry. The reason for this is that the decision making is more localized in the industries highly dependent on dealers, retailers and distributors. Their focus was mainly on dealers of passenger vehicles in five major regions of the U.S. The authors find a negative correlation between the sales objective of dealers and the sales through fulfillment of customer orders directly from the factory. Also, the inventory days at the firm level is negatively correlated to the outlets' sales objective. The main logic behind this as per De Leeuw et al. (2011) is that more sales require more inventories and conversely more inventory would lead to a higher amount of sales. No statistical connection was found between the firm level inventory and the dealers' level inventory. The reason based on the interviews was that the firms allocated quantities and models through a well-negotiated process in which the dealers had to take a large number of cars of the models that did not sell well to get larger stocks of the popular or bestseller models. Hence, the firms use their power to get rid of the inventory in their factory by restricting the allocation of high demand models to dealers. This, coupled with the customer unwillingness to wait for orders pushes the dealers to stock up large piles of inventory in order to be able to sell from their own stock (De Leeuw et al., 2011).

Comparing the results of the supplier side and retailer or dealer side inventories from the above studies, it could be noted that De Leeuw et al. (2011) and Kros et al. (2006) show that the suppliers and dealers or retailers in the automobile sector have been faced with a deterioration of their inventory trends, whereas Lieberman et al. (1999) show a marked improvement in the inventory of manufacturers and only tier-1 suppliers who focus on the employee productivity and strong customer communication in the automobile industry. This disproves the notion that retailers, suppliers and manufacturers are a homogenous lot and confirms that the retailers and suppliers do not show the same inventory trends as the manufacturers. This may also point to the fact that manufacturers try to push the inventory downstream and the dealers try to sell it off at discount prices to clear them.

2.2.5 IT investments

A few researchers try to analyze the impact of IT investments on inventory levels (e.g. Shah et al. (2007), Mishra et al. (2013) and Dehning et al. (2007)). Analyzing sector level data for the U.S., Shah et al. (2007) show that an increase in IT investments has a negative correlation with the inventory levels for the manufacturing and the retail sectors but has no impact on the inventory levels of the wholesale sector. On the whole, the manufacturing sector showed a continuous decline, whereas the inventory levels showed a growth in the retail and the wholesale sector. Mishra et al. (2013), on the other hand, arrive at the same conclusion utilizing firm level data for the U.S. They too affirm the positive impact of investment in Information Technologies on inventory performance.

Shah et al. (2007) also state that IT investments have a positive impact on the financial performance indirectly mediated by an improvement in inventory levels but no direct correlation. In contrast, Mishra et al. (2013) show a direct impact of IT on financial performance of firms and a partial impact mediated by inventory performance. Dehning et al. (2007) also find the positive impact of IT-based supply chain management systems on the inventory level of manufacturing firms. All the three papers agree on a negative correlation between information technology and the relative inventories.

2.2.6 Competition, profit margin & industry concentration

Blazenko and Vandezande (2003) state that the characteristics of firms' demand and marketing environment play a crucial role in determining inventory levels. Their findings suggest that higher profit margins have a positive impact and industry concentration has a negative impact on inventory levels. Higher profit margins induce firms to have larger inventories to avoid stock outs. Higher competition implies lower market power and hence less industry concentration. In presence of competition, firms prefer to have larger inventories to avoid stock outs as its impact on the revenue over the long term is greater due to customers' switching to other alternatives.

Amihud and Mendelson (1989) tried to ascertain the impact of the market power of firms on their inventory. They find a positive relationship between market power and inventories of the firm. In case of higher market power, the firms tend to have larger inventories to absorb the shocks from demand and supply fluctuations. This is in contrast to the findings of Blazenko et al. (2003) who state that lower industry concentration leads to larger inventories.

2.2.7 Unique response variable – Fixed weight Inventory to sales ratio

Some academicians like Irvine use a more unconventional method of defining their response variable for the inventory. Irvine (2003) argues that many of the previous studies do not reflect the reality of the inventory because of the measures they use. He suggests using fixed weight inventory to sales ratios (FWIS) instead of aggregate inventory to sales ratio (AIS). The main difference in the above two measures is that in the fixed weight IS, ratio an aggregation weight is associated with each sub-sector's inventory in proportion to its sales. In the aggregate IS, the inventories of all the sub-sectors are added and taken into consideration with the summation of sales across all the sub-sectors.

The aggregate inventory to sales ratio of the U.S. Department of Commerce Bureau of Economic Analysis (BEA) shows that the IS ratio for the retail and the wholesale sectors is trending upwards whereas for the manufacturing sector it showed no trend. But using the fixed weight IS ratio, Irvine (2003) concludes that all the three sectors showed a downward trend in the relative inventory levels measured in terms of fixed weight IS. The most significant finding of this research is that most of the downward trend in all the three sectors is in the sub-sectors selling durable goods, whereas those selling non-durable goods show an upward trend. Overall, the sales mix has drifted towards durable goods across sub-sectors resulting in an overall downward trend.

Fitting time trends into the fixed weight aggregate IS ratio, Irvine (2005) tries to find the exact year of the break in the inventory sales ratio trends. The decrease in the inventory to sales ratio for the total manufacturing sector started in 1983, for wholesale in 1985 and for retail in 1990.

2.2.8 Inventory trend and financial impact

There are also several empirical studies which focus on inventory behavior and financial performance. Chen et al. (2005) find that the inventory level did not have an immediate impact on the financial performance of the firms but had a long-term impact, i.e. in the long run, firms with abnormally high inventory levels had very poor long-term stock returns. Companies with a medium level of inventory had the best returns whereas companies with the least inventory level had ordinary returns. This was true for the firms in the U.S. manufacturing and wholesale sector but the U.S. retail sector showed no clear relation between the financial performance and inventory levels (Chen et al., 2005). Huson and Nanda (1995) demonstrate that a JIT adoption has a positive correlation with inventory as well as financial performance and the earning per shares also improved.

Shah et al. (2007) and Dehning et al. (2007) agree that inventory levels mediate the positive impact of IT investment upon the financial performance of the firms. Mishra et al. (2013) find a direct positive impact of inventory and IT investments on financial performance. However, Cannon (2008) did not to find any correlation between inventory and financial performance. He finds the correlation to be positive for some firm and negative for others; but overall, there was no impact. Fullerton et al. (2003) indicate that the firms with JIT implementation have better financial rewards and improvement in the financial performance. A detailed analysis on the financial impact of inventory performance will not be discussed here as it is not a part of the research question of this thesis.

2.2.9 Discussion

Based on the above literature review, it could be noted that firm size, level of IT investments, supplier and dealer relationship, globalization, competition, ordering type etc. have a significant impact on inventories. But whether the inventories declined or increased is difficult to say. Conflicting results are obtained on inventory trends under the influence of firm size while comparing the studies of Johnston (2014) Vergin (1998) and Cannon (2008). Also, when it comes to suppliers, Cheng et al. (2012) and Jain et al. (2014) show a decline in inventories due to supplier diversification and contract manufacturing but Kros et al. (2006) show no improvement in inventories of suppliers and Han et al. (2008) point towards a deterioration of inventories for manufacturers having global operations. In contrast, Lieberman et al. (1999) show an improvement in inventories of Tier 1 suppliers of the U.S. automobile industry. De Leeuw et al. (2011) point towards a deterioration of the inventory trends at the retailers' side of the supply chain. Blazenko et al. (2003) suggest that firms with a lower industry concentration and market power tend to have larger inventories whereas Amihud et al. (1989) indicate that firms with larger market power maintain larger stocks.

However, there is some consensus among the studies concentrated in studying the impact of JIT and IT investments on inventory behavior. All the studies, Demeter et al. (2011) Huson et al. (1995) and Fullerton et al. (2001), agree that a JIT implementation results in lower inventories. Similarly, the results of Shah & Shin (2007), Mishra et al. (2013) and Dehning et al.

(2007) all concur or acknowledge the negative correlation between IT and IT-based investments with the inventory behavior.

When it comes to the sector level analysis, many of the studies focusing on the U.S. manufacturers show a decline in their inventories. However, the results are conflicting for the U.S. wholesale sector. Chen et al. (2007) and Irvine (2003) find an improvement in the wholesale sector whereas Shah et al. (2007) point to a deterioration of the inventory trend for the same. For the U.S. retail sector, none of the papers studied so far except one, show any improvement in these inventory levels. Chen et al. (2007) and Johnston (2014) point towards no significant change in inventories of retail firms. Shah et al. (2007) and Gaur et al. (2005) find an increase in inventories of the U.S. retail firms. Only Irvine (2003) points towards a decline in them. Additionally, better customer communication and work force training tend to help companies in streamlining their inventory management (Lieberman et al., 1999).

Overall, it is difficult to say what happened or is happening to the inventories. All the above studies suggest or indicate mixed or conflicting results on comparison and it is difficult to make exact conclusions about the inventory trends based on them.

2.3 Non-U.S. studies and discussion

Until now, most of the analyses have been performed using data from U.S. firms or U.S. sectors. It is difficult to conclude a single result from the reviewed studies except that at an aggregate level, the manufacturing sector of the U.S. did show a decline in inventories at least until the 1980s. However, the other question is whether the results of the U.S.-based studies can be generalized to firms in other countries. To ascertain how the inventories in other economies behave, studies pertaining to significant economies outside North America like China, Germany and others are analyzed in the further part of the literature review.

2.3.1 Non-U.S. studies

Boute et al. (2003) replicate the work of Rajagopalan et al. (2001) for Belgian firms in the manufacturing, retail and wholesale industry with time and sector growth as explanatory variables. The raw material inventory ratios showed significant decrease for eight sub-sectors, work-in-progress inventory ratios declined in six sub-sectors but finished goods inventory ratios showed a decrease for only in four sub-sectors. Thus, overall the authors conclude that there is a decrease in inventory levels of manufacturing firms, but it is statistically smaller compared to U.S. manufacturing firms. Further, Boute et al. (2003) analyze the finished goods inventory ratio for the wholesale and retail companies of Belgium. They observe a significant decrease in the finished goods inventory level for retail firms but no significant decrease for firms in the wholesale sector for Belgium. This contrasts with Chen et al. (2005) who find a decrease in the inventories of U.S. wholesale firms but no trend for U.S. retail firms.

Shan et al. (2013) examine firms listed on the Chinese stock market and find a statistically significant negative relationship between inventory and time. The relative inventory levels measured in terms of inventory turnover dropped at a rate of about 1.5 % on average annually. On the other hand, Robb et al. (2012) analyzing Chinese manufacturing firms also conclude a decrease in the inventories across firms belonging to most sub-sectors in manufacturing except those in the tobacco industry. They also examine the link between inventories and the GDP per capita at a regional level within China and suggest a U-shaped correlation. This signifies that Chinese regions or provinces with larger and lower GDP per capita had higher inventories.

Kolias et al. (2011) replicate the methodology used by Gaur et al. (2005) for Greek retail firms. They observe a decline in inventory turnover of about 3.4 % in a year signifying a deterioration of inventory levels in retail firms. Also, inventory turnover was negatively correlated to gross margins and positively correlated to sales surprise and capital intensity.

Dividing the Greek retail sector into two, i.e. regions with increasing sales and regions with decreasing sales, Kolias et al. (2011) find that regions with declining sales showed larger changes in the same direction in inventory turnover compared to firms in regions with increasing sales. The reason they conclude for this behavior is that decreasing sales impact cash flows negatively which in turn render firms unable to take advantage of quantity discounts and results into increasing the operating costs which leads to a decline of the inventory turnover.

Utilizing inventory to sales ratio (IS) for the manufacturing, retail and wholesale sectors for Germany, Obermaier (2012) finds a decrease in the IS ratio for raw materials and finished goods while the IS ratio increased for work-in-progress inventory. This is in contrast to Rajagopalan et al. (2001) where raw materials and work-in-progress inventory declined for U.S. firms and also for Belgian firms in Boute et al. (2003). The overall total inventory declined for all the sectors. Among the sectors, the manufacturing sector showed a larger decline during the pre-1988 period whereas during the post 1988, the wholesale and retail sectors showed the greatest decline in their respective total inventories in the sample of firms from Germany (Obermaier, 2012).

Generally, the work-in-progress inventory is believed to be impacted most by the JIT implementation but here we find a contrasting result (Obermaier, 2012). He attributes the reason for this to the possible shift from a make-to-stock to a make-to-order approach among the German firms or to the higher bargaining power of upstream companies compared to the rest in a supply chain. In contrast to Obermaier (2012), Lieberman et al. (1999) show a decline in work-in-progress inventory of 52 Japanese automobiles companies and their suppliers. The main aim is to examine the impact of a JIT implementation in terms of work-in-progress inventory and labor productivity. Lieberman et al. (1999) explain that inventory presence on the shop floor prevents the discovery of problems on the shop floor. Reduction in work-in-progress inventory exposes defects in the manufacturing process which induces the managers to eliminate the source of process disruption. The results of Lieberman et al. (1999) show that most of the companies cut their WIP/sales ratio by more than 50% from the late 1960s to the early 1980s. On the whole, between 1970 and 1980, labor productivity grew on average by 9% annually. They also find a negative correlation between labor productivity and IS ratio. A reduction of about 10% in IS ratio resulted in approximately 1% improvement in labor productivity.

2.3.2 Discussion & Conclusion

Overall, except for Greece, results from all the other non-U.S. economies tend to show a decline in total or at least in one of the inventory types. The decline for the firms in Belgium is small, whereas the decline for China, the U.S., Japan and Germany is relatively large. The couple of cross-country studies (Demeter, 2003) and (Demeter & Matyusz, 2011), do not give a clear picture on the trends. From the above, it can be stated that the declining trend is seen in larger economies whereas the trend is not that prominent in small ones. However, the duration of the study is also something that cannot be ignored. For Greece, the study period is quite recent and very small compared to the study period for the other economies. Maybe if the data was obtained for an earlier period and for a larger duration, the results might have been different.

