Inventory, IT Investment, and Profitability: Empirical Evidence using Industry Groups

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June 1, 2004

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Abstract

This research investigates relationships among IT investment, inventory performance, and financial performance to find the empirical evidence for the theory that operational excellence in inventory management and relevant IT investment enhance profitability in the long run. Using ANOVA, post hoc analysis, and hierarchical regression, we analyze longitudinal data at the industry group level (manufacturing, wholesale trading, and retail trading sectors) to examine inventory trends during the last four decades, effect of IT investment on inventory performance, and effect of IT investment on the relationship between inventory performance and financial performance. The results indicate that 1) inventory levels have decreased in the manufacturing sector but increased in the wholesale and retail sectors over the last four decades; 2) increased IT investment has a positive influence on inventory reduction in manufacturing and retail sectors; and 3) a lower inventory level is beneficial to improving firms' profitability. However, the positive influence of IT investment on financial performance appears indirect and mediated by inventory performance.

Keywords: Inventory; IT investment; Longitudinal Analysis; Hierarchical Regression

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1. Introduction

Firms have been trying to reduce their inventory levels for decades. The principal focus of resource planning tools such as Material Requirements Planning (MRP) introduced in the 1970s and Enterprise Resource Planning (ERP) in the 1990s was on providing timely signals for efficient management of inventories and material flows (Benton and Shin, 1998). Moreover, increased focus on operational efficiency exemplified by Toyota Motor Company's lean production system and its extensive implementation in the United States has intensified emphasis on reducing inventories. More recently, inventory reduction efforts of independent firms have been integrated, leveraged by rapid progress of supply chain management.

Yet, it is rather surprising that little empirical evidence exists to support the conventional wisdom that inventory levels have reduced significantly over time in the US. Anecdotal evidence also suggests that inventory reduction may improve financial performance, but this relationship is even less established empirically. Lack of strong empirical support in the literature could be associated with challenges in longitudinal data collection. Indeed, collecting historical inventory and financial data at the business unit or firm level requires a great deal of time and expenses.

Examining inventory trend and its impact on financial performance is further complicated by the rapid deployment of information technology (IT). IT allows a firm to acquire, share, and disseminate information of customer orders and inventory positions within the firm and across its business partners outside the firm. Such

facilitation of information sharing by IT should help manage inventories more effectively and streamline operations, leading to a greater impact on financial performance. However, to our knowledge, empirical evidence to support the contention that IT affects the relationship between inventory performance and financial performance does not exist.

In an attempt to resolve these issues, this research evaluates relationships among three interrelated constructs – **inventory performance**, **financial performance** and **investment in information technology**, using longitudinal industry group level data provided by the Bureau of Economic Analysis (BEA). There are three industry groups under investigation, including manufacturing, wholesale trading, and retail trading industry groups. Our rationale for conducting analysis at the industry group level is that if individual companies in an industry benefit from improved inventory performance and IT investment, we should be able to find evidence for it at a macro industry group level. Inventory performance of each industry group was measured as *inventory-to-sales ratio*, financial performance as *profit-to-sales ratio* (profitability), and IT investment as *relative rate of increase in IT investment ratio.*

For the sake of brevity and clarity, we use the term "sector" instead of "industry group" in the rest of the paper. The terms, "industry group" and "sector" are often used interchangeably in the economic reports created by BEA and the US Census Bureau. Specifically, we examine the following research questions:

1) Have inventory levels decreased significantly in the manufacturing, wholesale, and retail sectors over the last four decades?

2) How has IT investment affected inventory performance of the manufacturing, wholesale, and retail sectors over the last four decades?
3) How have IT investment and inventory performance affected the financial performance in the manufacturing, wholesale, and retail sectors?

We acknowledge the importance of finding specific causes that lead to improvement in inventory performance and an increase in IT investment. However, we do not specifically examine them in the present study. Instead, the main objective is to empirically examine the nature of relationships among the three constructs, and to find preliminary support for the theory that a managerial focus on operational excellence measured as inventory performance supported by relevant investment in IT enhances financial performance in the long run. We use ANOVA and hierarchical regression to test the hypotheses derived from the research questions above.

The rest of the paper is organized as follows: A brief review of the relevant literature and three research hypotheses are presented in Section 2. Data, scales, and research methods are discussed in Section 3. The statistical results are described in Section 4, followed by discussion of the findings and their implications in Section 5. Finally, limitations and future research directions are discussed in Section 6.

2. Literature and Hypotheses

In this section, we provide a review of the relevant literature and develop the research hypotheses.

2.1. Long term nature of inventory performance

There is considerable anecdotal and limited empirical evidence that inventory performance has improved in some manufacturing industries over time (Rajagopalan and Malhotra, 2002). From a theoretical perspective, industry-wide inventory performance improvements can be attributed broadly to 1) accelerating pace of change in business environment and global competition and 2) process innovations and implementation of improvement programs.

The increasing pace of change and intensity of global competition require organizations to respond effectively to changing external environments (D'Aveni, 1994; Eisenhardt, 1989). The studies on "post-industrial organizations (Huber, 1984)," "industry clock speed (Fine, 1997; Mendelson and Pillai, 1999)," and "hypercompetitive industries (D'Aveni, 1994)" converge on the notion that post-industrial organizations face environments that are changing much faster than those of industrial organizations.

Process innovations such as lean production systems, cycle time reduction, and quick response are frequently credited as drivers for improving operational performance. Although studies show that implementation of lean production or other similar improvement programs lead to a superior operational performance, most of these studies analyze cross-sectional data from surveys of manufacturing firms (c.f. Shah and Ward, 2003). Shah and Ward (2003) found that implementation of lean practices contribute substantially to improved operational performance of plants. In addition, Im and Lee (1989), Inman and Mehra (1993) and White et al., (1999) provide empirical evidence that implementation of lean production systems

result in reduced inventory levels and increased inventory turnovers.

A few longitudinal studies have also examined the link between process improvement programs and firms' operational performance (Balakrishnan et al., 1996; Billesbach and Hayen, 1994; Chang and Lee, 1995; Huson and Nanda, 1995). However, they are constrained by short duration of data collection periods and relatively small sample sizes. For example, Balakrishnan et al., (1996) compared a sample of 46 manufacturing firms that publicly disclosed JIT adoption and a control group of non-adopters over a four-year period (from 1985 to 1989). They showed that the firms, which had adopted JIT systems, had lower raw materials, work in process, and total inventory levels.

We found only two studies (Rajagopalan and Malhotra, 2001; Vergin, 1988) that are similar in scope to the present study. The focus of these studies was to examine changes in inventory turnover ratios over a period of time, but neither of the studies explicitly specifies the causes of changes in inventory performance. Rather, they conjectured that increased competition and improvement approaches could be associated with higher inventory turns. In analyzing the data from 427 Fortune 500 firms, Vergin (1998) found that total inventory turns had changed significantly from 1986 to 1995. Rajagopalan and Malhotra (2001) examined inventory data from 1961 to 1994 for all manufacturing industries in the US. The results were mixed: While raw materials and work-in-process inventories decreased in most industries at SIC two digit level, finished goods inventories decreased only in a few industries. Despite its extensiveness, the study (Rajagopalan and Malhotra, 2001) was limited to the US manufacturing sector and failed to provide clear insights into inventory trends.

To our knowledge, the present study is the first longitudinal study, which examines inventory performance in the manufacturing, retail, and wholesale sectors. Additionally, this research examines the relationship between a sector's inventory performance trend and its financial performance.

In summary, the literature provides some evidence that process improvement programs have contributed to improvement in inventory performance. Although these studies mainly focus on manufacturing firms, we expect the same forces to play out in the wholesale and retail sectors, improving inventory performance of the two sectors as well. Therefore, we propose the following Hypothesis 1:

$H1_a$: *Average inventory per decade has decreased significantly during the last four decades in the manufacturing, retail, and wholesale sectors.*

2.2. Information technology and inventory performance

The literature on "IT payoff" has progressed through two phases. During the first phase, researchers failed to find any link between increased investments in IT and performance improvement at the industry or firm level (Brynjolfsson, 1993; Brynjolfsson and Hitt, 1996; Roach, 1987; Strassmann, 1985). This lack of evidence, popularly termed "the productivity paradox," was put to rest during the second phase. During the second phase, a number of studies began to establish some empirical links between investment in information technology and improved performance at the industry and firm level (Brynjolfsson and Hitt, 2000; Jorgensen and Stiroh, 2000; Kraemer and Dedrick, 2001; Devaraj and Kohli, 2003).

