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## **Comparative Analysis of IT Management and Productivity between Japanese and U.S. Firms<sup>1</sup>**

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### Abstract

This compares the use of IT at the firm level and its management practices between Japanese and U.S. firms, based on an analysis using data from the “International Comparative Survey of Firms’ IT Strategies.” According to our principal component analysis for characterizing the firm-level pattern of enterprise computing, three factors are identified: (1) overall IT-use intensity, (2) the degree of using information systems, and (3) the degree of using mission critical systems for the back office. In general, Japanese firms display high overall IT-use intensity, while the degree of informational system use is low. It is also found that the degree of informational systems and of using mission critical systems for the back office, instead of overall IT intensity is correlated with the total factor productivity (TFP) level of a firm, regardless of its nationality.

Key words: IT Management, Productivity, Japan, U.S.

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## 1. Introduction

Due to the declining birth rate and aging population in Japan, productivity growth is the key force in sustaining the long-term economic growth rate. The effective use of IT systems by firms is reported to be an important factor for increasing the productivity of the macro economy. The level of IT investment in Japan is not far behind that in the U.S., according to a macroeconomic comparison of IT and economic growth in the two countries (Jorgenson and Motohashi 2005). Despite the stagnant growth rate of the Japanese economy since the 1990s, Japanese firms have invested heavily in IT due to rapid technological progress and the rapid penetration of broadband infrastructure.

However, it is said that the productivity effects of IT in Japanese firms are limited compared with those in U.S. firms. According to a firm-level analysis on IT network use and the productivity of Japanese and U.S. firms, the productivity effects of network use in U.S. firms are twice that in their Japanese counterparts (Atrostic et al. 2005). IT is an effective tool for modernizing business processes at firms, but its effective use depends on how firms incorporate IT service management into their overall business strategies and management practices. In this sense, it is important to characterize a pattern of IT use in order to find possible factors behind the under-performance of Japanese firms on IT investment.

The Research Institute of Economy, Trade and Industry (RIETI) conducted the “International Comparative Survey of Firms’ IT Strategies” for listed companies in Korea, Japan, and the U.S. in 2006. The survey covered the level of IT systems deployment (e.g., IT investment per sale and coverage of IT system use by type of business), the relation between IT and management strategies, and internal and external IT management organization (duties of CIO, IT outsourcing, etc.). Motohashi (2007) provided a comparative analysis of Japanese, U.S., and Korean firms on IT and management, based on the firm-level data of this survey. This paper focuses on the comparison of Japanese and U.S. firms, and investigates the productivity impact of IT management of firms in both countries.

The next section of this paper reports the results of the comparative analysis of IT use and management for Japanese and U.S. firms. A principal component analysis reveals three factors illustrating patterns of IT use: (1) overall IT use intensity, (2) the degree of using informational systems and (3) the degree of using mission critical systems for the back office. Section 3 provides the results of regression analysis on IT use, IT management, and productivity level, where productivity impacts are compared between

Japanese and U.S. firms. In Section 4, outsourcing activities are used as a performance measurement, and the relationship between IT use and management is investigated. Finally, Section 5 provides a summary of findings and some managerial implications.

## 2. Comparison of IT use in Japan and the U.S.

The “International Comparative Survey of Firms’ IT Strategies” has been conducted by RIETI (Research Institute of Economy, Trade and Industry) for listed companies in Japan, the United States and Korea, which focused on revealing how IT is being used and its linkages with managerial strategies in relatively large firms. The topics of the survey are “Deployment of IT systems,” “The relation between IT investments and management strategies,” “Internal IT Organization,” and “Outsourcing of IT systems.” In this paper, the data on both Japanese firms (317 samples) and U.S. firms (200 samples) are used (see Motohashi [2007] for details).

Figure 1 shows the share of firms which have introduced each of the 11 types of IT system in Japan and the U.S. In both countries, a high deployment ratio can be found in “personnel/wage management,” “accounting transactions,” “document management,” and “ordering management.” For the two-country comparison, U.S. firms have a higher deployment ratio in areas such as “management strategy support,” “market analysis/building customer relations,” “production planning,” and “design support,” whereas the ratio is lower in “personnel/wage management” as compared to Japanese firms.

