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Abstract

Purpose - The study attempts to investigate the relationship between inventory management and firm performance using a multi-dimensional aspect of inventory management with respect to lean management practices across countries.

Research design, data, and methodology - 1643 manufacturing firms from Japan and the US that SIC ranges from 2000 to 3999 were chosen to conduct the empirical test. This study employs hierarchical OLS regression analysis to examine the impact of control variables, ABI, EBI, and the interaction between ABI and EBI on firm performance.

Results - The result indicates that in Japan high level of inventory negatively influences the accounting flows of business, while US manufactures exhibit strong positive impact of ELI on firm performance across accounting and market measures. The results show that the complementarity between the amount and the speed of inventory does exist. Except for Tobin's q, the sign of interaction term coefficient is negative, suggesting that when the amount of inventory increases and it stays longer in a firm, market values, ROS, and ROA suffers.

Conclusions - The major finding of this study is that there exist some complementarities between the scope and implication of inventory management for lean strategy across countries, particularly in U.S. and Japanese firms.

Keywords : Inventory Management, Lean Practice, Firm Performance, International Comparison, United States, Japan.

JEL Classifications : L23, L25, L60, M11.

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1. Introduction

As globalization deepens and broadens, suppliers are often scattered over the world and logistics spans the various parts of the nations, which heightens supply chain network risks. The risk embedded in supply chain disruptions presents challenges not only in managing a daily operations but also gaining competitive advantages over their counterparts. To mitigate supply chain risks, some companies choose to implement various risk management practices including more safety stock and inventory consignment. This dynamics may add a twist on the impact of lean management on firm performance. In fact, a larger amount of inventory may serve as the buffer to absorb risks between supplier, manufacturer and customers. The U.S. has gone through major restructuring after the financial meltdown in 2008 and the world economy has struggled with economic downturns as seen in the financial fiasco in Greece and European Unions. As a result, inventory in manufacturing sector has piled up and a number of manufacturers went bankrupt or opted for outsourcing significant portion of their business.

Meanwhile, sustainability has emerged as an essential dimension of competition and social responsibility. Sustainability can be understood as management practices to satisfy the needs of the present without compromising the capability of future generations to fulfill their own needs[1].

Sustainability concerns making processes and operations durable and protects the environment. Lean management facilitates the tenet of sustainability by eliminating wastes both internally and outwardly and by furthering organizational transformation that utilizes resources effectively (Fliedner & Majeske 2010). Lean management is also grounded in the philosophy to build a management system driven by demand that minimizes the amount of inventory and products at all time. Lean management encompasses eliminations of wastes not only in materials but also in time, movement and processes. Thus, lean management is foundational in achieving sustainability. For example, studies report that lean management helps firms to increase sustainable outcomes in manufacturing (Yang et al. 2011).

Inventory is an important measure of lean management. Inventory can take up as much as 50% of investment capital for companies in manufacturing and retail industries and thus has always been of inter-

1) UN commission, 1983 headed by Norwegian Prime Minister Brundtland

est of scholars and practitioners. A number of studies have centered on the optimal level of inventory management. However, a review of the extant literature on inventory management identifies the following research gaps. First, drawing from the lean and inventory management literature, this study uses two reliable measures of lean management: abnormal inventory (ABI) of the firm and the empirical leanness indicator (ELI). ABI embraces the length of inventory days whereas ELI captures the inventory leanness after accounting for economics of scale in inventory management and industry-specific inventory management characteristics. Past studies introduced and used these measures this study argues that using both measures together is a better way to capture the inventory management practices. Second, the aforementioned measures have not been tested in an international context. The effect of lean management practices have not been investigated across countries other than the U.S., Spain, and Greece. Besides, the impact of inventory management on the firm performance may vary depending on the type of performance measures used in the study. The past studies have used either financial or accounting measures of firm performance in investigating the prowess of inventory management, particularly in generalizing the diverse strategic aspect of lean management for firm performance across countries. As such, examining both accounting- and market-based measures makes it conducive to understand the influence of lean management on firms' short- and long-term goals (Lee & Roh 2012). Countries lay different weights on performance objectives, and it is reported that U.S. firms outperform other countries in accounting-based performance (Ittner et al. 2003), while Japanese firms show better performance in market-based and long-term performance (Yoder 1994; Merchant & Stede 2007). Since this study intends to compare the US manufacturing firms with Japanese ones, taking multiple performance measures into consideration is particularly important.