With the use of IT, firms have been able to enhance information availability all across their supply chains. Timely access to information regarding customer

demand patterns and inventory positions has enabled managers to make more informed choices and streamline inventories at each level of distribution. The significant role of IT in supply chain management has resulted in a tremendous increase in IT investments in all sectors of the US economy. Accordingly, we expect to find a positive influence of IT investment on industry group-wide inventory performance. Therefore, we propose to test the following Hypothesis 2:

$H2_a$: *There is a significant and negative association between IT investment and inventory performance (inventory level) in the manufacturing, retail and wholesale sectors.*

2.3. Information technology, inventory performance, and financial performance

As we stated in the introduction, a primary objective of the research is to examine the relationship between IT investment, inventory performance, and financial performance at the industry group level. With this objective in mind, we propose three research hypotheses that will be tested, using a multiple regression model.

IT investment and financial performance: Whether a positive relationship between IT investment and financial performance should be found at the industry level is not apparent. Most of the previous longitudinal IT payoff studies were conducted to examine the impact of IT investment on firms' operational performance such as productivity, quality, and service (Kohli and Devaraj, 2003). Although limited in extent, firm level studies support a positive but restrictive influence of IT investment on financial measures (Barua et al., 1995; Dewan and Min, 1997, Devaraj and Kohli,

2000). For instance, Barua et al (1995) found that IT was positively associated with some intermediate measures of profitability, but the effect size was small.

Logically thinking, if leading firms in an industry invest in IT and their investments in IT are viewed as a source of competitive advantage, the rest of the firms in the industry would mimic the leaders and make similar investments. Due to this "isomorphic" behavior of firms, according to institutional theorists, organizations come to resemble one another to gain legitimacy or achieve superior economic performance (DiMaggio and Powell, 1983; Haunschild and Miner, 1997). From this perspective, we can conjecture that empirical evidence for the positive impact of IT investment on financial performance can also be found at the industry group level. Therefore, we propose the following Hypothesis 3-1.

H3-1_a: *IT investment has a significant and positive association with the financial performance in the manufacturing, retail, and wholesale sectors.*

Inventory performance and financial performance: The relationship between inventory performance and financial performance is not straightforward because of the general accounting principles, which treat inventories differently in a firm's balance sheet and income statement. In the balance sheet, inventory is viewed as an asset base, which is a source of profit in the long run. In the income statement, however, a higher inventory level may lead to a lower profit margin because the higher inventory-related costs such as carrying, material handling, obsolescence, and insurance costs will increase costs of goods (merchandise) sold.

The link between inventory performance and financial performance has been

extensively examined in the context of Just in Time (JIT) production method. This is rooted in the belief that a lower level of inventories under JIT production will lead to a smaller asset base and, as a result, increase Return on Asset (ROA). Nonetheless, only a few studies have actually found support for the principle (Callen et al., 2000; Fullerton, et al., 2003). In comparing the financial performance of JIT and non-JIT firms, Balakrishnan et al (1996) found no difference in their ROAs. Balakrishnan et al (1996) argued that the benefits of asset base reduction under JIT are not apparent, especially in the short term.

The empirical evidence linking industry level operational performance to financial performance seems to be equally conflicting. However, we expect that improved inventory performance has a positive influence on financial performance particularly when the inventory performance was measured as a ratio of inventories to sales, as was in the presented study. Given a certain amount of sales, *ceteris paribus*, a reduction in inventory level would directly improve profit margin in the firms' income statements. Therefore, we propose to test the following Hypothesis 3-2:

H3-2_a: *Inventory performance (inventory level) has a significant and negative association with the financial performance in the manufacturing, retail, and wholesale sectors.*

Moderation effect of IT investment on inventory performance and financial performance: In addition to a direct effect of IT investment on financial performance, we investigate the moderation effect of IT investment on the relation between

inventory performance and financial performance; see Figure 1(a). The moderating role of IT investment on financial performance has not been investigated previously in the literature. If the effect of inventory performance on financial performance is dependent upon the level of IT investment, we can claim that IT investment moderates the impact of inventory performance on financial performance (Baron and Kenny, 1986; Venkatraman, 1989). We expect that a higher level of IT investments and a lower inventory level may have a positive and synergistic influence on improving financial performance. If both conditions (high IT investment and low inventory level) are not satisfied, the corresponding financial performance may be weaker. The net effect is an empirical question, which we propose to test through the following Hypothesis:

H3-3_a: *IT investment moderates the relationship between inventory performance and financial performance in manufacturing, retail, and wholesale sectors.*

Statistically, the moderating role of IT investment will be supported if the coefficient for the interaction (moderation) term in Figure 1(a) is significant.

[Figure 1 about here]

Mediation effect of Inventory Performance on IT investment and Financial Performance: Alternatively, inventory performance can also mediate the relationship between IT investment and financial performance; see Figure 1(b). From a theoretical standpoint, the mediation model resides in the classical industrial organization paradigm (Scherer and Ross, 1990), in which the impact of structural or

strategic decisions (IT investment) on performance (financial performance) is intervened (mediated) by the effectiveness of conduct (inventory performance). Therefore, if a mediation effect of inventory performance exists, the impact of IT investment on financial performance should be interpreted as an indirect effect.

To conduct a mediation analysis, we need to decompose the interlinked effects among inventory performance, IT investment, and financial performance included in the moderation model in Figure 1(a). Because this decomposition procedure can be done in testing Hypothesis 2 and 3, we do not provide a specific hypothesis for the test of mediation effect. Instead, the analytical results will be reported directly in Section 4.

3. Research Methods and Scale Development

To test our hypotheses, we develop a set of ratio scales from data. The raw data are available in "Annual Report to the President of the United States on the Activities of the Council of Economic Advisors (1999 and 2000)." The report is part of the "Economic Report of the President," which is delivered each year to the Congress of the United States. The raw data can also be obtained from BEA of the Department of Commerce.

3.1. Unit of analysis

The unit of analysis in this research is at the level of economic sector, which includes all companies and business establishments within the sector. For example, "manufacturing sector" in the US economy comprises all the companies engaged in

the mechanical or chemical transformation of materials or substances into new products. Similarly, all firms, businesses, and corporations that sell directly to consumers are grouped into "retail sector" and all those involved in wholesale trading are grouped into "wholesale sector" (See Appendix, Section I).

Employing the industry group (sector) level for analysis has the following merits. First, we can bypass the measurement issues caused by definitional changes in the industry classification systems (From SIC to NAIC). Second, the impact of drastic changes in individual firms' status and performance, which may occur due to strategic decisions or business failures, such as mergers, acquisitions, spin-offs, and bankruptcies, is negligible at the sector level. Lastly, this level of aggregation should allow us to predict general trends in inventory performance.

3.2. Scales and index construction

The simplest indicators for inventory and financial performance and IT investment are the corresponding dollar values measured at the end of each year. However, the dollar measures are inappropriate for standard statistical analysis because they are influenced by such economic factors as economic growth rate, industry output level, inflation rate, and exchange rate. To lessen these problems, we develop ratio scales for the three sector's inventory performance, financial performance, and IT investment during the last four decades (coverage from 1960 to 1999). Because we analyze the economic archival data, it is important to provide clear definitions of the terms, including *inventory*, *sales*, *profit*, and *IT investment*. Detailed definitions of the terminology are included in Appendix, Section II.

Inventory performance (*Inv_Perf*) of each sector is measured as a ratio of the sector's total inventory to total sales volume, which indicates the amount of inventory that is maintained in a sector to achieve a certain sales volume. Therefore, *Inv_Perf* of a sector represents the companies' overall efficiency in inventory management. A higher value of *Inv_Perf* indicates a higher level of inventories and consequently a lower level of relative efficiency.

Financial performance (*Fin_Perf*) is measured as a ratio of a sector's profit to its sales volume. Thus, *Fin_Perf* of a sector is an indicator of the relative profitability of the sector. Higher values of *Fin_Perf* are a sign of greater profitability of a sector.

Investment in information technology (*IT_Invest*): Brynjolfsson and Hitt (1996) conclude that "mis-measurement of IT investment" is one of the main sources of equivocal results in the IT payoff studies. Because the measurement employed and the calibration used to adjust the impact of time can influence the final research outcome, it is recommended that an appropriate deflator be used to create an unbiased ratio scale for IT investment (Brynjolfsson and Hitt, 1996). Investment in information technology was measured as follows:

$$IT\_Invest = [(ITR_t - ITR_{t-1})/(ITR_{t-1})](ITR_t) \quad (1)$$

where ITR represents the ratio of IT investment to total private investment and

t represents the year of investment.