A decline in work-in-progress inventories is observed in studies concerning U.S., Belgian and Japanese firms in Rajagopalan et al. (2001), Boute et al. (2003) and Lieberman et al. (1999) while German firms show an increase in them (Obermaier (2012)). Only German firms show a marked decline in finished goods inventory (Obermaier (2012)), whereas there is no trend or a deterioration of finished goods inventory levels for the firms in other countries (Rajagopalan et al., (2001); Boute et al., (2003); Lieberman et al., (1999)). The raw material inventory shows a decline across Belgian, U.S. and German firms in their respective studies. So far, the results are far from pointing to any particular direction when comparing sectors and inventory categories across countries. Overall, one thing seems more certain that in general, manufacturing firms have shown some decline in most studies for the U.S. and outside the U.S. as well.

Demeter et al. (2011) and Demeter (2003) are the only studies that take into consideration a few firms from Canada. But their results are quite generic in nature and nothing can be deduced in particular for Canada. Also, the number of firms is not sufficient to be representative of the Canadian economy. Thus, after all the deliberation on the behavior of inventories across the academic papers, it is still difficult to say with certainty what happened to the inventories. Moreover, no paper specific to Canada has been found in the literature. The purpose of this thesis is to try to fill this gap and to conduct a study that analyzes the inventory trends of Canadian companies.

3 Research Objective and hypotheses

3.1 Research Objective

The objective of this thesis is to examine the evolution of net inventories as well as various inventory categories for publicly listed Canadian firms. The inventory behavior is examined over a period of 30 years from 1987 to 2016 to ascertain whether there is a decline or growth in the inventory levels and compare the results with the studies discussed in the literature review. Also, an attempt has been made to find a correlation between net inventory and various firm level factors like company size, gross margin, investment in fixed assets and sales growth, and to study their impact on the net inventory of the Canadian firms. Based on the analysis done in the literature review, a detailed discussion of the hypotheses for the current study is provided in the next sub-section.

3.2 Hypotheses

In this sub-section, five hypotheses will be proposed for this research. As discussed previously in the introduction, the inventory is seen as lost investment opportunities due to the capital tied up in them. Also, excess inventory is seen as a cover up of various operational problems (Cannon, 2008). This coupled with the advent of Japanese firms in the 1970s, the popularization of the just-in-time and lean philosophies in North America during the 1980s would have led the domestic companies in Canada and the U.S. to try to minimize their inventories as much as possible (Huson and Nanda, 1995). Additionally, various innovations in the field of information technology like MRP, quick response, ERP, etc., would further augment the effort to reduce inventories in order to achieve optimum operational efficiency (Rajagopalan and Malhotra, 2001). Based on the above observations, the two parts of the first hypothesis for net inventory and the three inventory classifications namely – raw materials, work-in-progress and finished goods are stated as below.

Hypothesis 1-a:

Inventory turnover for net inventory of the Canadian companies is positively correlated with time.

Hypothesis 1-b:

Similarly, inventory turnover for the raw materials, finished goods and work-in-progress inventory of the Canadian companies is positively correlated with time.

A positive correlation between inventory turnover and time indicates that the ratios are increasing with time implying relative inventories are showing a declining trend with time. This is because inventory is inversely proportional to the inventory turnover. Here, a point to be noted is that the inventory categories – raw materials, finished goods and work-in-progress inventory are examined only for the time trends. The subsequent hypotheses with respect to the other explanatory variables are examined for net inventory only.

Based on the surveys conducted among the retail firms in their study, Gaur et al. (2005) suggest that the managers have to make a trade-off between gross margin and inventory turns. Further, they infer that goods with a higher margin have lower turns compared to the low-margin goods. Additionally, they explain a negative correlation between gross margin and inventory turnover directly through the factors such as product service level and indirectly through product price, product variety and its life cycle length. Shan et al. (2013) also suggest a positive relation between gross margin and inventory on the premise of the stochastic inventory models. Based on the above, the second hypothesis is as below:

Hypothesis 2:

Inventory turnover for net inventory of the Canadian companies is negatively correlated with gross margin.

Capital intensity is defined as investments in fixed assets of a firm (Gaur et al., 2005). Gaur et al. (2005) suggest that investment in fixed assets like warehouses, IT systems, etc., could lead to a reduction of lead times and safety stocks for the retailers. Also, they further state that the investment in fixed assets provides retailers more flexibility in dealing with uncertainty related to shipment of inventories across the stores. A decline in inventory in turn results in higher inventory turns. This leads to the third hypothesis.

Hypothesis 3:

Inventory turnover for net inventory of the Canadian companies is positively correlated with capital intensity.

Rumyantsev & Netessine (2007) state that the larger the firm, the better will be its ability to pool demand from various assets like stores and warehouses resulting in lower inventory. In short, a larger size of the firm helps it in achieving economies of scale in handling inventory. They base their argument on the insights from stochastic models. Johnston (2014) agrees with the above and proposes a hypothesis along similar lines of Rumyantsev et al. (2007). Shan et al. (2013) also prove the negative correlation between firm size and inventories. Based on the above research studies, the proposition for the fourth hypothesis is as below.

Hypothesis 4:

Inventory turnover for net inventory of the Canadian companies is positively correlated with firm size.

In their analysis, Rumyantsev et al. (2007) find a negative correlation of inventory with sales growth for U.S. firms. Shan et al. (2013) also find a significant negative relation between the two variables for Chinese firms. Here, the purpose of the current study is to examine the relation between inventory and sales growth for the Canadian firms. The fifth hypothesis is as below.

Hypothesis 5:

Inventory turnover for net inventory of the Canadian companies is positively correlated with sales growth.

A point to be noted here is that in case of raw materials, finished goods and work-in-progress inventory, the focus is to investigate their respective time trends for the Canadian companies. Their individual correlation with each of the explanatory variables will not be studied in the current study. The reason is that the published studies analyzing these variables do so only for net or total inventory. But none of them specifically investigates the correlation of these variables with the three inventory categories. The purpose of the current study is to replicate the methodology of some of the previous studies partly or completely as far as possible for the Canadian firms rather than propose a new proposition based on theoretical models and test them.

4 Methodology

4.1 Database and variables

4.1.1 Database

The database for this research is obtained from the Osiris database. It consists of 53,060 listed companies from over 130 countries around the world as of July 2016. The Osiris database is sourced from the following information providers – World'Vest Base, Reuters/Multex, Edgar Online, Fitch Ratings Bank Data, Fitch Ratings Insurance Company, Korea information service and Bureau van Dijk. The employees of these organizations and data analysts appointed by them are fully trained in the task of data collections with a well-defined set of procedures and numerous automated and manual error checks are in place to get the most accurate data. Also, independent audits of listed firms and verification and authentication of the provided data are done on a timely basis to ensure the accuracy of data. All the data are rigorously checked before being submitted to Osiris.[5]

4.1.2 Selection criteria and firm characteristics

For the research purpose, the annual balance sheet and income statement data of a total of 2,523 publicly listed Canadian companies were accessed from the Osiris database from 1987 to 2016. The companies were selected based on the two-digit NAICS 2012 industry classification. These 2,523 Canadian firms belong to ten sectors of the NAICS 2012 classification. These ten

[5] HEC online library – Osiris user guide
https://proxy2.hec.ca:3090/version-2016628/Search.QuickSearch.serv?_CID=1&context=35TZCN8NR6T9HQ1

sectors are – agriculture, forestry, fishing and hunting; construction; manufacturing; mining, quarrying, oil and gas exploration; retail trade; transportation and warehousing; health care and social assistance; accommodation and food services; utilities; wholesale.

Only those sectors where inventory plays a key role in the operations of firms were selected. Sectors where inventory was insignificant like finance and insurance; real estate; information; administrative, support and waste management; educational services; public administration and arts; management of companies and enterprises; professional, scientific, and technical services; entertainment and recreation were excluded. The complete list of sub-sectors within each of the sectors included and excluded in the current study is provided in the Table 14 and Table 15 of the appendix. From the annual balance sheet and income statement data, information with regards to net inventory, inventory related to raw materials, work-in-progress and finished goods, total sales, revenues, cost of goods sold, gross margin, total assets and total net fixed assets were extracted. The gross margin is expressed in percentage and all the other information categories are expressed in thousand Canadian dollars. The above information categories are also available on a quarterly basis, but the quarterly data is not available beyond 2008. Hence, the annual data of the firms was utilized for the empirical analysis.

Many of the firms had several missing values for many variables under the study and for several years across the selected timeline of 30 years (1987 – 2016). To overcome the problem of missing values, a second criterion for the selection of companies was applied based on Gaur et al. (2005). They selected only the firms that had at least five years of continuous data for their variables within the time duration of 14 years (1987 – 2000). On a similar basis, it was decided that only those companies which had at least 10 years of continuous data for net inventory during the studied period from 1987 to 2016, were taken into consideration. Firstly, since net inventory data is used in defining the dependent variable, it is utilized as a criterion for the selection of companies for testing. Without the inventory data, the rest of the information about the individual companies is of little use. Secondly, since the studied period for this thesis is about 30 years, which is almost double the length compared to the one chosen by Gaur et al. (2005), it was decided to have a longer period of 10 consecutive years for the selection criterion. This was done in order to discard the companies that have too few observations to perform a time series analysis.

After deleting the companies based on the above criterion, a total of 420 firms were left for the purpose of analysis. Table 3 provides the information about the total number of firms in each sector and their share of the total selected firms.

No	Sectors	NAICS 2012 Code	Total firms (% share)	Firms after selection criteria (% share)
1	Agriculture, Forestry, Fishing and Hunting	11	21 (0.83%)	6 (1.43%)
2	Construction	23	38 (1.50%)	12 (2.86%)
3	Manufacturing	31, 32, 33	451 (17.87%)	196 (46.67%)
4	Mining, Quarrying, and Oil and Gas Extraction	21	1787 (70.82%)	103 (24.52%)
5	Retail Trade	44, 45	36 (1.42%)	20 (4.76%)
6	Transportation and Warehousing	48, 49	37 (1.46%)	22 (5.24%)
7	Health Care and Social Assistance	62	21 (0.83%)	5 (1.19%)
8	Accommodation and Food Services	72	18 (0.71%)	5 (1.19%)
9	Utilities	22	51 (2.02%)	16 (3.81%)
10	Wholesale Trade	42	63 (2.49%)	35 (8.33%)
Total			2523	420

Table 3 – Sector-wise summary of selected Canadian firms

In the above Table 3, it is evident that the mining sector seems to have unusually larger number of firms than other sectors in the original data. However, this is backed by the facts of the Mining Association of Canada which states that there were about 3,700 firms directly involved or supporting mining operations in Canada as of 2014.[6] However, the total share of mining firms selected for the study is much lower compared with their share in the total firms. This is due to the fact that a big majority of the mining firms do not have the required data in their balance sheets and income statements. On the other hand, sectors like manufacturing, wholesale, retail and warehousing have required data for around half of the total firms available in each of these sectors. Hence, their share of firms selected for the study is higher. Due to the lack of availability of required data in certain sectors, we recognize that this might lead to a non-selection bias in our analysis. This is a limitation of the current study.

4.1.3 Variables

The various information categories stated in the previous sub-section are given notations as shown in the Table 4.

Sr. No	Information category	Notation
1	Net stated inventory	NI
2	Raw materials inventory	RM
3	Finished goods inventory	FG
4	Work-in-progress inventory	WIP
5	Cost of goods sold	COGS
6	Total net fixed assets	TNFA
7	Total assets	TA
8	Sales	Sales
9	Gross margin	GrossMargin

[6] http://mining.ca/resources/mining-facts

10	Total revenues	Trevenue
11	Companies	ID
12	Study period (1987 – 2016)	Year

Table 4 – Notations of various information categories

Here, each Canadian company whose data is utilized in the regression is given a unique identification number denoted by ID. The above notations are used to describe our dependent variables and explanatory variables. ID is the panel variable. The panel variable here represents the entities under study which in this case are Canadian firms (Torres-Reyna, 2007).

Inventory turnover as defined by Gaur et al. (2005) was chosen to be the dependent variable for the purpose of testing. For net stated inventory, inventory turnover is denoted by TI and is defined as follows:

TI = COGS / NI; (Cost of goods sold / Net inventory)

Similarly, for the various sub-classification of the inventories, the inventory turnover variable is defined as stated below.

For the raw materials inventory,

TIRM = COGS / RM; (Cost of goods sold / Raw materials inventory).

For the finished goods inventory,

TIFG = COGS / FG; (Cost of goods sold / Finished goods inventory).

For the work-in-progress inventory,

TIWIP = COGS / WIP; (Cost of goods sold / work-in-progress inventory).

Apart from the dependent variables, five explanatory variables are used. They are year, capital intensity, gross margin, sales growth and firm size. Year is the time variable representing the study period of 30 years from 1987 to 2016. The information on the gross margin is obtained directly from the balance sheet and income statement of the firms. The gross margin in the Osiris database is defined as the ratio of the gross profit and the operating revenue multiplied by 100.[7] The total revenue is used as a proxy for the firm size. An alternative for the size of the company would be the number of employees, but this specific value was missing for most of the companies in the study. Shan et al. (2013) use operating income or sales as a proxy for the company size. Johnston (2014) uses sales as a measure for the size of a firm. Here, it was preferred to use the total revenue instead of sales as sales denotes earnings from selling of goods and services to the customers, whereas revenue includes interests, royalties, fees, donations along with earnings from goods and services.[8]

Capital intensity is defined as below:

CaIn = TNFA / TA; (total net fixed assets / total assets).