Studies report that the transference of lean system from Japan to the US has been less successful than expected. The reasons are attributed to the fact that lean management demands employees to take the ownership of each process and make efforts to improve business processes every day, epitomized by Kaizan (Fairris & Tohyama 2002). The implementation of lean system requires the workers to be skillful and versatile in dealing with information, changes, and unusual operations. Workers are supposed to increase their knowledge on the entire operations and assume more responsibilities. Japanese firms motivate their employees to run lean system by providing incentives such as life-time employment and profit-sharing. Cultural difference also explains the gap in lean management practices in Japan and the U.S. In lean management, it is not quality control department or product engineering team but the production team that are responsible for a defect. Each team and its members collectively assume the responsibility for other member's performance (i.e., Jidoka) to attain to the quality standards of the company, which means that each team member becomes responsible for the performance of others. Lean management in Japan revolves around the group interest. However, the US workers are more inclined to put their self-interest above that of the group. Transplanting the lean culture into individualistic atmosphere in the US has met with challenges. Thus, the study expects the presence of divergent performance of lean system in the US and Japan.

This study seeks to investigate the operational relationship between inventory management/lean management and diverse dimensions of firm performance with respect to accounting-and market-based performance in U.S. and Japanese manufacturing firms. Using longitudinal data, the study also examines the historic changes happened in the business.

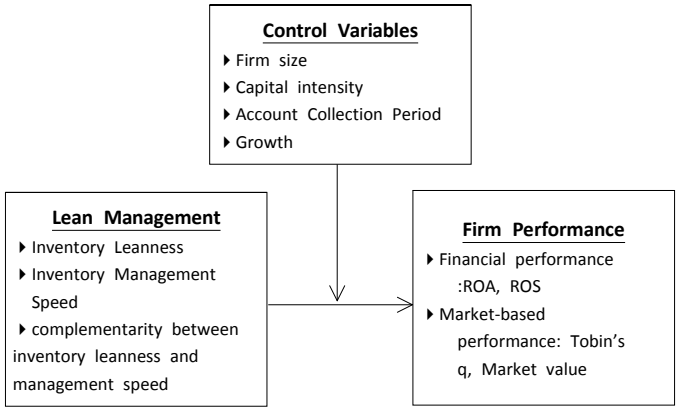
2. Theoretical Background of the Study

Prior studies have examined the relationship between inventory leanness and performance (Chen et al. 2005; Demeter & Matyusz 2011; Eroglu & Hofer 2011; Demeter & Matyusz 2011). There are a few reasons why the relationship is strong. First, lean inventory shrink wastes and costs involved in inventory management, improving a firm's financial performance. Inventory accompanies the interest on money, space, labor, and equipment for warehousing and handling, inventory shrinkage and obsolescence. Second, the implementation of lean management permeates throughout the organization and embed the philosophy of effectiveness into the fabric of an organization and supply chains. Thus, lean management has been introduced as an agent of organizational change and transformation (Womack & Jones 2003).