The term in square brackets of Equation (1) computes an annual change in IT

investment ratio (ITR) over consecutive years and represents a percent increase in ITR. Then, the term in square brackets is multiplied by the current year's ITR (outside the brackets), which is used as a deflator to eliminate outlier effects of IT investment in early years. In 1993, for instance, the retail sector's nominal increase in ITR over 1962 was 109.70%. However, the retail sector's IT investment ratio in 1963 was only 0.38%, indicating that the actual amount of IT investment in 1963 was not so significant compared to other private investments (such as buildings, utilities, and industrial equipment). To consider the relative importance of IT investment amount in comparison to other investments, the nominal increase rate was deflated to 0.42% (109.70% times 0.38%), using Equation (1). Therefore, in a limited way, *IT_Invest* can represent the effect of both cumulative IT asset value and the relative importance of net increase in IT investment.

Time (*T*) is an index of years where 1960 was coded as 1, 1961 was coded as 2 and so on. The index ranges from 1 to 40 for each of the 40 years included in the dataset. The time index is included to control for the effect of time in examining the association among other variables.

Interaction of IT Investment and Inventory Performance (*IT_Invest* x *Inv_Perf*) is computed by multiplying IT investment with inventory performance and standardizing the product. It is used to test the moderation effect of IT investment. High values of *IT_Invest* and low values of *Inv_Perf* would lead to a better financial performance. Therefore, *Inv_Perf* is inverse-coded so that the value of interaction term becomes higher when *Inv_Perf* is low and *IT_Invest* is high.

3.3. Research Methods

3.3.1. Hypothesis 1: Inventory trends

ANOVA is used to evaluate whether or not inventories have reduced over the last four decades. To do so, we adopt each of the last four decades (1960s, 1970s, 1980s, and 1990s) as the categorical independent variable for the ANOVA. Specifically, H1 is modeled as follows:

$$H1_0: \overline{Inv\_Perf}_{60s} = \overline{Inv\_Perf}_{70s} = \overline{Inv\_Perf}_{80s} = \overline{Inv\_Perf}_{90s}$$

$$H1_a: \overline{Inv\_Perf}_{60s} > \overline{Inv\_Perf}_{70s} > \overline{Inv\_Perf}_{80s} > \overline{Inv\_Perf}_{90s}$$

where $\overline{Inv\_Perf}$ *is a sector's average inventory-to-sales ratio for each decade.*

Although any duration of time can be used as ANOVA factors, a period of ten years is used for the following reasons. First, it is reasonable to divide the time period into decades. While there was little emphasis on inventory reduction during the 1960s, a distinct and dominant management program to improve inventory performance was introduced and prevailed in each of the other decades. For example, MRP became popular during the 70s, Just-in-time systems during the 80s, and supply chain management practices during the 90s. Second, comparison of average inventory levels across shorter time periods does not provide distinct and meaningful trends in inventory performance.

To ensure that grouping the data into decades is technically valid and does not violate the assumption of normality within the treatment cells, we conducted Kolmogorov-Smirnov goodness of fit test (Lilliefors, 1967), and Shapiro-Wilk normality test (Shapiro and Wilk, 1965). A total of twelve independent tests were

performed: 3 sectors x 4 decades. None of the treatment cells failed the Kolmogorov-Smirnov test and only one (*Inv_Perf* for the retail sector) failed the Shapiro-Wilk test. The test results indicate that our method does not violate the normality assumption.

Based on the ANOVA results, a set of post-hoc analyses was conducted to identify the pairs of means that significantly differ from each other. For each sector's data, we tested homogeneity of variance among the four treatment groups at .05 level of significance (α), using Leverne's statistic (Leverne, 1960). We report Dunnett's T3 pairwise mean comparisons, if the data failed in Leverne's test, violating the equal variance assumption. Otherwise, Tukey's Honest Significant Difference (HSD) is reported.

3.3.2. Hypothesis 2: Effect of investment in IT on inventory performance

Hierarchical regression analysis is used to test Hypothesis 2, which evaluates the effect of IT investment on each sector's inventory performance. To test Hypothesis 2, we propose the following group of standardized regression models.

$$\text{Model } A_1 : Inv\_Perf_{(t)} = \beta_1 T + \varepsilon_{(t)} \quad (2)$$

$$\text{Model } A_2 : Inv\_Perf_{(t)} = \beta_2 T + \beta_3 IT\_Invest_{(t)} + \varepsilon_{(t)} \quad (3)$$

where t is year ranging from 1960 to 1999 and $\varepsilon_{(t)}$ *is an error term with a mean of zero.*

In the first step, as shown in Eq. (2), the time index (*T*) is introduced as a

control variable because all the variables used in this research are time-dependent to some extent. Incorporating time (*T*) index into the regression models controls for the effect of time related factors (either unknown or excluded in this study) on the association among other variables. Therefore, the effect size of independent variable of interest on the dependent variable can be quantified more clearly (Cohen and Cohen, 1983, pp 88-89). In the second step, *IT_Invest* is entered to test its impact on *Inv_Perf* as shown in Eq. (3). A negative coefficient (β_3) for *IT_Invest* is expected because a larger amount of IT investment should lead to a lower inventory-to-sales ratio (*Inv_Perf*).

3.3.3. Hypothesis 3: Moderation effect of investment in IT on financial performance

Hierarchical regression is also used to test Hypothesis 3. Here, we evaluate the effect of inventory performance on the financial performance in each sector and the moderation effect of information technology on the association between the inventory performance and the financial performance, using the following standardized regression models.

$$\text{Model B}_1 : Fin\_Perf_{(t)} = \beta_4 T + \varepsilon_{(t)} \quad (4)$$

$$\text{Model B}_2 : Fin\_Perf_{(t)} = \beta_5 T + \beta_6 IT\_Invest_{(t)} + \beta_7 Inv\_Perf_{(t)} + \varepsilon_{(t)} \quad (5)$$

$$\text{Model B}_3 : Fin\_Perf_{(t)} = \beta_8 T + \beta_9 IT\_Invest_{(t)} + \beta_{10} Inv\_Perf_{(t)} + \beta_{11}(IT\_Invest_{(t)} \times Inv\_Perf_{(t)}) + \varepsilon_{(t)}$$

(6)

where t is year starting from 1960 to 1999 and $\varepsilon_{(t)}$ *is a error term with mean of zero.*

In each of the regression models for three sectors, the time index (*T*) is entered in the first step. In step two, *IT_Invest* and *Inv_Perf* are entered simultaneously. Lastly, the interaction term of IT investment and inventory performance (*IT_Invest* x *Inv_Perf*) is entered to examine the moderation effects of IT investment on the association between inventory performance and financial performance. The incremental F statistic and the t statistic for a coefficient provide information of each predictor's strength in its effect. Such variance partitioning procedures are commonly adopted to assess incremental effects of the predictors and moderation effects of the interaction terms (e.g. Boyer et al., 1997; Miller and Dröge, 1986; Tatikonda and Montoya-Weiss, 2001). Positive coefficients for *IT_Invest* (β_6 and β_9) and the interaction term (β_{11}) and negative coefficients for *Inv_Perf* (β_7 and β_{10}) are expected.

3.3.4. Mediation effect of inventory performance

In general, the mediation effect of *Inv_Perf* can be claimed to exist if 1) *IT_Invest* has a significant impact on the mediator (*Inv_Perf*), 2) the mediator has a significant unique impact on *Fin_Perf*, and 3) the effect of *IT_Invest* on *Fin_Perf* diminishes upon the addition of *Inv_Perf* in the regression model. Although these conditions can be investigated casually to judge whether or not the mediation effect exist, the procedure does not provide a formal statistical criterion in support of

mediation effects. Therefore, we conduct Sobel test (Goodman 1960, Sobel, 1982) and Goodman (I) test, two tests commonly used to examine mediation effects (Baron and Kenny, 1986). Both tests identify mediation effects by comparing the magnitude of unstandardized coefficients and their weighted standard error terms. It is recommended that both tests be used when the sample size is less than 50. Test statistics for Sobel test and Goodman (I) test converge when the sample size is greater than 50.

4. Statistical Results

Figures 2, 3, and 4 illustrate the general trends in inventory performance, and financial performance, and rate of changes in IT investment, respectively, for the manufacturing, wholesale and retail sectors.

Overall, average inventory levels increased between the 60s and 70s for all three sectors as evidenced by the increase in *Inv_perf* (see Figure 2). The manufacturing sector maintained the highest inventory-to-sales ratio (*Inv_perf*) during the first three decades that fell slightly below the retail sector during the 90s. The inventory level for the manufacturing sector exhibits a sharp decline only after the 80s perhaps due to the implementation of improvement programs, such as JIT, and the increased focus on efficiency during the 80s and 90s. The average inventory level for the wholesale sector remained unchanged during the 70s and 80s, but it has been inching upwards during the 90s. The retail sector's average inventory level also increased during the first three decades and has seen a small decline in the 90s.