Gaur et al. (2005) define capital intensity as the ratio of gross fixed assets to the sum of inventory and gross fixed assets. They also state that instead of gross fixed assets, net fixed assets and total assets could be utilized for defining the capital intensity. The information on gross fixed assets for the firms could not be obtained from the balance sheets data of the firms

[7] HEC online library – Osiris user guide
https://proxy2.hec.ca:3090/version-2016628/Search.QuickSearch.serv?_CID=1&context=35TZCN8NR6T9HQ1

[8] http://www.investopedia.com/ask/answers/122214/what-difference-between-revenue-and-sales.asp

taken from the Osiris database. Hence, the second alternative, i.e., the ratio of net fixed assets and total assets was chosen as both these data for the firms are available both from their respective balance sheet and income statements.

The sales growth is defined as follows:

SG = (Sales(t) – Sales(t-1)) / Sales t.

The above definition is based on the one used by Shan et al. (2013). Here, sales growth (SG) is the ratio of sales difference between the current and previous year to the sales of the current year. Shan et al. (2013) define sales growth using the cost of goods sold since they were using sales as a proxy for company size. Here, it was preferred to use sales instead of the cost of goods sold as the sales is not used as proxy for any of the variables or for defining any of them independently in the current study. Detailed information about the mean value and other descriptive statistics for all the variables is provided in Table 16 of the Appendix.

4.1.4 Variable characteristics

The distribution of variables can have an impact on the outcome of the regression tests. Sometimes, if the distribution of observations is non-linear or asymmetrical, then the regression models may not give significant results. Also, an asymmetrical distribution of data can impact the heteroscedasticity tests in the panel data (Alejo et al., (2015); Montes-Rojas et al., (2011)). This could result in improper interpretation of the bias in error terms (Torres-Reyna, 2007). Hence, it is imperative to check for the characteristics of the variables in the dataset.

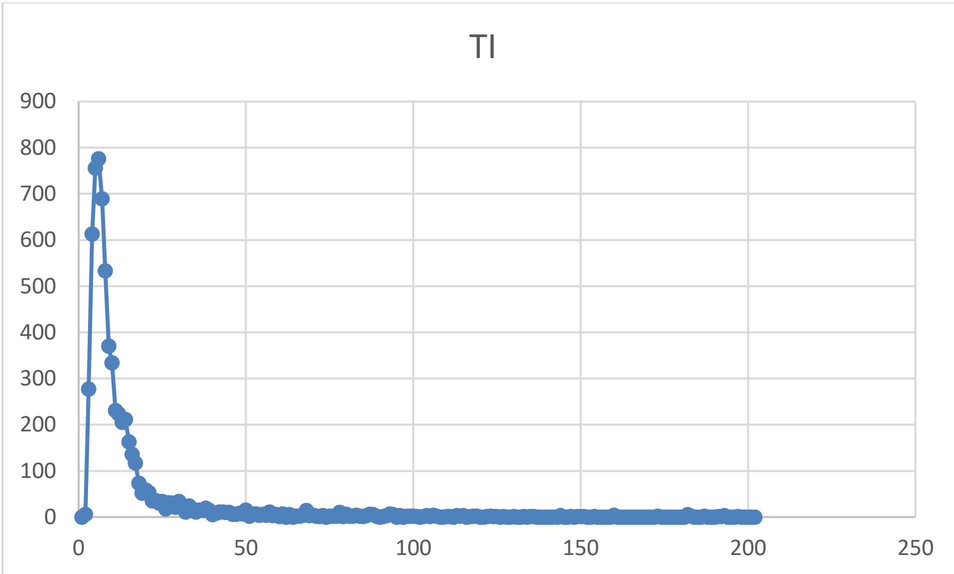

Figure 2 – Histogram of inventory turnover

The histogram graph in Figure 2 provides the distribution of the observations for the dependent variable inventory turnover (TI). As per the graph, it can be noted that the data for TI are skewed. About 50 observations were omitted from the above graph. These 50 observations out of the total of 6,682 observations for TI were quite far off from the mean, making it difficult to produce a graph with all the observations included. Note that they are still included in the data set for panel data regressions. Additionally, no statistical tests are conducted to detect outliers. This is a limitation of the current study. The log transformation of TI is given in Figure 3.

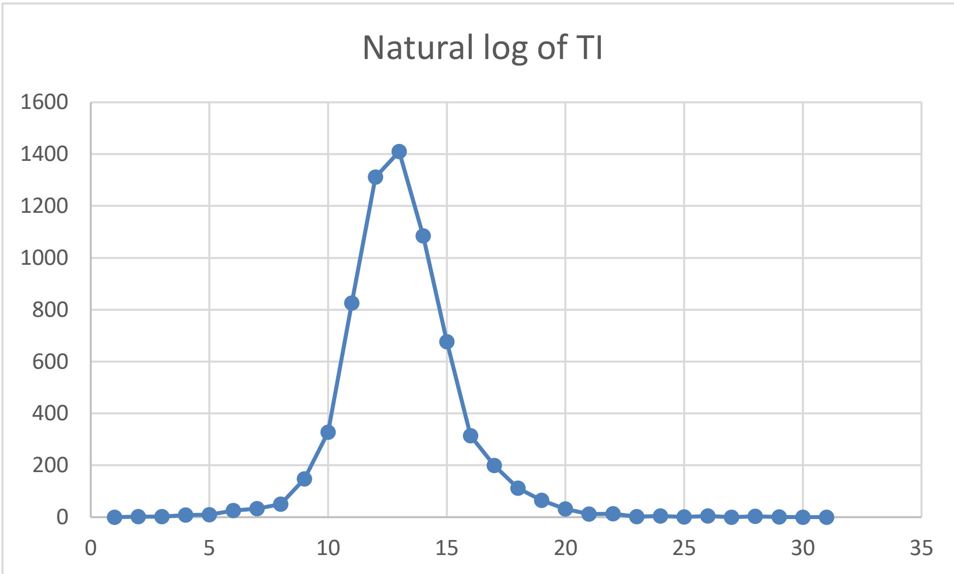

Figure 3 – Histogram of log of inventory turnover

Based on the above, it can be observed that the natural log transformation helps in normalizing the data distribution for TI. The natural logarithmic transformations may help in fitting the skewed variables into the model by normalizing them (Benoit, 2011). Gaur et al. (2005) also state that log transformation of the variables can improve prediction accuracy of the models.

The histogram graphs (Appendix: Table 17) for the explanatory variables gross margin, capital intensity, Trevenue and sales growth show that the distributions of these variables are mostly skewed or non-linear. This characteristic of the data is normal given the long study period of 30 years and the heterogeneous mixture of the firms across the ten different sectors. However, unlike TI, a log transformation of the four explanatory variables did not bring about any significant normalization of the data distribution for them. The histograms of the log transformations of the explanatory variables is provided in Table 17 of the Appendix. Thus, the log transformation was effective in normalizing only the dependent variable TI. Hence, it was decided to take the natural log for inventory turnover alone whereas the explanatory variables are used in unlogged form for the testing purpose.

4.2 Model description and diagnostic tests for model selection

There are various mathematical models available for performing time series analysis. Rajagopalan et al. (2001) use simple linear regression to study the changes in the inventory over time. Gaur et al. (2005) specify a log linear model with firm specific fixed effects. Chen et al. (2005) estimate inventory time trends by performing a panel data analysis using time series random effect, mixed effect and fixed effect models and also by formulating a log linear equation for each of these models. Shan et al. (2013) propose three models using logarithmic values of dependent and explanatory variables. The first model in Shan et al. (2013) is a linear regression model while the second and third models are fixed effect models.

Johnston (2014) and Kolias et al. (2011), both utilize log linear equations with fixed effect models to investigate trends over time for the inventory and its correlation with the other explanatory variables. Obermaier (2012) applies linear regression models to evaluate the overall time trend coefficients for the total inventory and all the three inventory types. Huson & Nanda (1995) employ three stage least square regression to perform time series analysis for inventory trends. The first part of this sub-section describes the model equation and the time series models utilized for the current study. The second part of the sub-section provides a detailed description of the panel data models used for data analysis. The last sub-section deals with various diagnostic tests for the model selection.

4.2.1 Model description

Based on the discussion in Section 4.1, the dependent variable inventory turnover is measured using natural logarithm in all the models of the current thesis. The following linear model is defined based on Torres-Reyna (2007) for the testing purpose.

$TI_{\text{(firm i, year t)}} = a + B_1\ Year_t + B_2\ GrossMargin_{(i,\ t)} + B_3\ CaIn_{(i,\ t)} + B_4\ SG_{(i,\ t)} + B_5\ Trevenue_{(i,\ t)} + E_1 \rightarrow (1)$

Here, *i* represents the companies and *t* represents the years studied. a is the intercept and E_1 is the error term. B_1, B_2, B_3, B_4 and B_5 are the coefficients of the respective variables Year (t), GrossMargin, CaIn, SG and Trevenue in the equation. The above equation takes the form as stated below for all the three categories of inventories.

$TIRM_{\text{(firm i, year t)}} = x + C_1\ Year_t + E_{12} \rightarrow (2)$

$TIWIP_{\text{(firm i, year t)}} = y + C_2\ Year_t + E_{13} \rightarrow (3)$

$TIFG_{\text{(firm i, year t)}} = z + C_3\ Year_t + E_{14} \rightarrow (4)$

Here, x, y and z are the intercepts and E_{12}, E_{13} and E_{14} are error terms for each of the inventory categories. C_1, C_2 and C_3 are the coefficients for the variable Year in the equations for each of the inventory categories.

4.2.2 Models specification

For the purpose of the study, it was decided to conduct a statistical analysis using the software STATA. The dataset for the current research topic is panel data where effort is being made to observe specific behavior of the entities – Canadian firms across time in terms of years.

There are various models proposed for analyzing panel data and it was decided to utilize four models namely – time series fixed effect model, least square dummy model, mixed effect models and time series random effect model.

Before using the STATA command for panel data, STATA has to be set to handle panel data by defining ID as the panel variable and Year as the time variable (Torres-Reyna, 2007). Then regression tests were run for all the four models. For net inventory, all the regression models were run for the time variable Year and all other the explanatory variables. For the inventory categories, regression tests were run only for Year for each category in all the four models.

The fixed effect model explores the relationship between the dependent and explanatory variables across time. The main assumption of the fixed effect model is that the variation among the companies is not significant or has negligible influence on the outcome of the variables (Torres-Reyna, 2007). To control for this, it is assumed that the intercepts and error terms are co-related with the predictor variables. In other words, fixed effect models are designed to study the outcomes of the dependent variable due to changes within the company (Torres-Reyna, 2007). The least square dummy model provides an alternative way to observe the fixed effects of the companies apart from the fixed effect model. Here, the impact of variations across the firms is controlled by creating a dummy variable for each individual firm to give the pure impact of explanatory variables on the dependent variable. (Torres-Reyna, 2007)

The third model utilized for the regression is a mixed effect model. This model contains the impacts of both fixed effect and random effect models. The coefficients and their estimates for the mixed effect model are similar to the fixed effect model. The random effects are not directly obtained in the mixed models, but are compiled in the form of variances and covariance. (StataCorp, 2013)

The random effects model is based on the assumption that unlike in fixed effect models, the variations across the companies is supposed to be random and uncorrelated with the dependent and the explanatory variables as well. Hence, the error term and intercepts are not correlated with the predictor variables (Torres-Reyna, 2007). If there is a reason to believe that the difference across the firms is having some sort of impact on the variables, then it is conducive to have random effects model (Torres-Reyna, 2007). In short, unlike fixed effects where the impact on the dependent variable within the individual company is observed, in a random effect model the impact on the dependent variable from the variation across all the selected companies and even time invariant factors are observed. (Torres-Reyna, 2007)

Equation (1) gets slightly modified for random effects model as below:

$TI_{(\text{firm } i,\ \text{year } t)} = a + B_1\ Year_t + B_2\ GrossMargin_{(i,\ t)} + B_3\ CaIn_{(i,\ t)} + B_4\ SG_{(i,\ t)} + B_5\ Trevenue_{(i,\ t)} + E_2 + E_3 \rightarrow (5)$

Here, the only difference is in the error terms. E_2 denotes the between entities error and E_3 denotes the within entity error terms (Torres-Reyna, 2007).

On similar basis, Equations (2), (3) and (4) are modified as below for random effects model.

$TIRM_{(\text{firm } i,\ \text{year } t)} = x + C_1\ Year_t + E_{21} + E_{31} \rightarrow (6)$

$TIWIP_{(\text{firm } i,\ \text{year } t)} = y + C_2\ Year_t + E_{22} + E_{32} \rightarrow (7)$

$TIFG_{(\text{firm } i,\ \text{year } t)} = z + C_3\ Year_t + E_{23} + E_{33} \rightarrow (8)$

E_{21}, E_{22} and E_{23} are between entities error terms and E_{31}, E_{32} and E_{33} are within entity error terms for their respective equations.

4.2.3 Model selection

For the purpose of the selection of models, the Hausman test and testparm command were run for the fixed effect models. In addition, the Breusch-Pagan Lagrange multiplier test was run to ascertain whether there are significant differences across the companies to use random effect model. Finally, tests were also performed to check for heteroscedasticity and serial correlation as well. (Torres-Reyna, 2007)

Table 5 presents the results of these various tests done for the inventory turnover defined for the net inventory of the firms in the dataset.

Test	Null hypothesis	TI
Hausman Test	H0 – random effect is better	Prob>chi2 = 0.0000
Testparm command	H0 – Years dummies are equal to zero	Prob > F = 0.0000
Breusch-Pagan Lagrange multiplier Test	H0 – No significant differences across companies	Prob > chibar2 = 0.0000
Modified Wald test	H0 – no heteroscedasticity	Prob>chi2 = 0.0000
Lagrange multiplier test for Serial Correlation	H0 – no first order correlation	Prob > F = 0.0000

Table 5 – Diagnostic tests for inventory turnover (Net inventory)

The Hausman test is conducted to determine whether the errors terms are correlated with the regressors (Torres-Reyna, 2007). The p-value of the test for Inventory turnover (TI) is 0.0000 which is below the 5% threshold. This indicates that the error terms and the regressors are co-related. Hence, it is better to use a fixed effect model. Further, using another diagnostic test called testparm command, the result shows that the p-value for TI is about 0.0000 which is significant. This rejects the null hypothesis that the year dummies are all equal to zero. This also indicates that a fixed effects model can be used for TI (Torres-Reyna, 2007).