A number of studies have delved into the impact of the speed of inventory management of financial performance of firms. Chen et al. (2005, 2007) reported that raw material and work in progress inventories have decreased from 1981 to 2004 and the decrease had a positive impact in stock market returns. After conducting 201 literatures, Kinney and Wempe (2002) found that lean production adoption improves profitability and return on assets. Using a survey of 253 manufacturing firms, Fullerton et al. (2003) found that lean production practices exhibits a positive effect on profitability, return on asset, and cash flow margin. Similarly, Shah and Ward (2003) found the positive relationship between lean production bundles and plant performance from 1575 manufacturing firms. However, a few studies contradict the reported results. In a study of automotive companies, Jayaram et al. (2008) found no significant influence of lean production on profitability and ROA. In a similar context, another study reports that inventory turnover rate has no influence on financial and accounting performance of the firms (Cannon 2008).

Another stream of research has looked into how the size of inventory is related to firm performance. Examining manufacturing firms from 1981 to 1998, a study finds that Toyota production system has affected inventory management styles broadly and high-performing firms carry less amount of inventories than low-performing firms (Swamidass 2007). Another study looked at the amount of inventory scaled by sales and examined its relationship with gross profit. Basing on the data from 1980 to 2005, the study found that inventory management positively affect gross profit (Capkun et al. 2009). Eroglu and Hofer (2011) investigated the relation by industry after creating a lean management measure that estimates a firm's inventory leanness relative to industry-specific norms after controlling economies of scale. The seminal study the strength and nature of the

inventory-performance link differs significantly across industries.



<Figure 1> Research Framework

Complementarity theory suggests that some activities and practices complements each other and thus tend to be implemented collectively in order to increase the impact of the other (Edgeworth 1881; Milgrom & Roberts 1995; Choi et al. 2008). For example, human resource management practices such as flexibility job assignments and training workers for multiple jobs go hand in hand and increase employees' productivity (Ichniowski et al. 1995). Other examples include the relationship between product design and product engineering (Love & Roper 2009), process and product innovation strategies (Mantovani 2006), information technology and service innovation (Bartel et al. 2007). This study argues that the effect of complementary practices in lean management will be larger than that of isolated practice because of the collectively positive synergy of bundled practices.

Lean management can be understood as the elimination of wastes, which encompasses various lean practices and tools. Just-in-time and Kanban systems represent the importance of maintaining a necessary inventory only. Such low level of inventory can be maintained when the replenishment of inventories are swiftly done throughout work stations and supply chains. As a result, the study anticipates that there is a complementarity between the amount of inventory management and the speed of replenishment of inventory. Figure 1 describes the relationship.

Hypothesis 1. Inventory leanness will have a positive effect on firm performanceregardless of different performance measures across countries.

Hypothesis 2. Inventory management speed will have a positive effect on firm performance regardless of different performance measures across countries.

Hypothesis 3. Complementarity between inventory leanness and inventory management speed will create synergy for firm performance regardless of different performance measures across countries.

3. Empirical Design and Methods

3.1. Samples and data collection

Manufacturing firms from Japan and the US that SIC ranges from 2000 to 3999 were chosen to conduct the empirical test. The selection of firms is based on a 4-digit SIC and each model will be run by each country (USA and JAPAN). The Sample will also cover all listed firms in U.S. A total of 1643 manufacturers were selected from the two countries for the purpose of this study (see Tables 1 and 2). All data for the various indices of performance variables employed in this study were taken from Compact-D World Scope and Research Insight for the period 2007 through 2009. Because the sample is a quasi-panel dataset and there were missing values for some firms and years, we deleted the firms with missing values. Aggregated averages were used to help minimize the effects of any outliers or idiosyncratic variations and thereby to provide a more accurate assessment of the effects of the variables being tested (Lee & Hall 2008).