[Figure 2 about here]

Figure 3 shows the financial performance measured as profit-to-sales ratio for the three sectors. Although the manufacturing sector has enjoyed the highest profit levels among the three sectors, it has also seen the sharpest decline between the 60s and 80s. Because of a steep decline in profit-to-sales ratio in the manufacturing sector, the gap between the manufacturing sector and the other sectors has narrowed in recent years. The retail sector also experienced a decrease during the period, with a pattern similar to that of the manufacturing sector. However, the retail sector recovered the lost ground during the 90s. The wholesale sector's financial performance shows a mixed trend.

[Figure 3 about here]

The average rate of change in IT investment has increased for all three sectors significantly over the last four decades; see Figure 4. Not surprisingly, the steepest increase occurred in the 90s. The increase appears most prominent in the wholesale sector partly because total private investment in the wholesale sector has observed the smallest increase compared to the other sectors, resulting in a large IT investment increase rates. On average, the wholesale sector's relative IT investment increase rate was 4.2 % in the 90s, compared to 2.2% for both manufacturing and retail sectors.

[Figure 4 about here]

4.1 Hypothesis 1: Inventory trends

The ANOVA results confirm the trends shown in Figure 2 and suggest that inventory performance indeed differs significantly over the four decades in all three sectors (Table 1). The post-hoc analysis, which compares the treatment group means

in a pairwise manner, indicates specifically which decades' inventory performance exhibited significant differences (Table 2).

[Tables 1 and 2 about here]

The average inventory levels in the manufacturing sector during the 90s are significantly lower than the inventory levels in the 60s (mean difference: $\mu_d = .292$, $p < .00$), 70s ($\mu_d = .307$, $p < .00$) and 80s ($\mu_d = .248$, $p < .00$); other pairwise comparisons were not significant. While some significant differences were found in both wholesale and retail sectors, the differences were in the opposite direction, meaning that average inventories in the later decades were higher than the earlier decades. In the wholesale sector, significant differences were found between the 60s and 80s ($\mu_d = -.066$, $p < .05$) and the 60s and 90s ($\mu_d = -.081$, $p < .01$); no other paired means were found significantly different. In the retail sector, inventory levels differed significantly between the 60s and 80s ($\mu_d = -.080$, $p < .00$), 60s and 90s ($\mu_d = -.065$, $p < .01$), and 70s and 80s ($\mu_d = .048$, $p < .05$); all other paired mean differences were insignificant.

Based on ANOVA and post hoc analysis, we can conclude that inventory levels have changed over the last four decades although not all decreased during the time period. In fact, only the manufacturing sector experienced a significant decrease while inventory levels increased for the other two sectors. Therefore, Hypothesis 1 ($H1_a$) is supported only for the manufacturing sector. Because of the contrasting trends in the inventory levels among the three sectors, an exploratory correlation analysis was conducted to examine pairwise bivariate correlations among the three sectors' inventory levels. None of the bivariate correlations were

significant at .05 level of significance.

4.2. Hypothesis 2: Impact of IT Investment on inventory performance

Table 3 summarizes the hierarchical regression results for the test of Hypothesis 2. *Inv_Perf* was the dependent variable, and time index and *IT_Invest* were entered in a sequential manner described earlier. Overall, the final regression model (Model A_2) explains significant amount of the variance in inventory performance for each of the three sectors. Specifically, the model explains 61.1% ($F = 29.067$, $p < .00$) of variance in *Inv_Perf* for the manufacturing sector, 24.6% ($F = 6.043$, $p < .01$) for the wholesale sector and 44.1% ($F = 14.571$, $p < .01$) for the retail sector. Time effect accounts for a large and significant amount of variance in each of the three models. This result is in agreement with Stock et al (2001), who also found that time effect accounts for a relatively large portion of variance in the dependent variables while analyzing time dependent data. The inclusion of *IT_Invest* results in a significant change in R^2 for the manufacturing and retail sectors but not for the wholesale sector.

[Table 3 about here]

In the manufacturing sector, time is negatively associated with *Inv_Perf* ($\beta_2 = -.537$, $p < .00$), implying that the inventory levels decreased significantly during the last four decades; see Model A_2 in Table 3. *IT_Invest* is also negatively associated with *Inv_Perf* ($\beta_3 = -.323$, $p < .05$), and adding *IT_Invest* into the model results in a significant incremental increase in the R^2 of .063 ($p < .05$). Therefore, we can conclude that 6.3 % of the variance in *Inv_Perf* can be attributed to the influence of

IT_Invest. The results confirm that increasing rate of investment in information technology leads to a significant reduction in the inventory levels of the manufacturing sector. Thus, Hypothesis 2 ($H2_a$) was supported for the manufacturing sector.

In the wholesale sector, time has a positive and significant association with *Inv_Perf* (β_2 = .566, p < .01) suggesting that inventory levels have increased in this sector over the four decades (Model A_2). The relationship between *IT_Invest* and *Inv_Perf* is not statistically significant (β_3 = -.109, p > .05), although it is in the expected direction. Accordingly, adding *IT_Invest* into the model does not result in a significant increase in R^2, and Hypothesis 2 ($H2_a$) was not supported for the wholesale sector.

The regression results for the retail sector are most interesting. The time index is positively associated with *Inv_Perf* (β_2 = .806, p <.00) with an R^2 of .311, suggesting that the inventory level increased significantly during the last four decades. *IT_Invest* is also found to be negatively associated with *Inv_Perf* (β_3 = -.438, p < .01), supporting Hypothesis 2 ($H2_a$) for the retail sector. Incorporating *IT_Invest* into the model results in a significant increase in the R^2 (incremental R^2 = .130, p < .01). This result clearly indicates that the increased investment in IT has a positive influence on inventory performance when the effect of time is controlled in the model.

4.3. Hypothesis 3: IT Investment, inventory performance and financial performance

Table 4 summarizes the hierarchical regression results for the test of Hypothesis 3. In each regression, the sector's profit-to-sales ratio (*Fin_Perf*) was the dependent variable, and the independent variables were introduced in the following hierarchical order: time index (Model B_1), *IT_Invest* and *Inv_Perf* (Model B_2), and the interaction term, *IT_Invest* x *Inv_Perf* (Model B_3).

Initially, three regression models (Models B_1, B_2, and B_3) were run to test Hypothesis 3. However, adding the interaction term, *IT_Invest* x *Inv_Perf*, into the regression model (Model B_3) did not improve the R^2 significantly in any of the three sectors (see Table 4). The results fail to provide support for the moderation effect of IT investment on other variables. In other words, the impact of inventory performance on financial performance was not altered (moderated) by the level of IT investment. Consequently, determining which of the two models (Models B_2 and B_3) is relevant and should be chosen as the final model for interpretation becomes a critical issue.

A prevailing approach suggests that we should prefer Model B_3 to Model B_2 because the inclusion of interaction term reduces the error term ($1 - R^2$). That is, it reduces the amount of variance in dependent variable that is not explained by the model. However, this rule cannot be applied universally, especially when the inclusion of an independent variable deteriorates the reliability of the regression model, leading to a decrease in F statistic (Cohen and Cohen, 1983; Neter et al., 1996). As shown in Table 4, F statistics of Model B_2 are 46.589 for the manufacturing sector and 21.315 for the retail sector. In Model B_3, these F values are significantly lower; they are 36.683 and 15.567 for the manufacturing and the

retail sector respectively. Therefore, Model B_2 was chosen as the final model for interpretation and discussion purposes.

The final regression model (Model B_2) explains significant amount of variance in *Fin_Perf* for the manufacturing (R^2 = .795, F = 46.589, p < .00) and the retail (R^2 = .640, F = 21.315, p < .00) sectors but not for the wholesale sector (R^2 = .140, F = 1.958, p > .05).