The Breusch-Pagan Lagrange multiplier test is used to determine the presence of panel effects, i.e. the existence of significant variation among the companies (Torres-Reyna, 2007).

The p-value for TI is equivalent to zero implying that the across firms' variations are significant. Hence, a random effect model can be used. The modified Wald test is used to ascertain the presence of heteroscedasticity, which means the variance terms are not constant (Torres-Reyna, 2007). The presence of heteroscedasticity can lead to a bias in the error terms (Williams, 2015). From Table 5, the presence of heteroscedasticity can be concluded for the tests involving TI as dependent variable. The 'robust' option in STATA can be used to control for the impact of heteroscedasticity in the regressions (Torres-Reyna, 2007).

The Lagrange multiplier test for serial correlation checks for serial correlation in the panel data as its presence can cause error terms to be smaller than actual and increase the value of R-squared (Torres-Reyna, 2007). The robust option in STATA can be used to control the impact of serial correlation in the models.[9] Here, the test for inventory turnover for net inventory and other predictor variables shows a p-value of less than 5%, indicating an absence of serial correlation among the variables in the dataset.

On similar lines, Table 6 summarizes the results of the above tests for the inventory turnover defined for all the three classifications of inventory.

[9] http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter4/statareg4.htm

Test	Null hypothesis	TIFG	TIWIP	TIRM
Hausman Test	H0 – random effect is better	Prob>chi2 = 0.8665	Prob>chi2 = 0.1487	Prob>chi2 = 0.5630
Testparm command	H0 -Years dummies are equal to zero	Prob > F = 0.8700	Prob > F = 0.0000	Prob > F = 0.0009
Breusch-Pagan Lagrange multiplier Test	H0 – No significant differences across companies	Prob > chibar2 = 0.0000	Prob > chibar2 = 0.0000	Prob > chibar2 = 0.0000
Modified Wald test	H0 – No heteroscedasticity	Prob>chi2 = 0.0000	Prob>chi2 = 0.0000	Prob>chi2 = 0.0000
Lagrange multiplier test for Serial Correlation	H0 – No first order correlation	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000

Table 6 – Diagnostic tests for the three inventory categories

From the above results, it can be concluded that all the dependent variables of all the three inventory categories fail in the Hausman test. However, the results of the testparm command indicate a presence of fixed effects for TIWIP and TIRM. However, TIFG fails for the testparm and Hausman test. The outcome of the Breusch-Pagan Lagrange multiplier test for all the three categories points towards a presence of significant variation among the firms. Thus favoring a random effects model. The modified Wald test for all the three inventory categories confirms the presence of heteroscedasticity. Finally, the Lagrange multiplier test confirms a lack of serial correlation for raw materials, finished goods and work-in-progress inventories.

The Hausman test rejects fixed effect models but the testparm command suggests fixed effect for most of the dependent variables. The Breusch-Pagan Lagrange multiplier also test supports random effect for all the dependent variables. The selection of models could be a tricky question and a very subjective issue as per Chen et al. (2005). Therefore, it was preferred to run regressions for all the models and compare their results for net inventory and the other three inventory categories.

The results of all the four models for TI, TIFG, TIRM and TIWIP are presented in the next section. A point to be noted here is that by default, STATA ignores the missing values and computes the regression tests from the available observations.[10]

[10] http://www.ats.ucla.edu/stat/stata/modules/missing.html

5 Results

5.1 Results for net inventory

Table 7 provides the results for the tests run for inventory turnover (TI) of net inventory for all the four models. The Global F-test of all the four models is less than 0.00001. Hence, all the models are statistically significant. The R-squared for the fixed effect and least square dummy models is 0.7649. Hence, these models explain about 76.5% of the variability in the response variable due to the explanatory variables. The multi-level models, like the mixed effect model and the random effect model have a hierarchical grouping of the entities which results in the residuals at each hierarchical level to have a different variance (Gelman el al., 2006). This implies that each hierarchical level having its own R-squared (Gelman el al., 2006). Hence, the R-squared for multi-level models is generally not used for evaluating these models (Nakagawa et al., 2013). Chen et al. (2005) employed fixed effect, mixed effect and random effect models for their data analysis and do not mention or utilize the R-squared value in case of the mixed effect and random effect models. Hence, following Chen et al. (2005) in the current study as well, the R-squared value is utilized for fixed effect model and least square dummy model only.

(TI) Inventory turnover – Net inventory				
Terms	Fixed Effect	Random Effect	LSDM	Mixed effect
Global F – test	0.0000	0.0000	0.0000	0.0000
R-squared	0.7649		0.7649	
Year	0.0042787 ** (0.003)	.0037091 ** (0.009)	0.0042787 ** (0.003)	0.0037707 ** (0.008)
GrossMargin	-0.0150924 ** (0.000)	-.0149517 ** (0.000)	-0.0150924 ** (0.000)	-0.014966 ** (0.000)
Trevenue (Firm size)	0.000000003 (0.184)	0.000000004 * (0.069)	0.000000003 (0.184)	0.000000004 * (0.076)
CaIn (Capital intensity)	-0.0963592 (0.162)	0.0854591 (0.190)	-0.0963592 (0.162)	0.0652729 (0.322)
SGs (Sales Growth)	0.0687902 ** (0.000)	0.068422 ** (0.000)	0.0687902 ** (0.000)	0.0684661** (0.000)

**Significant at 5%; *Significant at 10%

Table 7 – Results for net inventory turnover

From Table 7, it is clear that the variables Year, GrossMargin and SG are statistically significant for all the models. The variable Trevenue is statistically significant for the random effect and mixed effect models. The coefficient of the variable Year is significant at 5% for all the four models. The correlation between Year and inventory turnover (TI) for net inventory is positive and significant. This proves the first part of the Hypothesis 1. Based on the fixed effect and least square dummy model, it can be said that for every increase of one year in the variable

Year, the value of Inventory turnover increases by 0.43%. The mixed effect model states that for every unit increase in Year, the value of TI increases by 0.38%. Finally, as per the results of the random effect model, it can be said that the average effect of Year on TI is about 0.37% increase when Year changes across the companies.

The variable GrossMargin is also significant at 5% for all the models. GrossMargin is negatively correlated with inventory turnover in all the models. This supports Hypothesis 2 of the study. Based on the results of the fixed effect model and least square dummy model, it can be said that for every unit increase in gross margin, the TI decreases by 1.5%. The mixed effect model indicates that for a unit increase in gross margin, the corresponding decline in IT is 1.4%. Finally, the results of the random effect model indicate that the average effect of gross margin on TI is about 1.4% decrease when the gross margin changes across the companies and time.

The variable SG (sales growth) is also statistically significant at 5% for all the models. SG is positively correlated with inventory turnover in all the models. This supports Hypothesis 5 of the study. All the four models point towards an increase of about 7% in the value of TI for every unit increase in SG. The variable Trevenue is significant at 10% for random effect and mixed effect models only. Trevenue is positively correlated with TI supporting Hypothesis 4 of the current study. However, the impact of Trevenue though positive is negligible on TI. Both, random effect and mixed effect models suggest that every unit increase in Trevenue leads to an increase of less than 0.0001% in the value of TI. The coefficients of capital intensity (CaIn) is not statistically significant in any of the models. Therefore, nothing can be said about the correlation between TI and CaIn.

5.2 Results for Inventory categories

The tests were run for all the three types of inventory categories with statistically significant results only for work-in-progress inventory. None of the four models were significant for finished goods and raw materials inventory. Hence, no conclusion can be drawn about the correlation of their respective inventory turnovers and Year. The results for the time trend of the work-in-progress inventory is provided in Table 8.

Work in progress – Inventory turnover (TIWIP)				
Terms	Fixed Effect	Random Effect	LSDM	Mixed effect
Global F – test	0.0000	0.0000	0.0000	0.0000
R-squared	0.7023		0.7023	
Year	0.0332327 ** (0.000)	0.0324303 ** (0.000)	0.0332327 ** (0.000)	.0324012 ** (0.000)

**Significant at 5%

Table 8 – Results for work-in-progress inventory

Here, all the models are globally significant as indicated by their respective Global F-test value. The inventory turnover (TIWIP) for work-in-progress inventory is positively correlated with time proving the second part of Hypothesis 1. The fixed effect model and least square dummy model explain about 70.23% of the variability in TIWIP due to Year. This is comparable to the R-squared of the fixed effects and least square dummy models for the net inventory. As per the results of these models for TIWIP, an increase of one year in Year leads to an increase of 3.3% in the value of TIWIP. The mixed effect model suggests an increase of about 3.2% in TIWIP for every unit increase in Year. The random effect model also points towards an average impact of Year on TIWIP to be about an increase of 3.2% when Year changes across the companies.

5.3 Discussion

Based on the above results, it can be concluded that the inventory turnover for net inventory and work-in-progress inventory has been increasing with time across companies. Since inventory is inversely proportional to the inventory turnover, the results indicate that the relative inventory levels for the net inventory and work-in-progress inventory of the Canadian companies measured in terms of inventory turnover, have been declining over the period from 1987 to 2016. This answers the main question of this thesis – what was happening to the inventory trends among the Canadian firms?

This is in line with the findings of Rajagopalan et al. (2001), Boute et al. (2003), Obermaier (2012), Shan et al. (2013) and Vergin (1998) who all point towards a decline in the inventory levels for the firms in the countries of their respective study. Table 9 presents a comparison of the results of some of the published studies with their R-squared and inventory trends.

Paper	Study Period	R squared	Number of firms	Time trend - inventory
Gaur et al. (2005)	1987 – 2000	62.8% - 66.7%	311	Increase
Chen et al. (2005)	1981 – 2000	80% – 86%	7433	Decline
Shan et al. (2013)	2002 – 2009	42.9% – 76.7%	1286	Decline
Johnston (2014)	1982 – 2012	20.14% - 33.89%	126	No long-term trend
Dehning et al. (2007)	1994 – 2000	13.5 – 17.3%	123	Decline
Huson and Nanda (1995)	1980 – 1990	18.44%	55	Decline
Obermaier (2012)	1971 – 2005	67.46%	Sector level data	Decline
Vs				
Current study	1987 – 2016	76.49%	420	Decline

Table 9 – Comparison with previous studies

From the above Table 9, it can be deduced that the R-squared of the current study is equal or greater than the R-squared of most of the published articles mentioned in the table. Only Chen et al. (2005) have an R-squared slightly greater than the current study. This shows that the results of the current study explain a good amount of the variation in the inventories comparable to most of the other studies. Also, Chen et al. (2005), Obermaier (2012), Shan et al. (2003), Huson and Nanda (1995) and Dehning et al. (2007) all point towards a decline in total net inventory as measured by inventory turnover or inventory days or inventory to sales ratios, which is in sync with the results found in the current analysis. Only Gaur et al. (2005) and Johnston (2014) indicate a deterioration or no trend in inventory levels.

On comparing the total number of firms considered in the studies mentioned in Table 9, only Chen et al. (2005) and Shan et al. (2003) have a higher number of firms compared to the current study. One reason is that Chen et al. (2005) and Shan et al. (2003) studied the firms in the U.S. and China, which are comparatively bigger economies than Canada. In addition to this, initially in the current study there were 2,523 publicly listed Canadian firms. But only 420 firms were found to have the required information about net inventory necessary for performing the time series analysis. Most of the Canadian firms did not report the total net inventory in their respectively balance sheet and income statement. Even with these limitations, the current study still has more firms than more than half of the papers investigated in the literature review section. Hence, based on a good R-squared value of about 76.49% and with 420 firms from across 10 sectors it could be stated that the study is a good representation of the Canadian firms and the results are significant. This gives a good idea about their inventory trend.

Moving further, in terms of inventory categories, the results point towards a decline in the work-in-progress inventory for the Canadian companies. No statistically significant results could be obtained for the raw materials and finished goods inventory of the Canadian firms. Rajagopalan et al. (2001), Boute et al. (2003), Fullerton et al. (2001) and Chen et al. (2005) found a decline in work-in-progress and raw materials inventory and no trend in finished goods inventory. Obermaier (2012) and Cheng et al. (2012) point towards a decline in raw materials and finished goods inventory. Obermaier (2012) finds an increase in work in progress inventory whereas Cheng et al. (2012) finds no trend at all for the same.

Apart from time trends for the inventory, the current study also finds a negative correlation between gross margin and inventory turnover (TI) of the net inventory. This supports that managers do have a trade-off to make between gross margin and inventory turns. A higher gross margin of the products is associated with lower inventory turns compared to the products with a lower gross margin (Gaur et al., 2005). This is in line with the results of Gaur et al. (2005), Shan et al. (2003), Johnston (2014) and Kolias et al. (2011). All of them confirm a negative correlation between the inventory turnover and the gross margin of a product.

Further, the results of the current analysis of this thesis point towards a negative correlation between sales growth and relative inventory levels measured in terms of inventory turnover. Shan et al. (2003) and Rumyantsev et al. (2007) also confirm a negative correlation between inventory and sales growth. The results of the current study also support a positive correlation between firm size and inventory turnover. This indicates that with an increase in size of firms, the inventory levels decline. Larger size of the firms helps in lowering the inventory through economies of scale. Johnston (2014), Shan et al. (2003) and Rumyantsev et al. (2007) also find a positive correlation between TI and firm size. However, the impact of the firm size, though significant, causes a negligible difference in the value of TI for the Canadian firms. Finally, capital intensity shows a negative correlation with TI in the fixed effect and least square dummy models, but a positive correlation in the random effect and mixed effect models. However, since the correlation is not statistically significant in any of the models, nothing can be confirmed about its correlation with TI. Gaur et al. (2005), Kolias et al. (2011) and Shan et al. (2003) find a positive correlation between capital intensity and TI, whereas Johnston (2014) finds a negative correlation between them. Thus, overall the current study finds a confirmation for Hypotheses 1 2 4 and 5 but no confirmation for the Hypothesis 3.