<Table 1> Industry Specification by SIC and Country

Industry Classification	SIC CODE	USA	JAPAN
Food and Kindred Products	2000-2099	76	65
Tobacco Products	2100-2199	8	0
Textile Mill Products	2200-2299	0	11
Apparel & Other Textile Products	2300-2399	12	15
Lumber and Wood Products	2400-2499	12	3
Furniture and Fixtures	2500-2599	8	3
Paper and Allied Products	2600-2699	28	12
Printing and Publishing	2700-2799	36	11
Chemicals and Allied Products	2800-2899	152	119
Petroleum and Refining	2900-2999	32	3
Rubber and Plastics Products	3000-3099	16	34
Leather and Leather Products	3100-3199	8	0
Stone, Clay and Glass Products	3200-3299	0	22
Primary Metal Industries	3300-3399	28	49
Fabricated Metal Products	3400-3499	20	36
Industrial Machinery & Equipment	3500-3599	100	134
Electronic & Electric Equipment	3600-3699	133	146
Transportation Equipment	3700-3799	44	72
Instruments & Related Products	3800-3899	116	47
Misc. Manufacturing Industries	3900-3999	12	20
Total		841	802

<Table 2> Descriptive Statistics for Key Variables: U.S. and Japanese Firms

Key Variables	U.S. Firms		Japanese Firm	
	Mean	Std. Dev.	Mean	Std. Dev.
ROA	8.749	9.997	3.836	3.917
ROS	8.555	20.331	4.185	5.446
Tobin's Q	2.248	1.594	0.595	0.462
Market Value	16.102	1.130	17.595	1.566
Firm Size	15.648	1.216	13.698	1.270
Capital Intensity	1.320	0.698	1.140	0.437
A/C Collection Period	67.940	32.369	95.621	38.215
Sales Growth	8.535	11.373	3.523	7.388
S&Adm. Cost Efficiency	15.050	9.203	17.926	10.057
ABI:Abnormla Inventory	0.015	0.905	0.007	0.944
ELI:Inventory Leaness	-0.019	1.009	0.018	0.965
ABI x ELI	0.487	1.102	0.606	1.071

Note:
* ROA and ROS as accounting-based performance are measured by EBIT based ROA and ROS
* Tobin's Q and Market Value indicate market-based performance
* Firm size: US$ based Ln (Sales)
* Capital Intensity: US$ based Total Assets/Total Sales
* A/C Collection Period: Account Receivable/Sales *365
* S&Adm. Cost Efficiency: S&Administrative Cost / Total Sales *100
* Sales Growth: 3 years Moving Average in Sales Growth
* ABI: Abnormal Inventory = (ID - Mean ID of firm's 3-digit SIC)/(Standard Deviation of ID of firm's 3-digit SIC). ID = (Inventory x 365)/Cost of Goods Sale
* ELI: Inventory Leaness is measured by Residual of a firm's inventory level from Size adjusted within industry average inventory level within industry by SIC 3-digit.

3.2. Description and measurement of variables

Firm Performance: Most previous empirical studies investigating the impact of export and R&D intensity on performance were mostly focused onthe use of a single measure of performance, particularly with respect to accounting-based performance and/or productivity. In order to gain more accurate and generalized results, and to minimize possible weaknesses associated with the used of any single-performance (Lee & Roh 2012), this study adopted multi-dimensions of performance measures stemming from accounting-based performance (EBIT based ROAA and ROAS) and market-based performance (Tobin's Q, Market value). More specifically, they are operationalized in the following manner:

ROAA = (Earnings before Interest & Tax) / (Total assets)

ROAS = (Earnings before Interest & Tax (/ (Total Sales)

Tobin's Q = (Market value of shareholder's equity + Liquidating value of the firm's outstanding preferred stock + Book value of total debts) / (Book value of total assets)

Market Value = Ln (Year end closing stock price) * (Common shareholders' outstanding)

Key Inventory Management Variables: There exist a number of different approaches to measure inventory management. The appropriate ratios depend on the nature of the study and the use. In line with the main theme of this paper, two key measures for inventory management are adopted for this study.