[Table 4 about here]

In the manufacturing sector, time accounts for a significant amount of variance of *Fin_Perf* with an R^2 of .552 (p < .00). Adding *IT_Invest* and *Inv_Perf* into the model led to a significant increase in R^2 by .243 (p < .00). Adding the interaction term has increased R^2 by .012, but the increase was not statistically significant (p > .05). In Model B_2 for the manufacturing sector, time has a significant and negative association with *Fin_Perf* (β_5 = -1.314, p < .00), indicating that in general the manufacturing sector's profitability has reduced for the last four decades. *IT_Invest* is positively associated (β_6 = .118) with *Fin_Perf*, but the association is not significant. *Inv_Perf* shows a significant negative association with *Fin_Perf* (β_7 = -.672, p < .00). These results indicate that manufacturing sector's reduced inventory levels especially in the 80s and 90s has a positive influence on the financial performance when the effect of time (trend) is controlled. In other words, the reduced inventory level in the manufacturing sector over the last four decades has contributed to improving financial performance of the sector. Therefore, for the manufacturing sector, only Hypothesis 3-2 ($H3\text{-}2_a$) was supported.

None of the repressors was found to be significant for the wholesale sector.

In the wholesale sector, many unknown factors seem to intervene in the relationships among the variables under investigation. Hypothesis 3 was not supported for the wholesale sector, and detailed discussions will not be presented.

In the retail sector, time also accounts for a significant amount of variance of *Fin_Perf* with an R^2 of .142 ($p < .05$). Adding *IT_Invest* and *Inv_Perf* into the model also leads to a significant incremental increase in R^2 (incremental $R^2 = .498$, $p < .00$) as shown in Table 4. Adding the interaction term does not improve the model (incremental $R^2 = .00$, $p > .05$) at all.

In Model B_2 for the retail sector, whereas both time index and *Inv_Perf* are statistically significant ($p < .00$), *IT_Invest* ($p > .05$) is not significant. Therefore, only Hypothesis 3-2 (H3-2_a) is supported for the retail sector. Time is positively associated with *Fin_Perf* ($\beta_5 = .808$, $p < .00$), indicating that overall the financial performance in the retail sector has increased with time. The coefficient for *Inv_Perf* is significant and negative ($\beta_7 = -.826$, $P < .00$), meaning that the lower the inventory level, the higher the financial performance.

4.4. Mediation effect of Inv_Perf on the association between IT_invest and Fin_Perf

Figure 5 illustrates the detailed structure of the mediation model and also presents statistics (unstandardized beta coefficients, standard errors of beta coefficients, and corresponding p-values) obtained from the individual regression analyses, using Models A_2 and B_2. The unstandardized beta coefficients and the corresponding standard errors are used as input for Sobel test and Goodman (I) test as shown in Figure 5.

[Figure 5 about here]

The test results are summarized in Table 5. The mediation effect of *Inv_Perf* on the association between *IT_Invest* and *Fin_Perf* was found significant for manufacturing ($p < .05$) and retail ($p < .01$) sectors for both Sobel and Goodman (I) tests. In addition, the mediation effect was stronger in the retail sector. However, the mediation effect of *Inv_Perf* was found insignificant in the wholesale sector ($p > 0.05$). These results suggest that the mediation model in Figure 1(b) is more appropriate than the moderation model in Figure 1(a) to explain the empirical linkage among IT investment, inventory performance, and financial performance.

[Table 5 about here]

5. Findings and Discussion

This research suggests three major findings. In this section, we discuss each of the findings and their implications.

5.1. Inventory trends in manufacturing, wholesale and retail sectors

With regard to inventory trend in the US economy from 1960 to 1999, the results are encouraging, but provide a mixed picture. While the relative inventory level (inventory-to-sales ratio) in the manufacturing sector has decreased significantly during that time period, the wholesale and retail sectors have seen an increasing trend. For the manufacturing sector as a whole, increased managerial emphasis on operational efficiency and implementation of performance improvement programs seem to have paid off. However, in both wholesale and retail sectors, other factors (hidden or excluded in this study) have saddled the wholesale and retail

sectors with higher inventory levels.

A possible explanation for the increased inventory levels in the wholesale and retail sectors is the increasing proliferation of products that is required to meet divergent consumer needs. According to "Annual Report by Federal Reserve Bank of Dallas (1998)," the number of available products has increased considerably in every product category in recent years. For example, the number of automobile models has increased from 140 in the early 70s to 260 in the late 90s, breakfast cereals from 160 to 340, and running shoe styles from 17 to 140.

Increasing number of products can lead to inventory performance differences among the economic sectors in two ways. First, given that retailers and wholesales do not hold raw materials and work-in-process inventories, implementation of process improvement programs could be less beneficial to both wholesale and retail sectors. Rajagopalan and Malhotra (2001) indirectly support this viewpoint, showing that while raw materials and work-in-process inventories decreased in a majority of manufacturing industries at SIC two-digit level, finished goods inventories decreased only in some of the industries.

Second, as manufacturers have reduced their inventories, the burden of meeting consumer demand has been pushed downstream to wholesalers and retailers. Due to the progress of information technology, consumers at every level have been gaining the capability to compare and purchase products to satisfy their specific needs at the click of a mouse. Probability of losing a customer in the event of insufficient or unavailable inventory is becoming really high, making both wholesalers and retailers more acutely aware of the importance of service levels and

of holding excess inventories. This may have prevented the retailers and the wholesalers from reducing their overall inventory levels as extensively as manufacturers.

5.2. Role of IT on Inventory Performance

Impact of IT on firm performance is associated with a significant amount of hedging both at conceptual and at empirical level. At a conceptual level, Carr (2003) has recently argued that as the rate of investment in IT increases, and as IT becomes more ubiquitous, its impact on performance becomes increasingly smaller and ultimately disappears. At the empirical level, there are studies that show a positive, negative and even zero impact of IT on firm performance. The empirical ambiguity is often considered a consequence of the level of data aggregation, which is adopted to measure IT investment. Kohli and Devaraj (2003) suggest that as the aggregation level increases from firm level to a macro industry level, the impact of IT investment on performance becomes less evident.

Our findings do not conform to either of these contentions. The results suggest that, even after controlling for the effect of time, a higher rate of increase in IT investment is significantly associated with a lower level of inventories in both manufacturing and retail sectors, although not in the wholesale sector. One of the strengths of this industry group level research stems from its extensive data coverage from 1960 to 1999. Although important information technology applications, such as MRP and EDI, have been available since the 70s, most studies do not capture the benefits of these early investments in IT. In this context, the current findings of this

research make important contribution to the existing IT payoff literature.

While the negative association between IT investment and inventory level is not surprising for the manufacturing sector, it is somewhat unforeseen in the retail sector because in the retail sector both IT investment and inventory level demonstrated an increasing trend during the four decades. The significant and negative association is driven by the fact that inventory level in the retail sector increased at a decreasing rate in part due to the effect of investment in IT. Therefore, it is reasonable to conclude that without significant investment in IT, inventory level in the retail sector could have been higher. In other words, the rate of inventory level increase in the retail sector has been slowed down due to the investment in information technology.

We did not find the same significant impact of IT investment on inventory performance for the wholesale sector. Although the wholesale sector's IT investment has been increasing at a faster rate than that of the manufacturing and retail sectors, the wholesale sector's IT investment did not seem to translate into similar gains in inventory reduction. It is possible that IT investment in the wholesale sector is concentrated on enhancing coordination activities with trading partners in the manufacturing and retail sectors, making them the bigger beneficiaries of the increased investment. This result needs further examination in the future studies.

5.3. Inventory, IT Investment, and Financial performance

We find significant direct effects of inventory performance on financial

performance in the manufacturing and retail sectors but not in the wholesale sector. While the results from hierarchical regression clearly support the direct relationship, it can also be detected from Figures 1 and 2. As the retail sector's average inventory-to-sales ratio increased from the 60s to the 80s, the sector's profit-to-sales ratio decreases steadily. As the average inventory-to-sales ratio decreases slightly in the 90, the average profit-to-sales ratio improves. The results imply that the retail sector's poor inventory performance between the 60s and 80s is one of the main causes for the sector's worsening profitability during the period. The manufacturing sector's inventory and financial performance also shows similar patterns. When the inventory level increased between the 60s and 70s, the manufacturing financial performance deteriorated. The manufacturing sector's financial performance was improved between the 80s and 90s, leveraged by the sector's inventory performance improvement during the period. This strong association between inventory performance and financial performance in the manufacturing and retail sectors provides sound empirical evidence that reduction of inventories has a directive influence on the companies' financial performance.

Our research does not support a direct or a moderating role of IT investment and financial performance in any of the sectors. Rather, it appears that the impact of IT investment is mediated by the direct effect of inventory performance on financial performance. Some of the IT payoff studies provide possible explanations why the financial benefit of IT investment could not be easily detected; 1) lagged benefits of IT investment (Brynjolfsson and Hitt, 1998), 2) limited set of control variables that can reduce error terms by eliminating the noise of extraneous factors (Devaraj and

Kohli, 2003), 3) conflicting effect of IT investment which increases asset base but directly lowers profit each year, and so forth.