5.4 Sector-level analysis

In this sub-section, a brief discussion on the sector-level analysis for the selected Canadian firms is provided. The 420 firms selected for the current study belong to the ten sectors as mentioned in Section 4.1.1. Of these ten sectors, only the manufacturing and mining sectors have a sufficient number of firms to perform an individual sector level regression. Other sectors have too few firms, so it would not be feasible to perform panel data analysis for them separately. Hence, it was decided to assemble the firms of these 10 sectors into three groups. Using the three-sector theory by Fisher, all the ten sectors can be differentiated into primary, secondary and tertiary sectors (Schettkat et al., 2003). Companies in the primary sector are related to the extraction of raw materials which includes agriculture and mining sectors. The secondary sector includes manufacturing. The companies in the tertiary sector are those related to services. This group includes retail, warehousing, wholesale, utilities, health care, construction and food and accommodation sectors. Among them, only the manufacturing and mining sectors had a sufficient number of firms to allow an individual analysis. Hence, these two sectors were put in two separate individual groups. The retail, warehousing, wholesale and utilities sectors are more similar in characteristics compared to the rest. As a result, these four sectors are put together. The construction sector somewhat closely relates to mining compared to the other sectors. Consequently, the construction sector is grouped together with the mining sector. The first group contains only the firms of the manufacturing sector. The second group consists of companies belonging to the mining and construction sectors. The third group consisted of the firms from the retail, wholesale, utilities, transportation and warehousing sectors put together.

Three sectors (agriculture and forestry; food and accommodation services; health care and social assistance) were excluded from the sector level analysis as these sectors had fewer than 10 firms in each of them. Due to such a low number of companies in each of these sectors, it was not feasible to run regression tests on them individually or in a group put together. Also, it was not possible to put them in any of the above three groups as the characteristics of these sectors are considerably different from the latter. The sectoral mix of the groups with the total number of the firms in each of them is given in Table 10.

Group Number	Sectors	Total firms
Group 1	Manufacturing	196
Group 2	Mining, Quarrying, Oil and Gas Extraction; Construction	115
Group 3	Retail Trade; Transportation and Warehousing; Utilities; Wholesale	93

Table 10 – Groups for sector level analysis

The graphical representation of average net inventory against time for the three groups and the whole dataset together is given in the Table 18 in the Appendix. One limitation of these graphs is that the earlier years have more missing values compared to the latter. This may impact the average net inventory values, in-turn impacting the graphical presentation of the inventory trends in the respective graphical charts. The regression results for the manufacturing sector are provided in the Table 11. The results of the manufacturing sector are similar to the results of the tests performed for all the sectors together in a single model in the previous sub-section.

Manufacturing sector – inventory turnover (TI)				
Terms	Fixed Effect	Random Effect	LSDM	Mixed effect
Global F – test	0.0000	0.0000	0.0000	0.0000
R-squared	0.7522		0.7522	
Year	0.0123691 ** (0.000)	0.0119299 ** (0.000)	0.0123691 ** (0.000)	0.0119526 ** (0.000)
GrossMargin	-0.009824** (0.000)	-0.0099926 ** (0.000)	-0.009824 ** (0.000)	-0.0099837 ** (0.000)
Trevenue (Firm size)	-0.000000003 (0.320)	-0.000000002 (0.589)	-0.000000003 (0.320)	-0.000000002 (0.572)
CaIn (Capital intensity)	-.0133046 (0.870)	0.0651182 (0.409)	-.0133046 (0.870)	0 .0611246 (0.438)
SG (Sales Growth)	0.1816715 ** (0.000)	0.1845235 ** (0.000)	0.1816715 ** (0.000)	0.1843763 ** (0.000)

**Significant at 5%

Table 11 – Results for the manufacturing sector

The results of the Global F-tests indicate that all the four models are significant. The fixed effect model and the least square dummy models explain about 75.22% of the variability in inventory turnover due to the explanatory variables. Here, Year has a positive correlation with the inventory turnover, which is significant at 5% for all the models. This supports the first hypothesis for the public manufacturing companies in Canada. All the four models indicate that an increase of one year in the Year variable leads to an increase of 1.2% in the value of inventory turnover for manufacturing firms in Canada. This is a bigger increase compared to the increase for the complete sample. The GrossMargin is negatively correlated to the inventory turnover and its coefficient is significant at 5% for all the models. This supports the second hypothesis in case of the manufacturing firms. As per the results of the fixed effect model and the least square dummy model, every unit increase in gross margin leads to a decrease of 0.9% in the value of inventory turnover. The mixed effect and random effect models indicate that the inventory turnover declines by 1% with a unit increase in gross margin. Further, sales growth (SG) is positively correlated with inventory turnover in all the models. The fixed effect and least square dummy models point towards an increase of 19% in the value of TI for a unit increase in SG. The random effect and mixed effect models indicate about 20% increase in the value of TI with every unit increase in SG. The results for the correlation between firm size and capital intensity with inventory turnover is not statistically significant in any of the four models. Thus, overall the results support the Hypotheses 1 2 and 5 in case of the manufacturing companies.

Table 12 provides the results of the panel data regression for the second group of firms belonging to the mining and construction sectors.

Mining and Construction sectors (Group 2) – inventory turnover (TI)				
Terms	Fixed Effect	Random Effect	LSDM	Mixed effect
Global F – test	0.0000	0.0000	0.0000	0.0000
R-squared	0.7644		0.7644	
Year	0.0041168 (0.301)	0.0027587 (0.481)	0.0041168 (0.301)	0.0028249 (0.469)
GrossMargin	-0.0151329 ** (0.000)	-0.0155032 ** (0.000)	-0.0151329** (0.000)	-0.0154844 ** (0.000)
Trevenue (Firm size)	-0.000000002 (0.795)	0.000000005 (0.994)	-0.000000002 (0.795)	-0.000000004 (0.995)
CaIn (Capital intensity)	-0.4575172 ** (0.010)	-0.3998421 ** (0.019)	-0.4575172 ** (0.010)	-0.4025894 ** (0.018)
SG (Sales Growth)	0.0561453 ** (0.000)	0.0551928 ** (0.000)	0.0561453 ** (0.000)	0.0552406 ** (0.000)

**Significant at 5%

Table 12 – Results for mining and construction sectors

The results of the time series regression for Group 2 set of firms belonging to the mining and construction sectors, show that all the four models are statistically significant. The coefficients of the variables GrossMargin, sales growth (SG) and capital intensity (CaIn) are significant. All the models indicate that a unit increase in gross margin would result in 1.5% decrease in TI. Similarly, the results of the four models show an increase of about 5.7% in TI with a unit increase in SG. For capital intensity, all the models point towards a negative correlation between TI and CaIn. This is the opposite of the Hypothesis 3, thus disproving it for the mining and construction sectors. We do not have a clear explanation for this. One possible reason could be that investments in more warehouses lead to a decentralization of the stock which requires a higher level of safety stocks. The fixed effect and least square dummy models point towards a decrease of about 58% in TI for every unit increase in CaIn. Similarly, mixed effect and random effect models point towards a decline of 49% in the value of TI. The coefficients of Year and Trevenue are not significant for this group. Overall, the results of Group 2 support Hypotheses 2 and 5, reject Hypothesis 3, while no conclusion can be drawn for Hypotheses 1 and 4.

Table 13 provides the results for the Group 3 firms belonging to retail, wholesale, utilities and warehousing and transportation sectors.

Retail, Wholesale, Warehousing and Utilities (Group 3) – inventory turnover (TI)				
Terms	Fixed Effect	Random Effect	LSDM	Mixed effect
Global F – test	0.0000	0.0000	0.0000	0.0000
R-squared	0.7807		0.7807	
Year	-0.0048112 * (0.056)	-0.0050919 ** (0.042)	-0.0048112 * (0.056)	-0.0050473 ** (0.042)
GrossMargin	-0.0228157 ** (0.000)	-0.0221317 ** (0.000)	-0.0228157** (0.000)	-0.0223323 ** (0.000)
Trevenue (Firm size)	0.000000013 ** (0.000)	0.000000013 ** (0.000)	0.000000013 ** (0.000)	0.000000013 ** (0.000)
CaIn (Capital intensity)	0.049342 (0.756)	0.5405501** (0.000)	0.049342 (0.756)	0.3786761 ** (0.011)
SG (Sales Growth)	0.1106174 ** (0.008)	0.1216847** (0.004)	0.1106174 ** (0.008)	0.1180169 ** (0.004)

**Significant at 5%; *Significant at 10%

Table 13 – Results for retail, wholesale, utilities and warehousing sectors

For Group 3, all the models are significant globally. The variable Year is significant at a 5% level for the mixed effect and random effect models, and significant at 10% level for the fixed effect and least square dummy models. The variables GrossMargin, Trevenue and SG are significant at 5% level for all the models. The variable CaIn is significant only in the mixed effect and random effect models. Here, Year is negatively correlated with TI disapproving the Hypothesis 1 for Group 3 firms. The fixed effect and least square dummy models indicate a decrease of about 0.48% in TI for every unit increase in Year. The random effect and mixed effect models point towards a decrease of about 0.5% in TI for unit increase in Year. This shows that the relative inventory levels measured in terms of TI have been increasing for the firms belonging to the sectors in Group 3. This is in contrast with the results for the manufacturing sector and the main results for all the firms in a single model.

The GrossMargin is negatively correlated with TI supporting the Hypothesis 2. All the models point towards a decline of about 2.2 to 2.3% in the value of TI for every unit increase in GrossMargin. The variable Trevenue is positively correlated with TI, supporting the Hypothesis 4 for the Group 3 firms. However, the impact of Trevenue on TI is almost negligible in all the four models. SG is positively correlated with TI for Group 3 firms in all the models supporting the Hypothesis 5. The results of the four models indicate an increase of about 11.6 to 12.9% in TI for every unit increase in SG.

Finally, capital intensity (CaIn) is positively correlated to TI in the random effect and mixed effect models supporting Hypothesis 3 of the current study. The coefficients of CaIn in the fixed effect and least square dummy models is not statistically significant. The random effect models states that the average increase in TI is about 71% for every unit increase in CaIn. The mixed effect model points towards an increase of 46% in TI for a unit increase in CaIn. Overall, the results for the Group 3 consisting of firms from retail, wholesale, warehousing and utilities sectors support the Hypotheses 2 3 4 and 5 and disapprove Hypothesis 1.

Comparing the results of all the three groups, it can be said that the relative inventories of manufacturing sector firms have been declining, whereas the relative inventories of the firms in retail, wholesale, utilities and warehousing have been increasing over the current study period.

No conclusion could be drawn for the mining sector firms. Thus, manufacturing firms support Hypothesis 1, while Group 3 firms disapprove it. All the three groups agree on a negative correlation between gross margin and TI supporting Hypothesis 2. Similarly, all the three groups concur on a positive correlation between SG and TI, supporting Hypothesis 5.

Group 3 firms support the Hypothesis 4, stating a positive correlation between the firm size and TI. This is also in line with the main results of section 4.1. Finally, for capital intensity group 2 firms show a negative correlation with TI, rejecting Hypothesis 3; whereas firms in group 3 indicate a positive correlation between CaIn and TI, supporting Hypothesis 3. The manufacturing firms in Group 1 show no significant results for the firm size and capital intensity.

The above results show that the relative inventories, measured in terms of the inventory turnover, have been showing a declining trend for the firms in the Canadian manufacturing sector. This is in consonance with the findings of Rajagopalan et al. (2001), Chen et al. (2005), Obermaier (2012), Robb et al. (2012), Boute et al. (2003), Shah et al. (2007), Huson and Nanda (1995) and Mishra et al. (2013). All these authors confirm a decline in the relative inventory levels for the manufacturing sectors or manufacturing firms in their respective studies. In contrast to the above, the firms belonging to retail and wholesale sectors in Group 3 point towards an increasing trend in their relative inventory levels measured in terms of inventory turnover. Chen et al. (2007) and Irvine (2003) point towards an improvement in the relative inventory levels for the wholesale sector whereas Shah et al. (2007) indicates a deterioration of the same. Irvine (2003) and Boute et al. (2003) point towards a decline in the relative inventory levels for the retail sector, but Shah et al. (2007), Gaur et al. (2005), Johnston (2014), Kolias et al. (2011) conclude a deterioration or no trend in the relative inventory levels for the retail sector.

6 Conclusion

This thesis primarily investigated the time trends for the relative inventory levels in terms of inventory turnover of the net inventory and the three inventory categories, namely raw material, work-in-progress and finished goods inventory, for 420 publicly listed Canadian firms for the period from 1987 to 2016. Additionally, correlations of the gross margin, capital intensity, sales growth and firm size with net inventory were also analyzed. Based on the reported results, it can be concluded that the relative inventory levels of the publicly listed Canadian firms have been declining from 1987 to 2016. The decline has been found for net inventory as well as for work-in-progress inventory. The results help to clarify the question of what happened to inventory trends in the case of Canadian firms. There was a lack of investigation of Canadian firms in particular; in almost all of the academic studies concerning the inventory trends. Performing a time series analysis, the current study indicates a declining trend for Canadian firms. Apart from inventory trends, a significant positive correlation is found between the inventory and the gross margin of the products. Also, the correlation between the firm size and sales growth with inventory is found to be negative. However, no statistically significant results are found for capital intensity.