Empirical Leanness Indicator (ELI): Eroglu and Hofer (2011) proposed ELI as a superior measure of inventory leanness for it takes into consideration the nonlinear relationship between firm size and inventory holdings. Compared to conventional measures such as inventory turnover and average inventory levels, ELI gauges a firm's inventory leanness relative to the industry standard after accounting for economics of scale. ELI is calculated as the error term from the regression model, ln invifα0iα1iif + εifwhere invifthe average of the firm's total inventories reported at the end of 2009, and Salesifthe total sales volume of firm f in industry i. ELI less than 1 indicates that the firmi is holding less inventory than the firms of similar size (High LEAN) where ELI value greater than 1 means that the firm i is holding more inventory than the firms of similar size (Low LEAN).

Abnormal Inventory (ABI): Chen et al. (2005)proposed relatively simple way of measuring inventory. ABI captures how long inventory is held in a business and is calculated as follows. ABI = [Inventory Turnover - Average Inventory of 3-digit SIC Industry in which each firm belongs]/[Standard deviation of IT of 3-digits SIC Industry in which each firm belongs]. If ABI > 0, then firm i is holding inventory longer than do other firms in the same industry. Firms with ABI < 0 are holding inventory shorter than do their industry peers.

Control Variables: Since the strategic linkage between corporate reputation and firm performance can oscillate by other strategically important influences, it deemed necessary to control for potentially confounding variables as follows:

Firm Size = Natural log value of Total Sales

Average Collection Period = [(Account Receivables)* 360]/Total Sales

Sales Growth Rate = 3 years Moving Average in Sales Growth

Capital Intensity = Total Assets / Total Sales

Selling & Administrative Cost Efficiency =

[(Sales and Administrative Cost) / Total Sales] * 100

To check discriminant validity, a correlation matrix was created, as shown in Table 3. Some items show a correlation above 0.30 and thus the variance inflation factor (VIF) was scrutinized to detect the presence of multicollinearity. All of the VIFs turned out to be below 5, indicating that it does not pose a problem for the regression analysis (Belsley et al. 1980).

<Table 3> Correlation for All Variables: U.S. vs. Japanese Firmsa

	1	2	3	4	5	6	7	8	9	10	11	12
1. ROA		.800 ***	.453 ***	.316 ***	.118 ***	-.358	.099 **	.243 ***	.083 *	.231 ***	.331 ***	.057
2. ROS	.839 ***		.270 ***	.278 ***	.151 ***	-.343 ***	.103 **	.139 ***	-.093 **	.205 ***	.250 ***	.163 ***
3 Tobin's Q	.635 ***	.645 ***		.274 ***	-.350 ***	.064	.312 ***	.245 ***	.562 ***	.512 ***	.717 ***	.300 ***
4. Market Value	.382 ***	.419 ***	.557 ***		.851 ***	.171 ***	-.154 ***	.161 ***	.127 ***	.173 ***	.102 **	-.118 ***
5. Firm Size	.136 ***	.095 **	.161 ***	.851 ***		-.230 ***	-.264 ***	.021	-.402 ***	-.154 ***	.029	-.038
6. Capital Intensity	-.002	.354 ***	.221 ***	.171 ***	-.141 ***		.262 ***	-.015	.228 ***	.273 ***	.334 ***	.208 ***
7. A/C Collection Period	-.165 ***	.005	-.079 *	-.154 ***	-.258 ***	.369 ***		.016	.360 ***	.226 ***	.341 ***	.027 *
8. Sales Growth	.329 ***	.300 ***	.261 ***	.161 ***	.081 *	.070 *	-.055		-.122 ***	.152 ***	.114 ***	.281 ***
9. S&Adm. Cost Efficiency	.134 ***	.151 ***	.213 ***	.127 ***	-.020	.089 **	-.056	-.089 *		.248 ***	.427 ***	.079 *
10. ABI:Abnormal Inventory	-.031	.093 **	.104 **	.173 ***	.057	.337 ***	.103 **	-.013	.200 ***		.534 ***	.450 ***
11. ELI:Inventory Leaness	-.184 ***	-.032	.006	.102 **	-.018	.405 ***	.306 ***	-.088 *	.018	.666 ***		.222 ***
12. ABI x ELI	-.029	-.084 *	-.027	-.118 ***	-.070 *	-.051	-.015	.014	-.065	.179 ***	-.176 ***	

a. Below he diagonal are correlations for U.S. firms (n = 841) whereas Above the diagonal are correlations for Japanese firms (n = 802).