Although these explanations have been widely accepted, the findings from the present study strongly suggest that the benefits of IT investment are rather indirect through the improvement in operational performance. More specifically, our findings suggest that the manufacturing and the retail sectors' increased IT investment has contributed to the sectors' improved inventory performance, which in turn has shown a positive influence on financial performance. Therefore, the effect of IT investment on financial performance appears mediated by the stronger effect of inventory performance on financial performance. This result is consistent with the industrial organization paradigm proposed by Scherer and Ross (1990) that operational excellence (conduct) is a requisite for a successful implementation of strategy and structural decisions in order to improve firm's performance.

5.4. Managerial Implications

Our research findings have important managerial implications. First, results suggest that reducing inventories has a significant and direct relationship to financial performance. This provides strong justification for current managers to continue to emphasize efficient inventory management and supply chain inventory coordination. The results have added salience for the managers in the wholesale sector, given that the inventory levels in the wholesale sector have been increasing over the years. Perhaps, the managers in the wholesale sector need to seek out appropriate improvement programs applicable to their specific operations. Second, the

importance of operational excellence cannot be ignored. Our findings suggest that the financial benefits of IT investment will be realized indirectly through improvement in inventory performance. The large effect size of inventory performance on financial performance and the significant mediation test results collectively demonstrate that operational excellence is a necessary condition for reaping long term benefits from implementation of structural decisions (IT investment).

6. Conclusion

In this research, we evaluated important relationships among IT investment, inventory performance, and financial performance at the aggregated manufacturing, retail and wholesale sector level. The research objective was to find empirical evidence for the theory that companies' focus on operational excellence in inventory management and the relevant IT investment would enhance the firms' profitability in the long run.

The findings of this research make important contributions and raise meaningful research questions as well. First, the ANOVA results show that not all industries witnessed significant inventory reductions during the last four decades. Opposed to the conventional wisdom that inventory performance of the US firms has improved over time, the retail and the wholesale sectors have encountered a significant increase in their inventory levels. Inventory levels have declined only in the manufacturing sector.

Second, the findings suggest that increased IT investment has an immediate,

positive, and significant impact on inventory reduction in the manufacturing and retail sectors, but not in the wholesale sector. Contrary to the argument forwarded by Carr (2003) in "IT doesn't matter,", our result provides a strong support for the managerial belief that investing in IT improves a firm's operational efficiency.

Finally, this research confirms that a reduction in inventory level leads to a higher level of financial performance for the manufacturing and the retail sectors. More interestingly, we do not find any support for a direct or a moderating effect of increased IT investment on financial performance, but the financial benefit of IT investment appears to exist through a mediation effect of improved inventory performance. In other words, increased IT investment improves inventory performance, which in turn improves financial performance

Limitations of this research are related primarily to the scope and the characteristics of the data used in the study. The empirical linkage and related hypotheses were tested based upon the economic data aggregated at the sector level. Although the results support a positive influence of IT investment on inventory performance and a positive impact of inventory reduction on financial performance, one must be careful when using the results to generalize at a lower level of aggregation such as business units, firms, or corporations. Thus, future research replicating this study at a lower level of aggregation can help explain the relevant relationships more in depth. In addition, underlying factors that caused opposing inventory patterns in different sectors are worth studying in the future. Identification of such factors can help firms promote the positive influences while minimizing the impact of factors that affect inventory trends negatively.

APPENDIX

In this appendix, we summarize the terminology of this research, which is also available on the Bureau of Economic Analysis site (http://www.bea.doc.gov/bea/glossary/glossary_i.htm) or US Census Bureau site (http://www.census.gov/mtis/www/mtis.html). Thus, additional citations are omitted.

I. Industry-group classification

Manufacturing industry group (sector) comprises companies engaged in the mechanical or chemical transformation of materials or substances into new products.

Wholesale Treading industry-group comprises companies with one or more establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The wholesaling process is an intermediate step in the distribution of merchandise.

Retail Trading industry group comprises companies with one or more establishments that sell merchandise and related services to final consumers.

II. Variable definitions

Inventory of each sector represents the total value of the end-of-month stocks. While inventories in the manufacturing sector includes purchased materials and supplies, goods in process, or finished goods regardless of stage of fabrication, inventories in the wholesale and the retail sectors are mainly merchandise inventories held for sales purposes. Inventories associated with the non-business activities are excluded.

Sales of each sector are monthly shipment data with seasonality adjusted. Sales are net values after deductions such as refunds and allowances for merchandise returned by customers. The industry group wide sales estimates are aggregated from three surveys conducted by the US Census Bureau: the Monthly Retail Trade Survey, the Monthly Wholesale Trade Survey, and the Manufacturers' Shipments, Inventories, and Orders Survey.

Profit represents aggregated *Corporate Profits* (quarterly data) of a sector with *Inventory Valuation Adjustment*.

Corporate profits are the income earned by corporations as a result of current production and established business. It excludes capital gains and losses, and it is calculated by valuing depreciation of fixed assets and inventory withdrawals at current cost, rather than at historical cost.

Inventory valuation adjustment is an adjustment made to corporate profits in order to remove inventory profits, which are more like a capital-gain than like profits from current production.

IT investment (quarterly data) represents the sum of three components (Computers and peripheral equipment, Software, and Other) as asset, which is categorized as Information

Processing Equipment Investment and Software in the non-residential area.

Total private investment (quarterly data) is a sum of the investments as asset including the investments in Buildings, Utilities, Mining Exploration, Shafts, Wells, Industrial Equipment, Transportation Equipment, Information Processing Equipment and Software and others.

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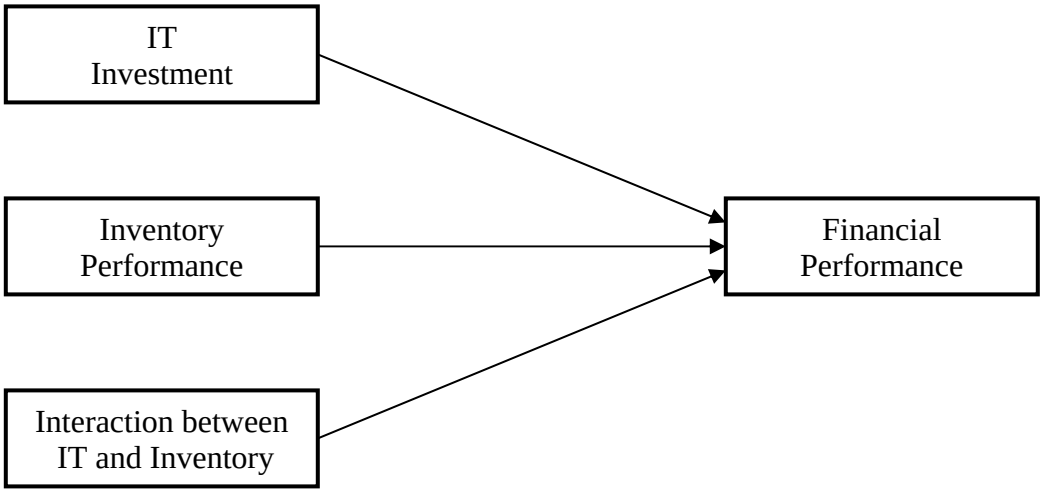
(a) The Moderation Model