Additionally, at the sector level analysis, the results confirm a decline in the inventory trends for Canadian firms belonging to the manufacturing sector, but an increase in the inventory levels for Canadian firms belonging to retail, wholesale, warehousing and utilities sectors. No significant result is found for the inventory levels of the firms belonging to mining and construction sectors. The results of all the sectors confirm a positive correlation between the gross margin and the inventory and a negative correlation between sales growth and the inventory. Only firms from the retail, wholesale, warehousing and utilities sectors show a negative correlation between the firm size and the inventory. For capital intensity, the mining and construction sectors show a positive correlation, whereas retail, wholesale, warehousing and utilities sectors show a negative correlation with the inventory.

The biggest limitation of this study is the limited amount of data. A large number of the Canadian firms did not provide inventory data in their respective balance sheets and income statements. Out of the total 2,523 Canadian firms from ten industries, only 420 firms had declared enough inventory to allow panel data analysis. Another 300 firms did have inventory data but had too many missing values for many of the years of the studied period (1987–2016). Despite this limitation, the current study provides statistically significant results answering the research question. Another limitation was that the majority of the Canadian firms in our sample either belonged to manufacturing or mining sectors. Thus, this could result in bias as a larger share of manufacturing and mining industries could impact the outcome of the firms in other industries. Moreover, due to the smaller number of firms in sectors other than manufacturing and mining, it was not feasible to conduct an individual sector level analysis. In addition to the above, it could be interesting if the data about inventory for Canadian firms could be obtained for the period prior to 1987. Lastly, the current research could be further improved by performing firm level analysis by introducing dummy variables for representing the sectors in the current model.

This study provides a base for further analysis of inventory trends for Canadian companies. A time series analysis can be performed along similar lines to the current study on a dataset containing more Canadian firms obtained from another data source other than the Osiris database and having much more complete information. It would be interesting to compare both the results. Another approach could be to perform an aggregate sector level analysis instead of firm level for the Canadian economy to understand inventory trends. Future researchers could also correlate the inventory performance with the financial performance of Canadian firms. In addition to that, researchers could try to analyze the impact of various factors like supplier co-ordination, information technology, globalization etc., on inventory trends not taken into consideration in the current study due to a lack of information. Lastly, it could be interesting to find more firms with required data in the sectors other than the manufacturing sector and analyze their inventory behavior and compare them. This investigation could further be extended to the sub-sector level within a sector provided adequate data is available for such an analysis.

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http://mining.ca/resources/mining-facts

Appendix

Sectors selected for the current study		
No	Sector	Sub-sectors
1	Agriculture, Forestry, Fishing and Hunting	Crop production; Animal production and aquaculture; Forestry and logging; Fishing, hunting and trapping; Support activities for agriculture and forestry.
2	Construction	Construction of buildings; Heavy and civil engineering construction; Specialty trade contractors.
3	Manufacturing	Food manufacturing; Beverage and tobacco product manufacturing; Textile mills; Textile product mills; Apparel manufacturing; Leather and allied product manufacturing; Wood product manufacturing; Paper manufacturing; Printing and related support services; petroleum and coal products manufacturing; Chemical manufacturing; Plastics and rubber products manufacturing; Nonmetallic mineral product manufacturing; primary metal manufacturing; Fabricated metal product manufacturing; Machinery manufacturing; Computer and electronic product manufacturing; Electrical equipment, appliance and component manufacturing; Transportation equipment manufacturing; Furniture and related product manufacturing; Miscellaneous manufacturing.
4	Mining, Quarrying, Oil and Gas exploration	Oil and gas extraction; Mining (except oil and gas); Support activities for mining.
5	Retail Trade	Motor vehicle and parts dealers; Furniture and Home Furnishings Stores; Electronics and Appliance Stores; Building Material and Garden Equipment and Supplies Dealers; Food and Beverage Stores; Health and Personal Care Stores; Gasoline Stations; Clothing and Clothing Accessories Stores; Sporting Goods, Hobby, Musical Instrument, and Book Stores; General Merchandise Stores; Miscellaneous Store Retailers; Nonstore Retailers.
6	Transportation and Warehousing	Air Transportation; Rail Transportation; Water Transportation; Truck Transportation; Transit and Ground Passenger Transportation; Pipeline Transportation; Scenic and Sightseeing Transportation;

		Support Activities for Transportation; Postal Service; Couriers and Messengers; Warehousing and Storage.
7	Health Care and Social Assistance	Ambulatory Health Care Services; Hospitals; Nursing and Residential Care Facilities; Social Assistance.
8	Accommodation and Food Services	Accommodation; Food Services and Drinking Places.
9	Utilities	Utilities.
10	Wholesale Trade	Merchant Wholesalers, Durable Goods; Merchant Wholesalers, Nondurable Goods; Wholesale Electronic Markets and Agents and Brokers.

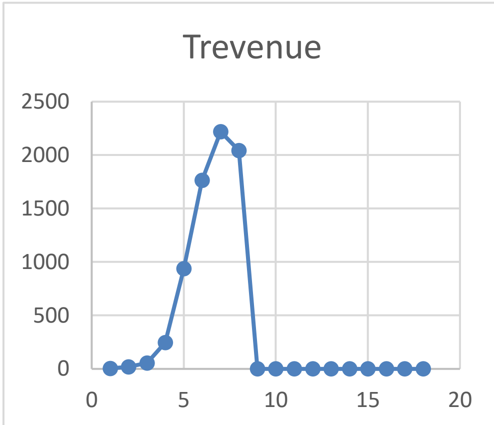
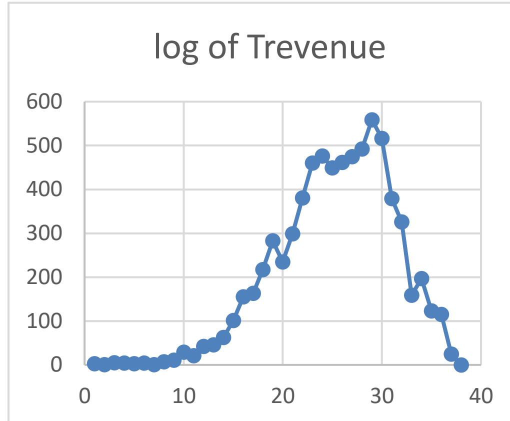
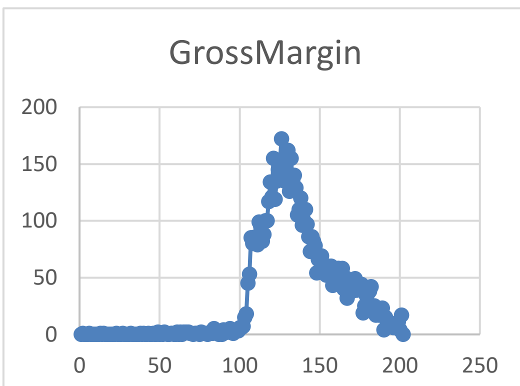
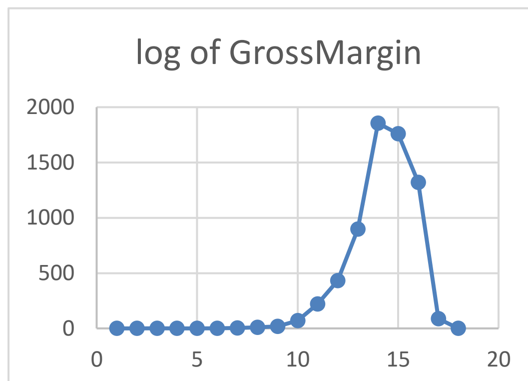
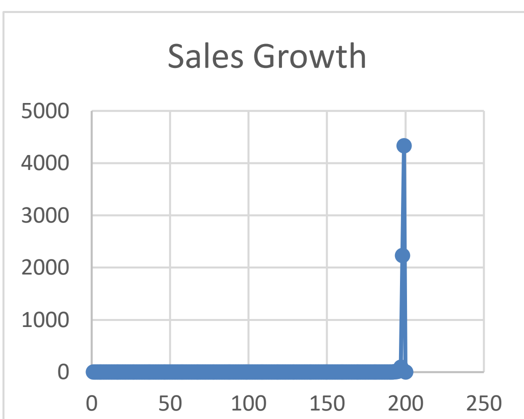
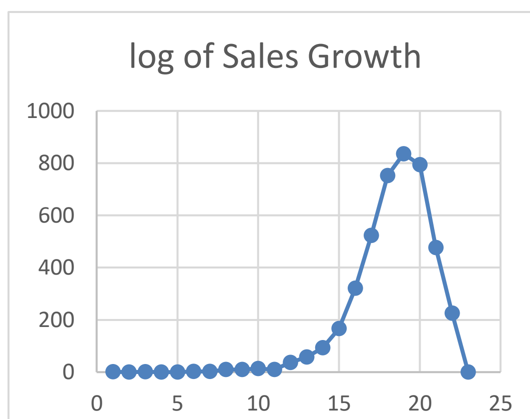
Table 14 – Sectors and sub-sectors included in the current study

Sectors excluded from the current study		
No	Sector	Sub-sectors
1	Information	Publishing Industries (except Internet); Motion Picture and Sound Recording Industries; Broadcasting (except Internet); Telecommunications; Data Processing, Hosting, and Related Services; Other Information Services.
2	Finance and Insurance	Monetary Authorities-Central Bank; Credit Intermediation and Related Activities; Securities, Commodity Contracts, and Other Financial Investments and Related Activities; Insurance Carriers and Related Activities; Funds, Trusts, and Other Financial Vehicles.
3	Real Estate and Rental and Leasing	Real Estate; Rental and Leasing Services; Lessors of Nonfinancial Intangible Assets (except Copyrighted Works).
4	Professional, Scientific, and Technical Services	Professional, Scientific, and Technical Services.
5	Management of Companies and Enterprises	Management of Companies and Enterprises.
6	Administrative and Support and Waste Management and Remediation Services	Administrative and Support Services; Waste Management and Remediation Services.
7	Educational Services	Educational Services.
8	Arts, Entertainment, and Recreation	Performing Arts, Spectator Sports, and Related Industries; Museums, Historical Sites, and Similar Institutions; Amusement, Gambling, and Recreation Industries.
9	Public Administration	Executive, Legislative, and Other General Government Support; Justice, Public Order, and Safety Activities; Administration of Human Resource Programs; Administration of Environmental Quality Programs; Administration of Housing Programs, Urban Planning, and Community Development; Administration of Economic Programs; Space Research and Technology; National Security and International Affairs.

Table 15 – Sectors and sub-sectors excluded in the current study

No	Variables	No. Of observations	Mean	Standard deviation	Skewness	Kurtosis
1	Inventory turnover	6,682	23.78	326.76	38.43	1,681.03
2	Gross Margin	6,872	35.64	22.92	0.28	3.90
3	Trevenue	7,292	1,993,521	5,424,094	4.64	27.51
4	Sales growth (SG)	6,723	-0.90	4.03	-43.12	2,093.39
5	Capital intensity (CaIn)	7,422	0.58	0.24	-0.42	2.23

Table 16 – Summary of the variables

<table>
<tr><th>Variables</th><th>Unlogged histogram</th><th>Natural log histogram</th></tr>
<tr><td>Trevenue</td><td>
</td><td>
</td></tr>
<tr><td>Gross Margin</td><td>
</td><td>
</td></tr>
<tr><td>Sales growth (SG)</td><td>
</td><td>
</td></tr>
<tr><td>Capital</td><td></td><td></td></tr>
</table>