The Japanese Ministry of Economy, Trade and Industry (METI) "ICT Workplace Survey" detailed IT use and the effects of IT investments by Japanese firms. The results of this survey indicate that Japanese firms have been successful in increasing the effectiveness of their businesses by introducing accounting informational systems or reducing inventory costs by implementing inventory management systems. But only a small portion of firms have been able to use IT to increase sales, for example by developing new customers (METI 2005). In addition, comparing the IT investment patterns of Japanese and U.S. firms, U.S. firms have invested heavily in areas that strengthen the competitiveness of the firm, such as systems that support decision-making and analyze the environment that the firm is facing (JEITA 2007). This is consistent with the results of the survey in the METI study.

Referring back to the results regarding the differences in the types of areas that IT systems are deployed in Japanese and U.S. firms, the ratio of system deployment in Japanese firms is high in areas directed toward “mission-critical systems,” or systems

that increases efficiency of daily business operations, such as order management and systems for the back office divisions, whereas deployment lags in “informational systems” such as managerial strategy support, market analysis/developing new customers, and design support/information management of technology. Mission-critical systems are a typical type of system that rationalizes business processes. These systems been implemented since the advent of general-purpose computers in the 1970s and are a classical means of IT use by firms. On the other hand, recently, great attention is paid to the use of “informational systems” to perform intricate analysis regarding management decision-making and market analysis using data collected by the mission-critical systems. The idea of using informational systems to facilitate managerial strategies has been around since the 1970s, exemplified by concepts such as management information systems (MIS) and decision support systems (DSS). But it was not until the 1990s that these systems became of practical use due to the sharp increase in memory and processing capabilities of computers. Data warehouses have been created in order to integrate information that was previously dispersed around the firm, and data mining techniques have enabled firms to extract critical information from the data warehouse to facilitate corporate strategy. In the 2000s, the concept of business intelligence (BI) has been put forward to offer a user-friendly environment and enable access to non-IT specialists of the management and planning divisions of the firm.

We have conducted a principal component analysis of 11 types of IT-use variables, in order to characterize the firm-level pattern of IT use. Table 1 shows the coefficients to the first three components. For these three components, about 63.3% of total variance can be explained.

The first component has positive coefficients to all types of IT systems. Therefore, this factor shows the overall IT intensity of a firm. In the second component, positive coefficients are loaded to “management strategy support,” “market analysis/developing customers,” and “customer relationship management,” while negative ones are found with “inventory management” and “ordering management.” Therefore, this component can be interpreted as a degree of the informational system feature of an IT system (versus a mission-critical system). Finally, in the third component, positive coefficients are loaded to “personnel/wage management,” “accounting transactions,” and “document management,” while negative ones are found with “production planning/process” and “design support.” Therefore, this factor can be interpreted as the degree of back office-type mission-critical system as compared to a production-related mission-critical system.

(Table 1)

In Table 2, the scores of these three components are compared between Japanese and U.S. firms. In general, Japanese firms have higher overall IT intensity than U.S. ones. On the other hand, the degree of informational system use is lower in Japanese firms. Finally, the degree of back office-type mission critical system is higher for Japanese firms.

(Table 2)

### 3. IT use, IT management, and productivity

In this section, the relationship between IT use, IT management, and productivity is investigated by regression analysis. As IT use variables, we use the three principal components in the previous section: overall IT intensity, the degree of informational system (versus mission-critical system) and the degree of back office-type mission-critical system (versus product-related mission-critical system).

In terms of IT management factors, we use a variable regarding the linkage between IT strategy and corporate strategy. In order to achieve better performance from IT, it is important to align IT system architecture with business strategy at the corporate level instead of deploying an IT system depending on individual specific needs in an ad-hoc way. Therefore, whether an IT strategy (3-5 year IT investment strategy at a firm) is developed in line with the corporate strategic plan can be a good indicator of better IT management. Figure 2 compares Japanese and U.S. firms with regard to the linkage between IT strategy and corporate strategy. Firstly, the share of firms with an IT strategy is found to be smaller for Japanese firms. Also, the share of firms for which an IT strategy is clearly defined in the corporate strategy is larger in U.S. firms. Therefore, generally speaking, the linkage between IT strategy and corporate strategy is stronger for U.S. firms.