(b) The Mediation Model

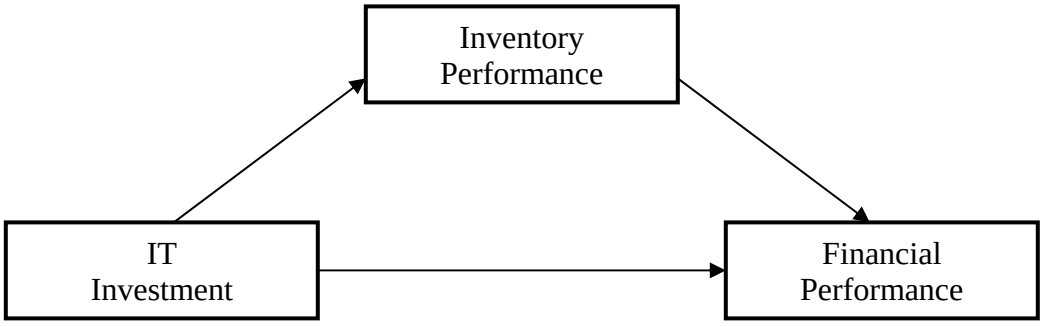


Figure 1: A Schematic Comparison between Moderation Model and Mediation Model

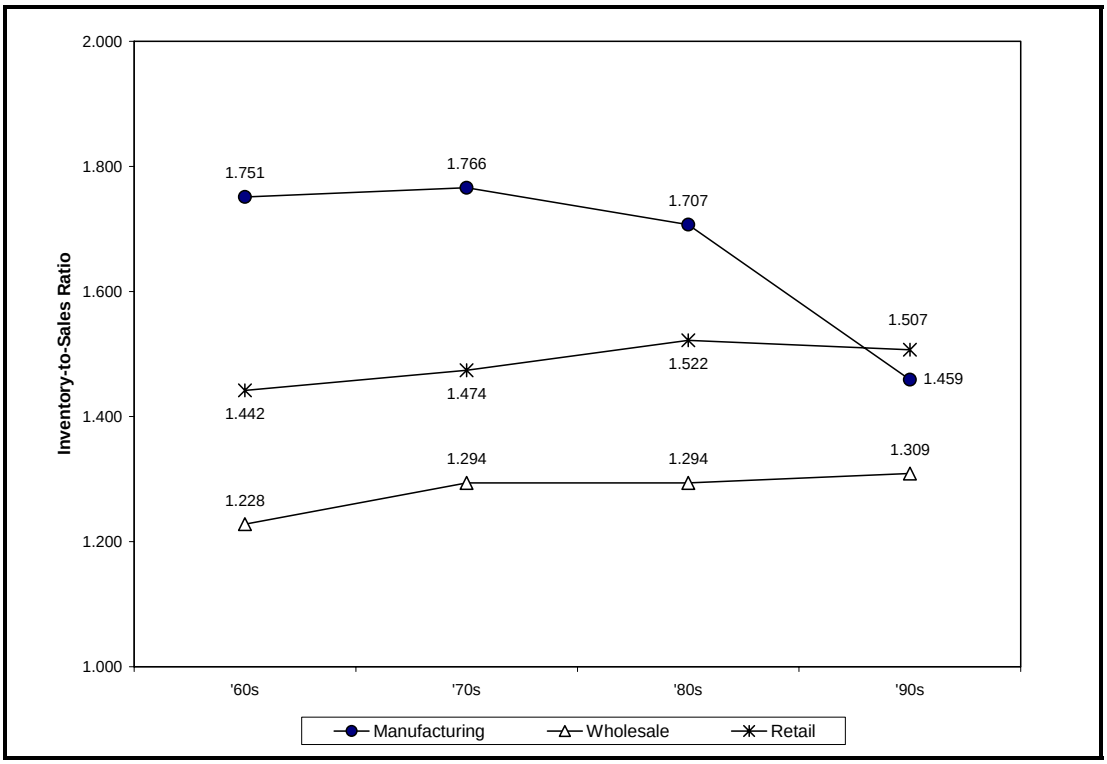


Figure 2: Trend of Inventory Performance: Average Inventory to Sales Ratios

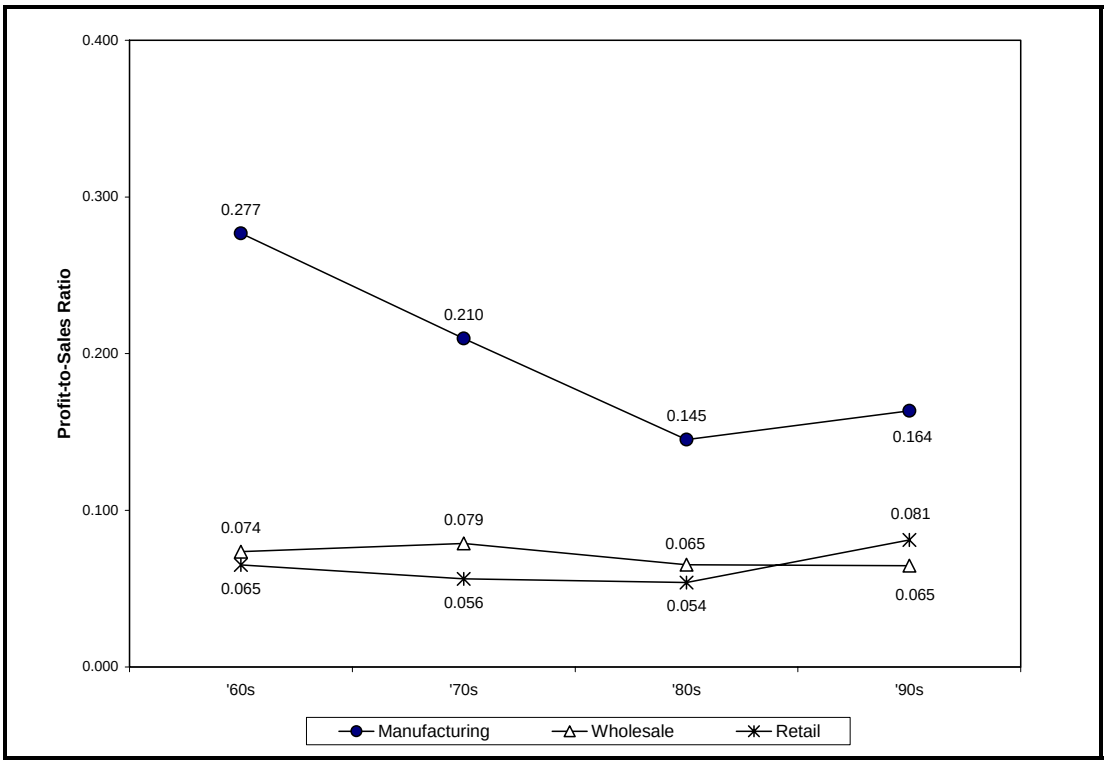


Figure 3: Trend of Financial Performance: Average Profit to Sales Ratios

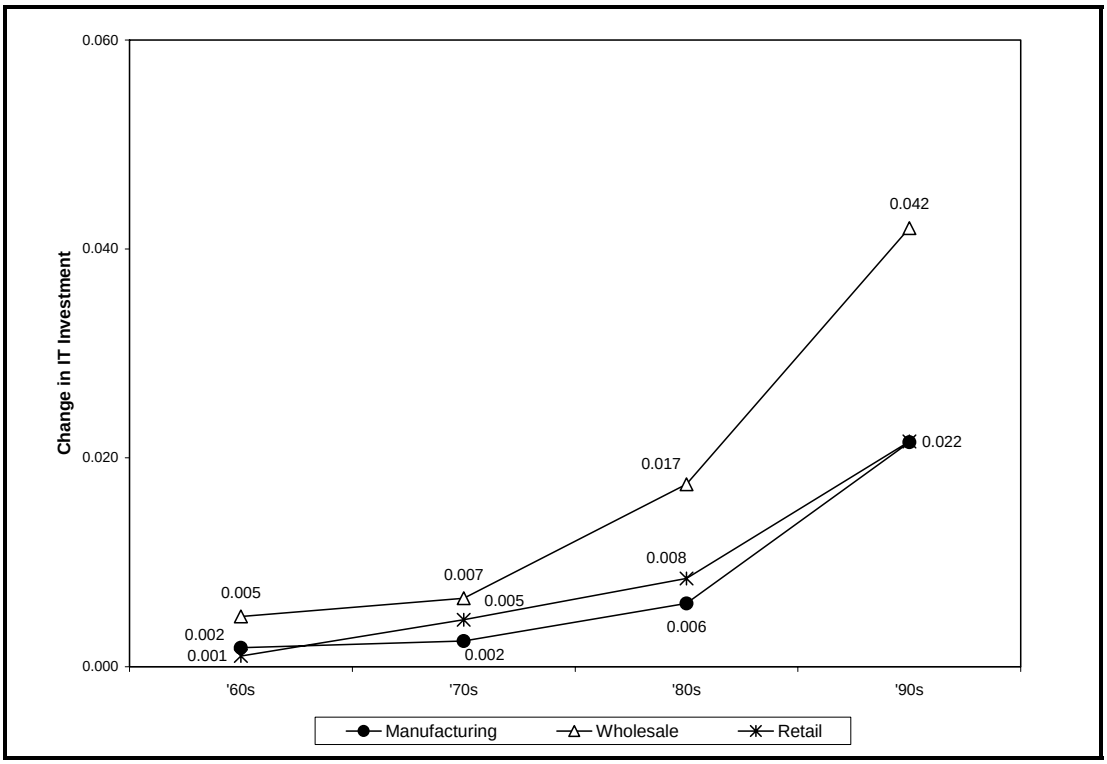
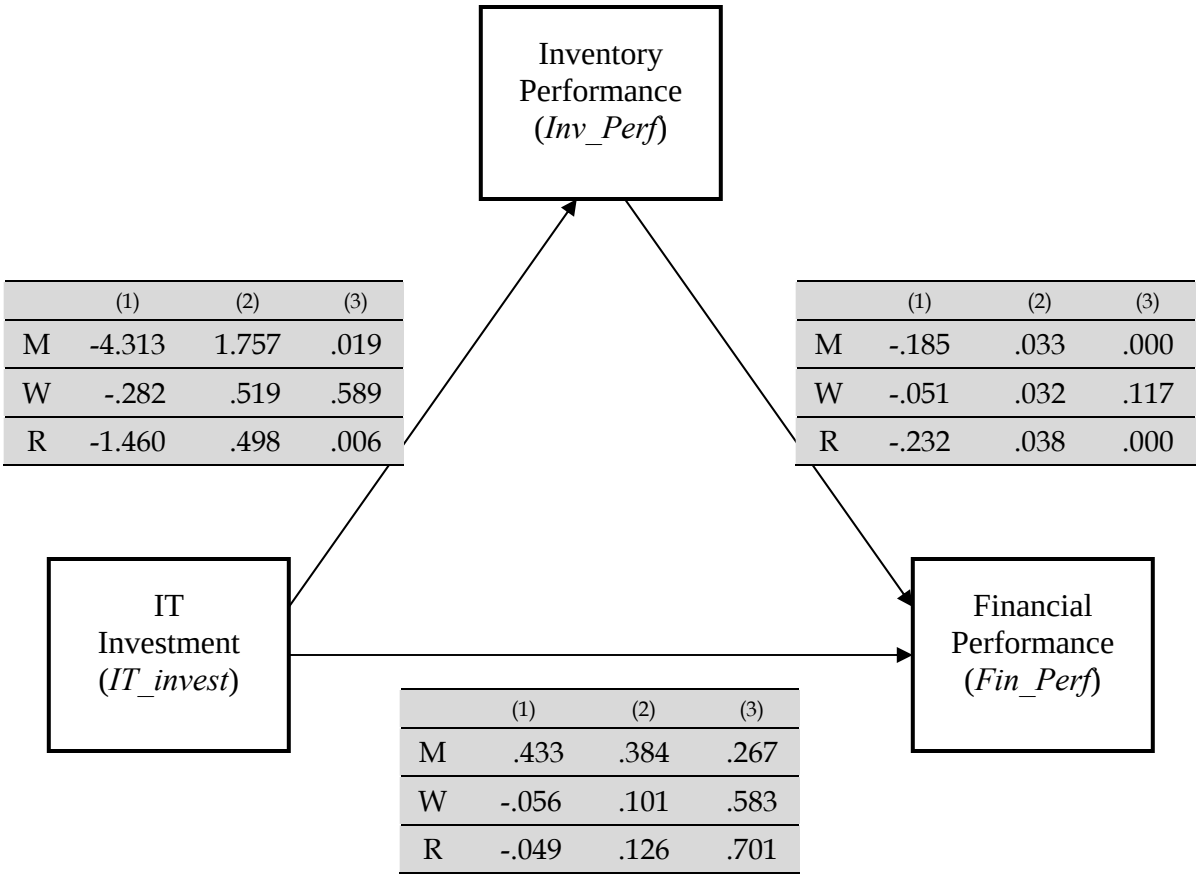


Figure 4: Trend of IT Investment Change: Average IT Investment Increase Ratio



	(1)	(2)	(3)
M	-4.313	1.757	.019
W	-.282	.519	.589
R	-1.460	.498	.006

	(1)	(2)	(3)
M	-.185	.033	.000
W	-.051	.032	.117
R	-.232	.038	.000

	(1)	(2)	(3)
M	.433	.384	.267
W	-.056	.101	.583
R	-.049	.126	.701

- **Legend**
  M: Manufacturing Sector
  W: Wholesale Sector
  R: Retail Sector
- The values in Tables are in the following order:
  (1) Unstandardized beta coefficient, (2) Standard error of beta coefficient, and (3) p-value

Figure 5: Input Statistics within the Mediation Model Structure

Table 1. ANOVA results on Inventory Performance (*Inv_Perf*: Inventory to Sales Ratio)

[Factor: Decades – ‘60s, ‘70s, ‘80s, ‘90s.]

		Sum of Squares	DF	Mean Square	F	p - value	R^2
Manufacturing Sector	Between Groups	.617	3	.206	22.340	.00	.651
	Within Groups	.331	36	.009			
	Total	.948	39				
Wholesale Sector	Between Groups	.039	3	.013	6.245	.00	.342
	Within Groups	.076	36	.002			
	Total	.115	39				
Retail Sector	Between Groups	.038	3	.013	8.183	.00	.405
	Within Groups	.056	36	.002			
	Total	.094	39				

Table 2. Inventory Performance (*Inv_Perf*) Mean Comparisons

	Factor (*I*)	Factor (*J*)	Inventory Performance Mean Difference (*I*)-(*J*)
Manufacturing Sector	‘60s	‘70s	-.015
	“	‘80s	.044
	“	‘90s	.292***
	‘70s	‘80s	.059
	“	‘90s	.307***
	‘80s	‘90s	.248***
Wholesale Sector	‘60s	‘70s	-.066
	“	‘80s	-.066*
	“	‘90s	-.081**
	‘70s	‘80s	.000
	“	‘90s	-.015
	‘80s	‘90s	-.015
Retail Sector	‘60s	‘70s	-.032
	“	‘80s	-.080***
	“	‘90s	-.065**
	‘70s	‘80s	-.048*
	“	‘90s	-.033
	‘80s	‘90s	.015

*$p < .05$; **$p < .01$; ***$p < .001$