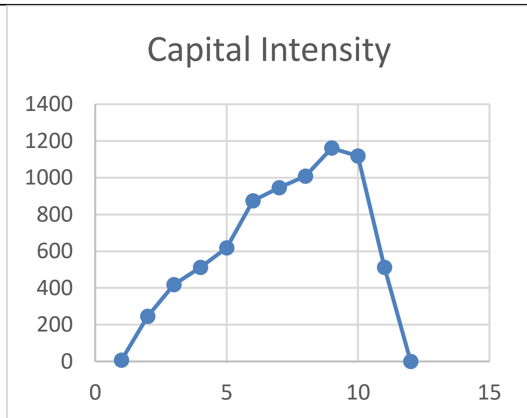
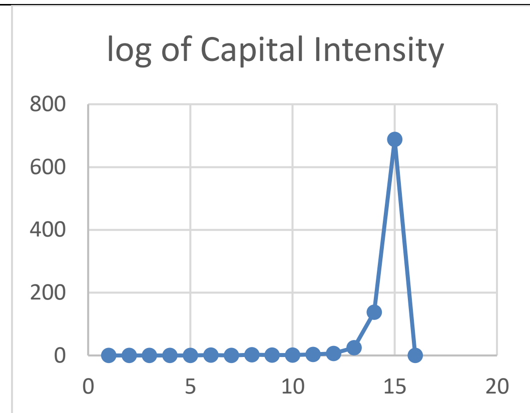
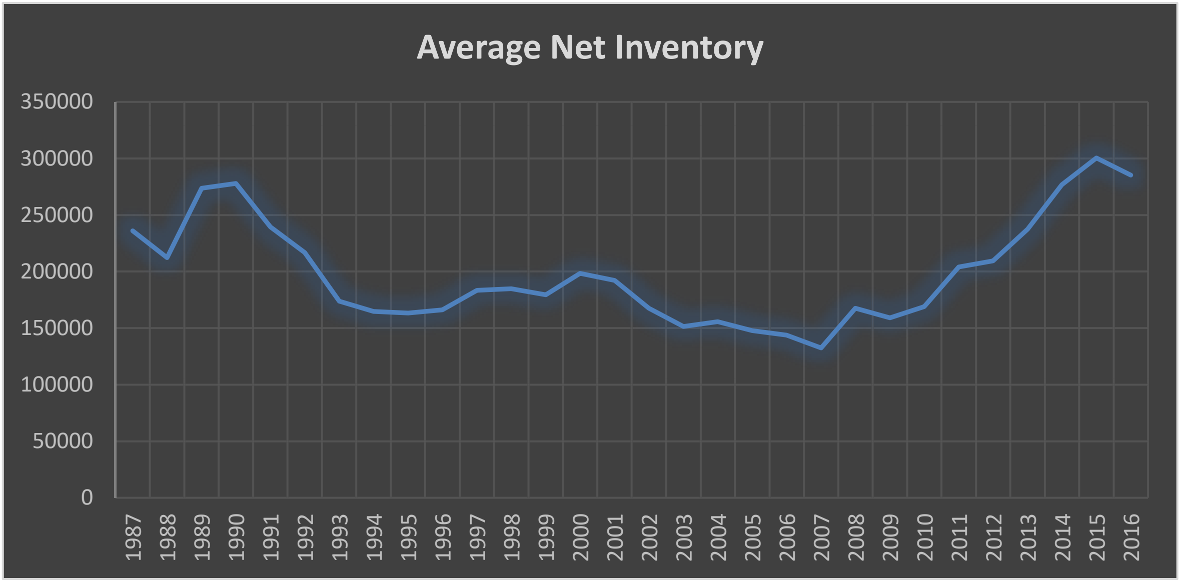
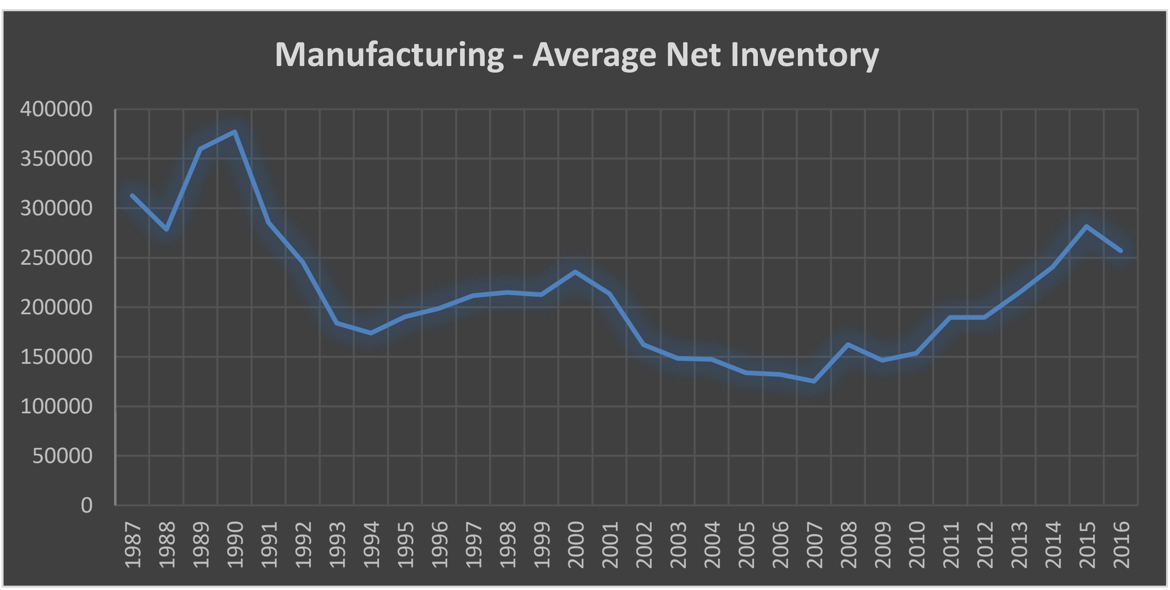
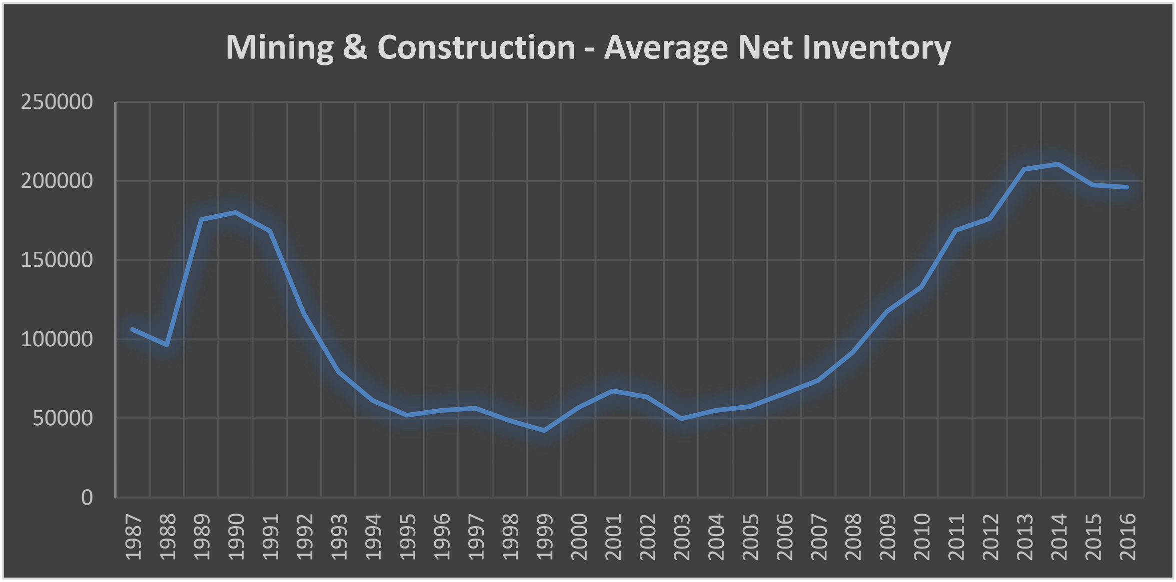
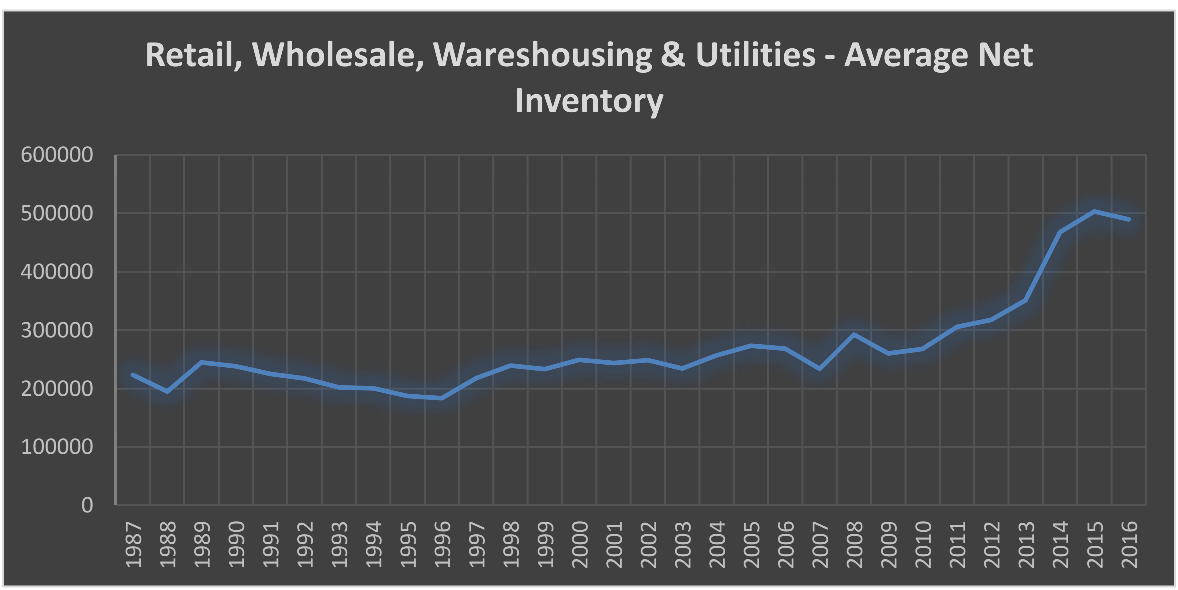
Intensity (CaIn)		

Table 17 – Histogram of explanatory variables

No.	Graphs
1	 Average net inventory (all sectors)
2	 Average net inventory – Manufacturing sector

<table>
<tr><td>3</td><td>


Average net inventory – Mining and construction sectors
</td></tr>
<tr><td>4</td><td>


Average net inventory – Retail, wholesale, warehousing and utilities sectors
</td></tr>
</table>

Table 18 – Graphical presentation of the average net inventory

STATA outputs for net inventory

Fixed effect model

```
. areg logTI Year SG GrossMargin Trevenue CaIn, absorb( ID)

Linear regression, absorbing indicators          Number of obs   =       6239
                                                 F(   5,   5821) =     189.10
                                                 Prob > F        =     0.0000
                                                 R-squared       =     0.7649
                                                 Adj R-squared   =     0.7480
                                                 Root MSE        =     0.5682

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0042787   .0014347     2.98   0.003     .0014662    .0070911
          SG |   .0687902   .0051213    13.43   0.000     .0587505    .0788299
GrossMargin_ |  -.0150924   .0005546   -27.21   0.000    -.0161796   -.0140051
   Trevenue_ |   3.35e-09   2.52e-09     1.33   0.184    -1.59e-09    8.28e-09
        CaIn |  -.0963592   .0689153    -1.40   0.162    -.2314588    .0387404
       _cons |  -6.208658   2.873496    -2.16   0.031    -11.84178    -.575539
-------------+----------------------------------------------------------------
          ID |      F(412, 5821) =     36.470   0.000          (413 categories)
```

Random Effect model

```
. xtreg logTI Year SG GrossMargin Trevenue CaIn, re

Random-effects GLS regression                   Number of obs      =      6239
Group variable: ID                              Number of groups   =       413

R-sq:  within  = 0.1387                         Obs per group: min =         1
       between = 0.0615                                        avg =      15.1
       overall = 0.0820                                        max =        29

                                                Wald chi2(5)       =    958.86
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0037091   .0014233     2.61   0.009     .0009194    .0064988
          SG |    .068422   .0051275    13.34   0.000     .0583723    .0784716
GrossMargin_ |  -.0149517   .0005444   -27.47   0.000    -.0160186   -.0138848
   Trevenue_ |   4.48e-09   2.47e-09     1.82   0.069    -3.48e-10    9.32e-09
        CaIn |   .0854591   .0657804     1.30   0.194    -.0434681    .2143863
       _cons |  -5.177545   2.854297    -1.81   0.070    -10.77186    .4167742
-------------+----------------------------------------------------------------
     sigma_u |  .91751095
     sigma_e |  .56815521
         rho |  .72282934   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Least square dummy model

```
      Source |       SS       df       MS              Number of obs =    6239
-------------+------------------------------           F(417,  5821) =   45.41
       Model |  6112.56995   417  14.6584411           Prob > F      =  0.0000
    Residual |  1879.02083  5821  .322800348           R-squared     =  0.7649
-------------+------------------------------           Adj R-squared =  0.7480
       Total |  7991.59078  6238  1.28111426           Root MSE      =  .56816

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0042787   .0014347     2.98   0.003     .0014662    .0070911
        CaIn |  -.0963592   .0689153    -1.40   0.162    -.2314588    .0387404
GrossMargin_ |  -.0150924   .0005546   -27.21   0.000    -.0161796   -.0140051
   Trevenue_ |   3.35e-09   2.52e-09     1.33   0.184    -1.59e-09    8.28e-09
          SG |   .0687902   .0051213    13.43   0.000     .0587505    .0788299
      _IID_2 |   .7318968   .1555063     4.71   0.000     .4270467    1.036747
      _IID_3 |    .347496   .1789927     1.94   0.052    -.0033963    .6983882
```

Mixed effect model

```
. xtmixed logTI Year SG GrossMargin Trevenue CaIn || ID: , var

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -6097.6077
Iteration 1:   log likelihood = -6097.6077

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =      6239
Group variable: ID                              Number of groups   =       413

                                                Obs per group: min =         1
                                                               avg =      15.1
                                                               max =        29


                                                Wald chi2(5)       =    964.97
Log likelihood = -6097.6077                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0037707   .0014183     2.66   0.008     .0009908    .0065506
          SG |   .0684661    .005104    13.41   0.000     .0584624    .0784698
GrossMargin_ |   -.014966   .0005432   -27.55   0.000    -.0160306   -.0139015
   Trevenue_ |   4.36e-09   2.46e-09     1.77   0.076    -4.64e-10    9.18e-09
        CaIn |   .0652729   .0658442     0.99   0.322    -.0637793    .1943252
       _cons |  -5.289097   2.844304    -1.86   0.063    -10.86383    .2856362
------------------------------------------------------------------------------
```

STATA outputs for work-in-progress inventory

Fixed effect model

```
. areg logTIWIP Year, absorb( ID)

Linear regression, absorbing indicators          Number of obs   =       2716
                                                 F(   1,   2444) =     102.93
                                                 Prob > F        =     0.0000
                                                 R-squared       =     0.7023
                                                 Adj R-squared   =     0.6693
                                                 Root MSE        =     0.8470

------------------------------------------------------------------------------
    logTIWIP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0332327   .0032756    10.15   0.000     .0268094     .039656
       _cons |  -63.45728    6.57535    -9.65   0.000    -76.35111   -50.56344
-------------+----------------------------------------------------------------
          ID |      F(270, 2444) =     20.967   0.000          (271 categories)
```

Random Effect model

```
. xtreg logTIWIP Year, re

Random-effects GLS regression                   Number of obs      =      2716
Group variable: ID                              Number of groups   =       271

R-sq:  within  = 0.0404                         Obs per group: min =         1
       between = 0.0001                                        avg =      10.0
       overall = 0.0126                                        max =        29