(Figure 2)

In order to address the question of the productivity impact of IT variables, we use the following TFP index at each firm  $i$  over time  $t$ .

$$\ln TFP_{i,t}^j = \ln VA_{i,t}^j - \overline{\ln VA_{i,t}^j} - S_{emp_t}^j \cdot (\ln EMP_{i,t}^j - \overline{\ln EMP_{i,t}^j}) - (1 - S_{emp_t}^j) \cdot (\ln CAP_{i,t}^j - \overline{\ln CAP_{i,t}^j})$$

(1)

Where VA, EMP, and CAP are value added, the number of employees, and capital stock,

respectively, for firm ‘i’ in year ‘t’, and  $\overline{X_{i,t}^j}$  is an average of X over the category by industry, country, and firm size (‘j’). Semp is the shares of labor compensation, i.e., an average of the ratio of total wage to value added of the category ‘j.’ and that of the firm ‘i’. This TFP index indicates the relative productivity of each firm within each industry, country, and firm size, which is widely used in literature on the relationship between the market dynamics of productivity (Baily et al. 1992). The data for VA, EMP, and CAP are collected from financial statement data from the Development Bank of Japan for Japanese companies and from the Compustat North America Database for U.S. companies. In RIETI’s IT management survey, the variable of IT use is available for around 2003 as well as more recent status (2006), the data for financial statements are collected for 2003 and 2005 (most recent data).

This TFP index for two years (2003 and 2005) is regressed with the following variables.

- Three principal components in Section 3 of (1) overall IT use, (2) the degree of informational system use, and (3) the degree of back office-type mission-critical system use
- Japanese firm dummy
- Cross terms of three principal components and a Japanese firm dummy
- IT Strategy dummies: ITStrategy1 for a firm for which the IT strategy is clearly defined in its corporate strategy as 1 and ITStrategy2 for a firm for which the IT strategy is not clearly defined but consistent with the corporate strategy as 1
- Cross terms of IT strategy dummies and principal components
- Cross terms of IT strategy dummies and Japanese firm dummy

A year dummy is also included, and it should be noted that the industry and firm size dummies are not needed here since the TFP index (dependent variable) is a relative measure within each industry, firm size, and country. Regression results are presented in Table 3.

(Table 3)

The result in Model (1) shows that the productivity difference among firms does not come from the overall IT use intensity, but the way in which a firm uses IT. Both the degree of informational system use and back office-type, mission-critical system use

are positively correlated with productivity. When a Japanese firm dummy is included in Model (2), statistically significant coefficients to the principal component factors disappear. However, the value of coefficients to principal components factors does not change very much, which suggests that there is no systematic difference for the result in Model (1) across countries.

In model (3), the relationship between IT strategy variables and productivity is tested. A firm with an IT strategy clearly defined in corporate strategy (ITStrategy1) is found to have higher productivity, while a firm with an IT strategy not clearly defined (ITStrategy2) does not. Model (4) is an extension of Model (3), by way of including a Japanese firm dummy. We cannot find a significant difference in the results across countries. In Model (5), IT strategy variables and principal component factors are interacted. It is found that the coefficient to cross term of the component 3 and ITStrategy1 is positive and statistically significant, which means that the use of a back office-type, mission-critical system and the consistency between an IT strategy and corporate strategy are complementary from the viewpoint of the productivity level. Finally, the result in the full model (Model 6) suggests these findings are not coming from country effects, but applied to firms in both countries.

#### 4. IT Management and outsourcing performance

Management of IT outsourcing can be another type of outcome measurement of IT use and IT management. A firm with better understanding of its business processes with clear strategic objectives for IT investment may be able to achieve better performance from IT outsourcing projects. In contrast, a firm without a clear idea about IT architecture at the corporate level cannot make a good “make” or “buy” decision on IT services. Consequently, an outsourcing project by such firms will end up with unsatisfactory results.