b. Significance level: * P <0.05; ** P <0.01; *** P < 0.001

4. Empirical Results and Analysis

Hierarchical OLS regression analysis examines the impact of control variables, ABI, EBI, and the interaction between ABI and EBI on firm performance. Tables 4-(a) is for the U.S. firms 4(b) for Japanese firms. From the tables for the U.S. and Japanese SMEs, all regression models were highly significant ($p < .01$ except ROAE in the U.S. firms), indicating that the multiple regression models were useful in exploring the major determinants of firm performance in manufacturing firms across the U.S and Japan. In addition, most models including ABI and ELI and the interaction between them are useful for exploring the simultaneous effect of lean inventory management on the firm performance. With other business strategy factors held constant, the firm's lean inventory management has significant impacts on improving or decreasing the firm's performance across performance measures.

The first hypothesis addresses the relationship between inventory amount and firm performance. Under the umbrella of lean management, inventory is regarded a form of wastes and thus the hypothesis expected the negative relationship between ELI and firm performance. ELI of Japanese manufacturers showed a negative association with accounting performance measures such as ROA and ROS. Its impact is stronger than ABI. However, for Tobin's q and market value, market based measures, ELI turned out to have no impact. The result seems to indicate that in Japan high level of inventory indeed negatively influences the accounting flows of business but the stock valuehas little to do with the amount of inventory. The US manufactures, however, exhibit strong positive impact of ELI on firm performance across accounting and market measures. The coefficients are three to five times greater than those of ABI in magnitude. The impacts are greater for market performance measures. The interpretation is that the higher the inventory amount is, the greater the firm performance is. The analysis result contradicts the hypothesis. One interpretation is that the US manufacturers may view the amount of the inventory as a positive ground for better performance and stakeholders in the US also regard it as an indicator of good performance. As the lean inventory management has been widely implemented in business, the amount of inventory may now serve as a pointer to a strong fundamental for active business and performance.

The second hypothesis concerns the positive relationship between the speed of inventory management and firm performance. The fast turnover over of inventory shows that the business is moving rapidly and growing fast. Usually, fast inventoryturnover is related to high volume of sales. As the smaller ABI indicates the faster inventory management speed, this study predicts negative sign of the coefficient. The US manufacturers, however, turn out to have positive relationship between ABI and their performance, although the magnitude is relatively smaller than that of ELI. In Japanese manufacturing context, ABI seem to have no significant impact on firm performance except for ROS. Invariably, the relationship is positive, meaning that the longer the inventory management cycle is, the better the performance.

The third hypothesis was that complementarity between the lean inventory management and the speed of inventory management cycle exists. The less amount of inventory is carried and the faster the cycle of inventory management is, the better firm performance. The analyses results show that the complementarity between the amount and the speed of inventory does exist. This is especially true for Japanese manufacturers. Except for Tobin's q, the sign of interaction