Table 3. Hierarchical Regression on Inventory Performance (*Inv_Perf*: Inventory to Sales Ratio)

		Standardized Beta Coefficients	
		Model A_1	Model A_2
Manufacturing Sector	*Time index* (*t*)	-.740***	-.537***
	IT_Invest		-.323*
	R^2	.548	.611
	Change in R^2	.548***	.063*
	Model F statistic	46.023	29.067
	Model p-value	.000	.000
Wholesale Sector	*Time index* (*t*)	.490**	.566**
	IT_Invest		-.109
	R^2	.240	.246
	Change in R^2	.240**	.006
	Model F statistic	12.012	6.043
	Model p-value	.001	.005
Retail Sector	*Time index* (*t*)	.557***	.806***
	IT_Invest		-.438**
	R^2	.311	.441
	Change in R^2	.311***	.130**
	Model F statistic	17.125	14.571
	Model p-value	.000	.000

*$p < .05$; **$p < .01$; ***$p < .001$

- Model A_1 is for Eq. (2), and Model A_2 for Eq. (3)

Table 4. Hierarchical Regression on Financial Performance (*Fin_Perf*: Profit to Sales Ratio)

		Standardized Beta Coefficients		
		Model B_1	Model B_2	Model B_3
Manufacturing Sector	*Time index* (*t*)	-.743***	-1.314***	-1.288***
	IT_Invest		.118	-.249
	Inv_Perf		-.672***	-.532**
	IT_Invest x *Inv_Perf*			.466
	R^2	.552	.795	.807
	Change in R^2	.552***	.243***	.012
	Model F statistic	46.776	46.589	36.683
	Model p-value	.000	.000	.000
Wholesale Sector	*Time index* (*t*)	-.273	-.049	-.049
	IT_Invest		-.120	-.116
	Inv_Perf		-.286	-.289
	IT_Invest x *Inv_Perf*			-.004
	R^2	.075	.140	.140
	Change in R^2	.075	.066	.000
	Model F statistic	3.060	1.958	1.428
	Model p-value	.088	.138	.245
Retail Sector	*Time index* (*t*)	.377*	.808***	.815***
	IT_Invest		.052	.122
	Inv_Perf		-.826***	-.845***
	IT_Invest x *Inv_Perf*			-.078
	R^2	.142	.640	.640
	Change in R^2	.142*	.498***	.000
	Model F statistic	6.283	21.315	15.567
	Model p-value	.017	.000	.000

*$p < .05$; **$p < .01$; ***$p < .001$

- Model B_1 is for Eq. (4), Model B_2 for Eq. (5), and Model B_3 for Eq. (6).

Table 5. Test of Mediation Effects

		Test statistic (z)	p-value
Manufacturing Sector	Sobel Test	2.249	0.025
	Goodman (I) Test	2.219	0.026
Wholesale Sector	Sobel Test	0.514	0.607
	Goodman (I) Test	0.442	0.658
Retail Sector	Sobel Test	2.706	0.007
	Goodman (I) Test	2.683	0.007