In the RIETI international IT strategy survey, data on outsourcing management is available. We acquired information on two kinds of outsourcing projects (firm-wide mission-critical systems and division-specific systems). For each type of outsourcing project, a firm is asked to choose from three options: outsourcing projects are “ordered after outsourcing activities are clearly defined,” “ordered before articulation of outsourcing specification,” or the firm “decided outsourcing contents upon consultation with counterpart.” Among these options, “order after outsourcing activities are clearly defined” is the best way to manage outsourcing projects. Here, multi-nominal logit regressions are conducted by using “decided outsourcing contents upon consultation



with counterpart” as the base category, and all IT use and management variables in the previous section as independent variables. The results are provided in Table 4.

(Table 4)

The Japan dummies for “clarification before outsourcing” and “clarification after outsourcing” are negative for both types of outsourcing project. Compared to U.S. firms, Japanese firms are likely to decide outsourcing projects via consultation with outsourcing partners. This finding reflects that Japanese firms may not have clear IT architecture. In the “International Comparative Survey of Firms’ IT Strategies,” a large proportion of Japanese firms reported that “The system deployment did not proceed as stated in the contract and resulted in high cost.” The likely reason for this is that the outsourcing activity starts before the terms of the contract are finalized and the terms of the agreed upon contract are ambiguous, as is shown in Table 4.

It is often noted that prepackaged software is not popular and custom software is used extensively in Japanese firms (Motohashi 2005). Compared with the customization of prepackaged software, production of custom software requires meeting specific, individual user needs. In this case, it becomes arduous to clearly state the terms of the contract ex ante due to the complexity of the terms of the outsourcing activity. Therefore, these differences in the terms of the contract may have affected the results, which indicate ambiguous responsibility between the outsourced and outsourcing firms.

However, it should be noted that the Japanese firms with higher IT intensity and degree of informational IT use are likely to clarify activities before outsourcing (positive and statistically significant coefficients to the cross terms of Japan and component 1 and 2 in model 5]). In addition, a firm in which the IT strategy is clearly stated in its corporate strategy is likely to clarify activities before outsourcing. Therefore, while Japanese firms, in general, are not as good at outsourcing management when compared to U.S. firms, the firms which have invested in informational systems with well-defined IT strategies are relatively better in their outsourcing management practices.

## 5. Conclusion

This paper compares the use of IT at the firm level and its management practices between Japanese and U.S. firms, based on an analysis using data from the “International Comparative Survey of Firms’ IT Strategies.” According to our principal component analysis for characterizing the firm-level pattern of enterprise computing, three factors are identified: (1) overall IT-use intensity, (2) the degree of using

information systems, and (3) the degree of using mission critical systems for the back office. In general, Japanese firms display high overall IT-use intensity, while the degree of informational system use is low.

The results indicate a large difference in the method of IT service management between Japanese and U.S. firms. It should be noted that there is a substantial difference in the economic institutions (tacit and implicit rules regarding the law and economic transactions) of these two countries. The Japanese system relies more on implicit information transactions, while U.S. firms are more based on explicit decision rules and contracts (Aoki and Okuno 1996). For example, the responsibilities of the IT division and the IT-user divisions are ambiguous in the Japanese firm system, which makes it difficult to achieve a firm-wide IT strategy. In Japanese firms, substantial interdivisional communication is also needed to facilitate IT service management, and slowdown of the decision-making process hinders effective use of state-of-the-art IT systems (Motohashi 2006).

Active interdivisional communication in Japanese firms could be a reason why their use of “informational systems” trails firms in the U.S. Since information sharing is already active, incentive to “visualize” the internal movements of the firm using IT is low. However, due to the increased intensity of global competition and the complexity of business domains, it is increasingly important to execute corporate decisions based on a wider information base. Due to these changes in the environment, there is increasing risk in using internal tacit information as the source for corporate decision-making. Therefore, Japanese firms may need to incorporate some aspects of “information distributed systems” in their IT use, in order to expedite the information flow of internal, explicit knowledge. On the other hand, U.S. firms are increasingly using IT effectively as an information-sharing tool. There may be an advantage in the U.S. firm system effectively using IT, due to rapid technological process in this field.