<Table 4 – A> Results of Hierarchical Regression Analysis: Japanese Firmsa

Variables	Accounting-based Performance								Market-based Performance							
	EBIT based ROA				EBIT based ROS				Tobin's Q				Market Value			
	Step 1	Step 2	Step 3	V.I.F.	Step 1	Step 2	Step 3	V.I.F.	Step 1	Step 2	Step 3	V.I.F.	Step 1	Step 2	Step 3	V.I.F.
Ln (Sales US$)	.105**	-.020	-.018	1.414	.075*	-.045	-.055	1.414	-.146***	-.343***	-.351***	1.414	.903***	.684***	.687***	1.447
Capital Intensity	-.402***	-.535***	-.530***	1.260	-.359***	-.495***	-.516***	1.260	-.106***	-.306***	-.322***	1.260	.193***	.014*	.020***	1.257
Collection Period	.182***	.091**	.088**	1.284	.244***	.153***	.167***	1.284	.107***	-.033	-.023	1.284	.121***	-.014*	-.018***	1.286
Sales Growth Rate	.259***	.171***	.180***	1.150	.124***	.033	-.001	1.150	.315***	.185***	.159***	1.150	.106***	-.008	.003	1.152
S&Adm. Efficiency	.181***	-.022	-.020	1.631	-.049	-.252***	-.261***	1.631	.529***	.217***	.211***	1.631	.337***	.029***	.031***	1.659
ABI		.098**	.114***	1.733		.136***	.070*	1.733		.116***	.067***	1.733		-.004	.017**	1.749
ELI		.423***	.420***	1.989		.406***	.419***	1.989		.663***	.673***	1.989		.696***	.692***	2.013
ABI x ELI			-.037	1.371			.151***	1.371			.114***	1.371			-.048***	1.374
Model R2	.2490	.3972	.3982		.1779	.3336	.3502		.4549	.7942	.8037		.6759	.9794	.9811	
Adjusted R2	.2444	.3921	.3924		.1730	.3260	.3439		.4516	.7925	.7049		.6739	.9792	.9810	
Δ in R2		.148***	.001			.156***	.017***			.339***	.010***			.304***	.002***	
F-ratio	55.01***	77.94***	68.41***		35.93***	59.22***	55.72***		138.53***	456.5***	423.2***		334.6***	544.1***	519.5***	
F-ratio for Δ in R2		101.8***	1.410			96.74***	21.09***			682.7***	39.85***			590.4***	72.50***	

a. n=841; Standarized regression coefficient. V.I.F. indicate Variance Inflation Factor
* P < 0.05; ** p <0.01; *** P <0.001

<Table 4 – B> Results of Hierarchical Regression Analysis: U.S. firms

Variables	Accounting-based Performance								Market-based Performance							
	EBIT based ROA				EBIT based ROS				Tobin's Q				Market Value			
	Step 1	Step 2	Step 3	V.I.F.	Step 1	Step 2	Step 3	V.I.F.	Step 1	Step 2	Step 3	V.I.F.	Step 1	Step 2	Step 3	V.I.F.
Ln (Sales US$)	.074*	.087**	.079*	1.107	.103***	.117***	.102***	1.107	.140***	.143***	.141***	1.107	.882***	.881***	.876***	1.111
Capital Intensity	.010	.061	.058	1.382	.363***	.416***	.410***	1.382	.237***	.252***	.251***	1.382	.286***	.281***	.279***	1.375
Collection Period	-.121***	-.085*	-.078*	1.322	-.079*	-.040	-.028	1.322	-.110**	-.100**	-.098**	1.322	-.020	-.025	-.021	1.318
Sales Growth Rate	.355***	.336***	.334***	1.046	.291***	.271***	.267***	1.046	.252***	.246***	.246***	1.046	.080***	.082***	.081***	1.050
S&Adm. Efficiency	.163***	.153***	.139***	1.136	.144***	.132***	.108***	1.136	.222***	.220***	.215***	1.136	.126***	.128***	.121***	1.134
ABI		.060	.107*	2.543		.068	.153***	2.543		.014	.028	2.543		-.010	.015	2.527
ELI		-.199***	-.248***	2.706		-.213***	-.302***	2.706		-.055	-.070	2.706		.024	.000	2.623
ABI x ELI			-.073*	1.384			-.133***	1.384			-.022	1.384			-.039**	1.314
Model R2	.1774	.1995	.2034		.2508	.2757	.2865		.1973	.1991	.1994		.8324	.8312	.8339	
Adjusted R2	.1722	.1925	.1953		.2460	.2693	.2813		.1922	.1920	.1913		.8314	.8312	.8322	
Δ in R2		.022***	.004*			.025***	.013***			.002	.000			.000	0.001*	
F-ratio	34.34***	28.27***	25.31***		53.28***	43.18***	40.19***		39.12***	28.19***	24.69***		778.9***	556.1***	490.1***	
F-ratio for Δ in R2	10.97***	3.82*				13.68***	14.23***			.887	.352			.652	5.576*	