                                                Wald chi2(1)       =    100.92
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
    logTIWIP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0324303   .0032281    10.05   0.000     .0261032    .0387573
       _cons |  -61.74432   6.483427    -9.52   0.000     -74.4516   -49.03703
-------------+----------------------------------------------------------------
     sigma_u |  1.3337535
     sigma_e |  .84699038
         rho |  .71261656   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Least square dummy model

```
      Source |       SS       df       MS              Number of obs =    2716
-------------+------------------------------           F(271,  2444) =   21.27
       Model |  4135.63626   271  15.2606504           Prob > F      =  0.0000
    Residual |  1753.30778  2444  .717392711           R-squared     =  0.7023
-------------+------------------------------           Adj R-squared =  0.6693
       Total |  5888.94405  2715  2.16904017           Root MSE      =  .84699

------------------------------------------------------------------------------
    logTIWIP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0332327   .0032756    10.15   0.000     .0268094     .039656
```

Mixed effect model

```
. xtmixed logTIWIP Year || ID: , var

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -3803.3631
Iteration 1:   log likelihood = -3803.3631

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =      2716
Group variable: ID                              Number of groups   =       271

                                                Obs per group: min =         1
                                                               avg =      10.0
                                                               max =        29


                                                Wald chi2(1)       =    100.54
Log likelihood = -3803.3631                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
     logTIWIP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0324012   .0032313    10.03   0.000     .0260679    .0387345
       _cons |  -61.68649   6.489794    -9.51   0.000    -74.40626   -48.96673
------------------------------------------------------------------------------
```

Stata outputs for manufacturing sector

Fixed effect model

```
. areg logTI Year SG GrossMargin Trevenue CaIn, absorb( ID)

Linear regression, absorbing indicators          Number of obs   =       2958
                                                  F(   5,   2759) =      66.40
                                                  Prob > F        =     0.0000
                                                  R-squared       =     0.7522
                                                  Adj R-squared   =     0.7344
                                                  Root MSE        =     0.5174

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0123691   .0018805     6.58   0.000     .0086817    .0160565
          SG |   .1816715   .0150303    12.09   0.000     .1521997    .2111434
GrossMargin_ |   -.009824   .0007981   -12.31   0.000    -.0113889   -.0082591
   Trevenue_ |  -3.70e-09   3.71e-09    -1.00   0.320    -1.10e-08    3.59e-09
        CaIn |  -.0133046   .0812063    -0.16   0.870    -.1725359    .1459266
       _cons |  -22.92879   3.772965    -6.08   0.000    -30.32691   -15.53067
-------------+----------------------------------------------------------------
          ID |       F(193, 2759) =     35.347   0.000          (194 categories)
```

Random effect model

```
. xtreg logTI Year SG GrossMargin Trevenue CaIn, re

Random-effects GLS regression                   Number of obs      =      2958
Group variable: ID                              Number of groups   =       194

R-sq:  within  = 0.1070                         Obs per group: min =         1
       between = 0.0895                                        avg =      15.2
       overall = 0.0945                                        max =        29

                                                Wald chi2(5)       =    346.80
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0119299   .0018688     6.38   0.000     .0082671    .0155927
          SG |   .1845235   .0150048    12.30   0.000     .1551147    .2139323
GrossMargin_ |  -.0099926   .0007799   -12.81   0.000    -.0115211   -.0084641
   Trevenue_ |  -1.97e-09   3.64e-09    -0.54   0.589    -9.10e-09    5.17e-09
        CaIn |   .0651182   .0788514     0.83   0.409    -.0894277    .2196642
       _cons |  -22.10639   3.752746    -5.89   0.000    -29.46163   -14.75114
-------------+----------------------------------------------------------------
     sigma_u |  .83784611
     sigma_e |  .51739537
         rho |  .72393279   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Least square dummy model

```
      Source |       SS       df       MS              Number of obs =    2958
-------------+------------------------------           F(198,  2759) =   42.30
       Model |  2242.3276   198  11.3248869            Prob > F      =  0.0000
    Residual |  738.57871  2759  .267697974            R-squared     =  0.7522
-------------+------------------------------           Adj R-squared =  0.7344
       Total | 2980.90631  2957  1.00808465            Root MSE      =   .5174

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0123691   .0018805     6.58   0.000     .0086817    .0160565
        CaIn |  -.0133046   .0812063    -0.16   0.870    -.1725359    .1459266
GrossMargin_ |   -.009824   .0007981   -12.31   0.000    -.0113889   -.0082591
   Trevenue_ |  -3.70e-09   3.71e-09    -1.00   0.320    -1.10e-08    3.59e-09
          SG |   .1816715   .0150303    12.09   0.000     .1521997    .2111434
       _IID_2 |   .0664722   .1391179     0.48   0.633    -.2063136     .339258
```

Mixed effect model

```
. xtmixed logTI Year SG GrossMargin Trevenue CaIn || ID: , var

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -2603.9227
Iteration 1:   log likelihood = -2603.9227

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =      2958
Group variable: ID                              Number of groups   =       194

                                                Obs per group: min =         1
                                                               avg =      15.2
                                                               max =        29


                                                Wald chi2(5)       =    347.86
Log likelihood = -2603.9227                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0119526   .0018642     6.41   0.000     .0082989    .0156064
          SG |   .1843763   .0149643    12.32   0.000     .1550469    .2137057
GrossMargin_ |  -.0099837   .0007787   -12.82   0.000    -.0115098   -.0084575
   Trevenue_ |  -2.06e-09   3.63e-09    -0.57   0.572    -9.18e-09    5.07e-09
        CaIn |   .0611246   .0787544     0.78   0.438    -.0932312    .2154804
       _cons |  -22.15044   3.743546    -5.92   0.000    -29.48766   -14.81323
------------------------------------------------------------------------------
```

STATA outputs for mining and construction sectors

Fixed effect model

```
. areg logTI Year SG GrossMargin Trevenue CaIn, absorb( ID)

Linear regression, absorbing indicators         Number of obs   =       1465
                                                F(   5,   1348) =      55.49
                                                Prob > F        =     0.0000
                                                R-squared       =     0.7644
                                                Adj R-squared   =     0.7441
                                                Root MSE        =     0.6557

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0041168   .0039802     1.03   0.301    -.0036911    .0119248
          SG |   .0561453   .0062709     8.95   0.000     .0438435    .0684471
GrossMargin_ |  -.0151329   .0011067   -13.67   0.000    -.0173039    -.012962
   Trevenue_ |  -1.91e-09   7.35e-09    -0.26   0.795    -1.63e-08    1.25e-08
        CaIn |  -.4575172   .1764482    -2.59   0.010    -.8036601   -.1113744
       _cons |  -5.364835   7.953919    -0.67   0.500    -20.96824    10.23857
-------------+----------------------------------------------------------------
          ID |      F(111, 1348) =     31.975   0.000          (112 categories)
```

Random effect model

```
. xtreg logTI Year SG GrossMargin Trevenue CaIn, re

Random-effects GLS regression                   Number of obs      =      1465
Group variable: ID                              Number of groups   =       112

R-sq:  within  = 0.1705                         Obs per group: min =         5
       between = 0.1226                                        avg =      13.1
       overall = 0.1296                                        max =        29

                                                Wald chi2(5)       =    290.66
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0027587   .0039127     0.71   0.481    -.0049102    .0104275
          SG |   .0551928   .0062582     8.82   0.000     .0429269    .0674588
GrossMargin_ |  -.0155032   .0010883   -14.25   0.000    -.0176362   -.0133702
   Trevenue_ |   5.46e-11   7.14e-09     0.01   0.994    -1.39e-08    1.41e-08
        CaIn |  -.3998421   .1702812    -2.35   0.019    -.7335872    -.066097
       _cons |  -2.705695    7.82911    -0.35   0.730    -18.05047    12.63908
-------------+----------------------------------------------------------------
     sigma_u |  1.0029398
     sigma_e |  .65566659
         rho |  .70058324   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Least square dummy model

```
      Source |       SS       df       MS              Number of obs =    1465
-------------+------------------------------           F(116,  1348) =   37.70
       Model |  1879.92328   116  16.2062352           Prob > F      =  0.0000
    Residual |  579.503411  1348  .429898673           R-squared     =  0.7644
-------------+------------------------------           Adj R-squared =  0.7441
       Total |   2459.4267  1464  1.67993627           Root MSE      =  .65567

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0041168   .0039802     1.03   0.301    -.0036911    .0119248
        CaIn |  -.4575172   .1764482    -2.59   0.010    -.8036601   -.1113744
GrossMargin_ |  -.0151329   .0011067   -13.67   0.000    -.0173039    -.012962
   Trevenue_ |  -1.91e-09   7.35e-09    -0.26   0.795    -1.63e-08    1.25e-08
          SG |   .0561453   .0062709     8.95   0.000     .0438435    .0684471
      _IID_2 |   .7183709   .1813087     3.96   0.000      .362693    1.074049
```

Mixed effect model

```
. xtmixed logTI Year SG GrossMargin Trevenue CaIn || ID: , var

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -1649.3492
Iteration 1:   log likelihood = -1649.3492

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =      1465
Group variable: ID                              Number of groups   =       112

                                                Obs per group: min =         5
                                                               avg =      13.1
                                                               max =        29


                                                Wald chi2(5)       =    292.30
Log likelihood = -1649.3492                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |   .0028249   .0039004     0.72   0.469    -.0048197    .0104694
          SG |   .0552406   .0062338     8.86   0.000     .0430225    .0674587
GrossMargin_ |  -.0154844   .0010848   -14.27   0.000    -.0176106   -.0133582
   Trevenue_ |  -4.02e-11   7.12e-09    -0.01   0.995    -1.40e-08    1.39e-08
        CaIn |  -.4025894   .1698992    -2.37   0.018    -.7355858    -.069593
       _cons |  -2.837458   7.804188    -0.36   0.716    -18.13339    12.45847
------------------------------------------------------------------------------
```

STATA outputs for retail, wholesale, utilities and warehousing sectors

Fixed effect model

```
. areg logTI Year SG GrossMargin Trevenue CaIn, absorb( ID)

Linear regression, absorbing indicators            Number of obs   =      1648
                                                   F(   5,   1551) =    100.08
                                                   Prob > F        =    0.0000
                                                   R-squared       =    0.7807
                                                   Adj R-squared   =    0.7671
                                                   Root MSE        =    0.5394

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |  -.0048112   .0025127    -1.91   0.056    -.0097399    .0001174
          SG |   .1106174   .0415072     2.67   0.008     .0292013    .1920335
GrossMargin_ |  -.0228157   .0011081   -20.59   0.000    -.0249893   -.0206421
   Trevenue_ |   1.37e-08   3.65e-09     3.74   0.000     6.50e-09    2.08e-08
        CaIn |    .049342   .1585451     0.31   0.756    -.2616433    .3603274
       _cons |   12.37895   5.020025     2.47   0.014     2.532197     22.2257
-------------+----------------------------------------------------------------
          ID |       F(91, 1551) =     34.367   0.000          (92 categories)
```

Random Effect Model

```
. xtreg logTI Year SG GrossMargin Trevenue CaIn, re

Random-effects GLS regression                   Number of obs      =      1648
Group variable: ID                              Number of groups   =        92

R-sq:  within  = 0.2390                         Obs per group: min =         4
       between = 0.1499                                        avg =      17.9
       overall = 0.1621                                        max =        29

                                                Wald chi2(5)       =    496.25
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |  -.0050919   .0025072    -2.03   0.042     -.010006   -.0001779
          SG |   .1216847   .0421482     2.89   0.004     .0390757    .2042936
GrossMargin_ |  -.0221317   .0010881   -20.34   0.000    -.0242643   -.0199991
   Trevenue_ |   1.33e-08   3.59e-09     3.69   0.000     6.22e-09    2.03e-08
        CaIn |   .5405501   .1472474     3.67   0.000     .2519505    .8291497
       _cons |   12.64867   5.017796     2.52   0.012     2.813974    22.48337
-------------+----------------------------------------------------------------
     sigma_u |  .76901408
     sigma_e |  .53939705
         rho |  .67024971   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Least Square Dummy Model

```
      Source |       SS       df       MS              Number of obs =    1648
-------------+------------------------------           F( 96,  1551) =   57.51
       Model |  1606.40791    96  16.7334157           Prob > F      =  0.0000
    Residual |  451.262172  1551  .290949176           R-squared     =  0.7807
-------------+------------------------------           Adj R-squared =  0.7671
       Total |  2057.67008  1647  1.24934431           Root MSE      =   .5394

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |  -.0048112   .0025127    -1.91   0.056    -.0097399    .0001174
        CaIn |    .049342   .1585451     0.31   0.756    -.2616433    .3603274
GrossMargin_ |  -.0228157   .0011081   -20.59   0.000    -.0249893   -.0206421
   Trevenue_ |   1.37e-08   3.65e-09     3.74   0.000     6.50e-09    2.08e-08
          SG |   .1106174   .0415072     2.67   0.008     .0292013    .1920335
       _IID_2 |   -.941779   .1690564    -5.57   0.000    -1.273382   -.6101758
```

Mixed effect model

```
. xtmixed logTI Year SG GrossMargin Trevenue CaIn || ID: , var

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -1504.9429
Iteration 1:   log likelihood = -1504.9429

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =      1648
Group variable: ID                              Number of groups   =        92

                                                Obs per group: min =         4
                                                               avg =      17.9
                                                               max =        29


                                                Wald chi2(5)       =    506.72
Log likelihood = -1504.9429                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       logTI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Year |  -.0050473   .0024806    -2.03   0.042    -.0099091   -.0001855
          SG |   .1180169    .041438     2.85   0.004        .0368    .1992338
GrossMargin_ |  -.0223323   .0010825   -20.63   0.000     -.024454   -.0202105
   Trevenue_ |   1.35e-08   3.57e-09     3.77   0.000     6.45e-09    2.05e-08
        CaIn |   .3786761   .1493305     2.54   0.011     .0859937    .6713586
       _cons |   12.66513   4.963827     2.55   0.011     2.936213    22.39406
------------------------------------------------------------------------------
```