Despite the large difference in IT use between the two countries, we cannot find a substantial difference in the pattern of their productivity impacts. The degree of informational systems and of using mission critical systems for the back office, instead of overall IT intensity is found to be correlated with the total factor productivity level of firm. However this finding is not correlated with the firm’s nationality.

This paper investigates the impact of IT management as well as IT use on productivity. A firm’s means of IT management is measured by the link between IT strategy and corporate strategy. A firm in which the IT strategy is clearly defined in its corporate

strategy was found to have higher productivity growth. This finding is persistent even after the regression model is controlled by a country dummy.

Different patterns of IT use across two countries can be explained by the unique characteristics of economic institutions in each country. However, the pattern of association between IT use and productivity is quite similar, regardless of differences in economic institutions. All these findings suggest great potential for Japanese firms to improve productivity by investing in informational systems. In addition, the share of firms exhibiting a link between strong IT strategies and corporate strategies is smaller for Japan. Therefore, room for productivity improvement also remains in the area of IT management, in a way of ensuring consistency between IT strategy and corporate strategy and treating IT systems as a tool for strengthening company-wide competitiveness.

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Figure 1: IT use by type of IT system

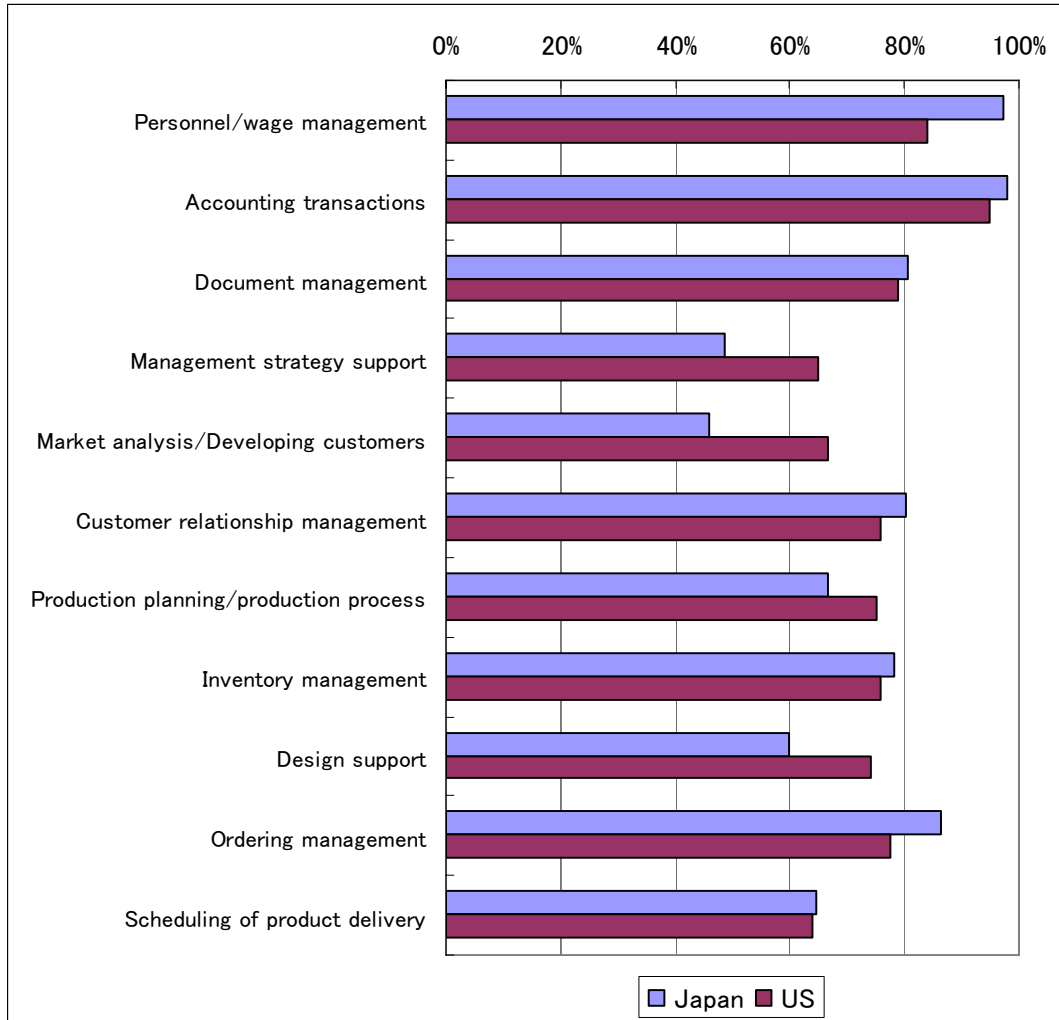


Table 1: Principal Components Analysis

	1	2	3
Personnel/wage management	0.265	-0.083	0.567
Accounting transactions	0.293	-0.157	0.505
Document management	0.263	0.198	0.301
Management strategy support	0.294	0.489	-0.131
Market analysis/Developing customers	0.283	0.522	-0.184
Customer relationship management	0.305	0.262	0.137
Production planning/production process	0.322	-0.233	-0.287
Inventory management	0.324	-0.423	-0.184
Design support	0.284	0.051	-0.275
Ordering management	0.345	-0.274	-0.030
Scheduling of product delivery	0.327	-0.194	-0.268

Table 2: Components comparison

	JP	US
Score of component 1(overall IT use)	0.126	-0.207
Score of component 2(Information sytsem	-0.155	0.255
Score of component 3(mission critical, BC	0.128	-0.211