a. n=802; Standardized regression coefficient. V.I.F. indicates Variance Inflation Factor
* P < 0.05; ** p <0.01; *** P <0.001

term coefficient is negative, suggesting that when the amount of inventory increases and it stays longer in a firm, market values, ROS, and ROA suffers. The two elements are complementing each other to bring positive outcomes to the accounting and financial values. However, Tobin's q seems to be indifferent to this complementarity in inventory management setting in Japanese manufacturers. For the case of US manufacturing firms, this complementarity holds true for market value only. The coefficient of the interaction term is negative. This coefficient is particularly interesting because the individual coefficient of ELI and ABI on market value is positive but the interaction term is negative. Individually the amount and speed of inventory management may contradict the conventional notion that lean management increases the firm performance. When the amount of inventory increases due to low inventory turnover, market value suffers as a result. For the case of the US manufacturers, however, the results are mixed. the interaction has no significant impact on ROA and its impact on market value is negative. Further, the positive significant coefficient of the interaction effect on ROS and Tobin's q again challenges the conventional notion about the complementarity. According to the results, the larger amount of inventory and the longer stay of inventory in firm will bring in higher ROS and Tobin's q. The reason for this has to be sought out further.

5. Conclusion

Inventory has drawn the attention of practitioners and scholars for its importance in business. It is one of the most expensive assets that take up to 50% of total invested capital. Although it is an asset, it is a liability for the business because it causes much cost in the form of warehousing, material handling, insurance, obsolescence and the like. Despite the costs and disadvantages associated with insurance, inventory offers many advantages and leeway for business to operate. It protects against uncertainties in demand, supply, lead times, and schedule changes, and accurate record keeping enables firms to take discounts for the firms. The rise of Japanese manufacturing firms in 1970s and 1990s can be contributed, in part, to the lean management that slashed the amount and cycle of inventory drastically. As a result, firms have attempted to learn lean management practices from Japan, a boom was rising in the USA to implement lean methods such as just in time.

The major findings of our study suggest that the complementarity between the amount and speed of inventory management exists in US and Japanese manufacturers. If the amount and speed of inventory are managed lean, it leads to positive accounting and financial results, especially in Japanese manufacturing firms. However, in the US, the complementarity seems to be weak. Tobin's q and ROS showed positive relationship with the interaction term. In addition, the individual impact of lean inventory management and speedy inventory turnover contradicted the conventional wisdom about the lean management.

The contribution of this paper is three fold. First, the study employed two validated lean management index to explore the relationship between lean management and firm performance. ELI and ABIare independently developed, and yet they have not been applied together although one measures the amount of inventory and the other the speed of inventory management. Second, the study finds the international variance among lean management practices and their impact on organizational outcomes. The past studies mainly dealt with the US firms and extrapolated the implications from the results. While this study confirms the positive relationships in general, different pattern of the relationship between the US and Japanese firms emerges. The complementarity between the speed and the amount of inventory management works stronger in Japanese firms than the US firms. The third contribution of this study is the use of diverse performance variables. Different from the previous studies, the current study look into accounting and market performance outcomes.

Generalizing from this study requires caution. One of the limitations of this study is that other factors than those examined can affect the performance of a corporation. Some scholars have noted the difficulty in comparing and predicting the magnitude and direction of accounting differences in financial profitability, as in the ROA and ROE of the United States and Japan. In addition, the study included mostly publicly traded large companies of the world's leading countries. Although our study discloses the variations among different industry contexts, the firm size effect (e.g., small vs. medium or large companies) is not examined.

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