Figure 2: Linkage between IT strategy and corporate strategy

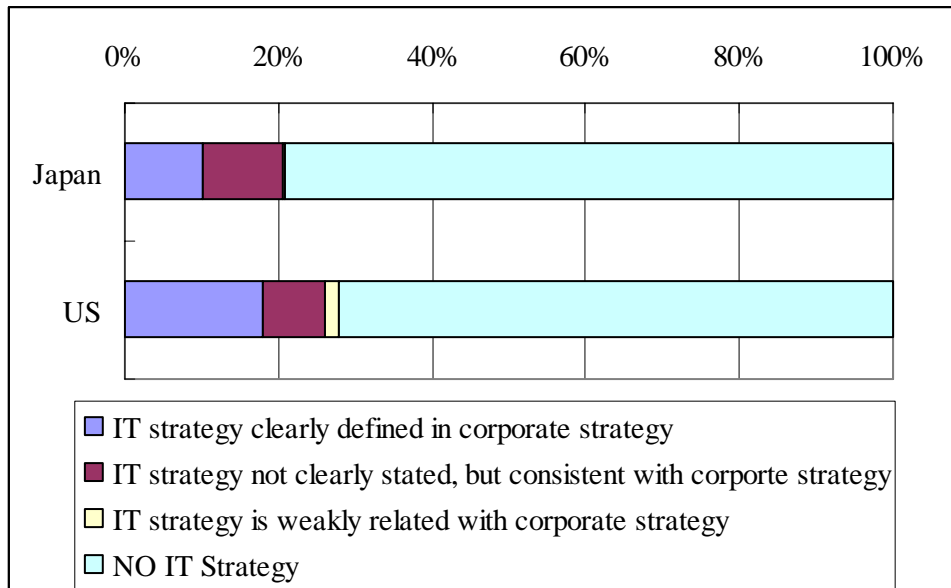


Table 3: Regression results on IT use, IT management, and productivity

	(1)	(2)	(3)	(4)	(5)	(6)
Component1 (Overall IT Use)	0.008 (0.42)	0.022 (0.73)			0.007 (0.33)	0.037 (1.14)
Component2 (Informational System)	0.054 (1.66)+	0.058 (0.99)			0.053 (1.52)	0.058 (0.97)
Component3 (Mission Critical Back Office)	0.092 (2.66)**	0.088 (1.43)			0.078 (2.16)*	0.057 (0.90)
Japan Dummy		0.055 (0.69)		0.048 (0.57)		0.048 (0.55)
Japan* Component1		-0.023 (0.67)				-0.046 (1.26)
Japan* Component2		0.002 (0.02)				-0.003 (0.04)
Japan* Component3		-0.001 (0.01)				0.022 (0.30)
ITStrategy1 (Clearly Defined)			0.382 (3.65)**	0.222 (1.45)	0.464 (4.21)**	0.300 (1.83)+
ITStrategy2 (Not clearly defined)			0.023 (0.18)			
ITStrategy1*Component1					-0.031 (0.67)	-0.071 (1.44)
ITStrategy1*Component2					-0.135 (1.39)	-0.097 (0.96)
IT Strategy1*Component3					0.243 (2.16)*	0.208 (1.79)+
Japan* ITStrategy1				0.335 (1.59)		0.364 (1.59)
Japan* ITStrategy2						-0.002 (0.01)
Year Dummy	0.020 (0.24)	0.019 (0.22)	-0.037 (0.51)	-0.036 (0.50)	0.008 (0.09)	0.000 0.00
Constant	-0.001 (0.02)	-0.035 (0.45)	-0.026 (0.49)	-0.058 (0.74)	-0.046 (0.82)	-0.076 (0.92)
Observations	810	810	810	810	810	810
R-squared	0.01	0.01	0.02	0.02	0.04	0.04

Absolute value of t statistics in parentheses

+ significant at 10%, \* significant at 5%; \*\* significant at 1%

Table 4: Regression results on outsourcing

	Firm-wide mission critical systems (e.g., financial accounting)				Business division specific systems (eg. SCM)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Component1 (Overall IT Use)	-0.006 (0.07)	0.147 (1.26)	0.060 (1.13)	0.063 (0.84)	-0.129 (1.54)	-0.115 (1.06)	0.052 (0.91)	0.023 (0.32)
Component2 (Informational System)	0.014 (0.08)	0.161 (0.68)	0.356 (3.83)**	0.316 (2.42)*	-0.178 (0.93)	0.099 (0.41)	0.290 (2.93)**	0.166 (1.33)
Component3 (Mission Critical Back Office)	0.331(+) (1.80)	0.269 (1.09)	0.040 (0.43)	0.064 (0.48)	0.681 (3.14)**	0.844 (3.12)**	0.007 (0.07)	-0.042 (0.34)
Japan Dummy	-0.841 (3.54)**	-0.923 (2.84)**			-0.778 (3.27)**	-0.746 (2.48)*		
Japan* Component1	0.120 (1.23)	-0.081 (0.60)			0.291 (2.97)**	0.200 (1.57)		
Japan* Component2	0.334 (1.62)	0.055 (0.20)			0.592 (2.68)**	0.034 (0.12)		
Japan* Component3	-0.351 (1.67)	-0.224 (0.78)			-0.785 (3.24)**	-1.094 (3.61)**		
ITStrategy1 (Clearly Defined)			0.933 (3.33)**	0.307 (0.68)			0.527(+) (1.85)	-0.660 (1.19)
ITStrategy1*Component1			0.031 (0.26)	0.119 (0.62)			0.109 (0.84)	0.087 (0.40)
ITStrategy1*Component2			-0.437 (1.69)	-0.323 (0.82)			-0.427(+) (1.66)	-0.224 (0.50)
IT Strategy1*Component3			0.021 (0.07)	-0.179 (0.37)			0.423 (1.42)	-0.094 (0.16)
Year Dummy	0.140 (0.65)	0.235 (0.77)	0.142 (0.67)	0.174 (0.58)	0.161 (0.69)	0.077 (0.25)	0.152 (0.67)	0.042 (0.14)
Constant	0.304 (1.30)	-0.764 (2.39)*	-0.494 (3.31)**	-1.481 (6.96)**	0.074 (0.32)	-0.717 (2.44)*	-0.634 (4.00)**	-1.258 (6.14)**
Observations	570	570	570	570	570	570	570	570

Note: The base category is "Decide the outsourcing activity upon consultation with the outsourcing firm"

Model (1), (3), (5) and (7): Clarification of activity before outsourcing

model (2), (4), (6) and (8) : Clarification of activity after outsourcing

Absolute value of z statistics in parentheses

+ significant at 10%, \* significant at 5%; \*\* significant at 1%