One Question, Two Answers: Mixed Findings of Information Technology Capability and Firm Performance and Their Implications

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Abstract:

This study conducted a conceptual replication on Chae et al. (2014) by utilizing multiple comparison groups of IT leading firms. Empirical testing for the positive association between information technology (IT) capability and firm performance has been a celebrated debate in IS research due to mixed findings; Bharadwaj (2000) and Santhanam and Hartono (2003) confirmed the positive impact of IT capability on firm performance, but Chae et al. (2014) suggested no relationship between the IT capability and performance. Understanding what produces contradictory results is a timely and critical issue because a large body of the business value of IS research has employed IT capability as a key construct. Whereas Chae et al. (2014) investigated the link between IT capability and firm performance by comparing the performance of an IT leader and that of a single matched group from 2001-2004, this study examined the relationship by building multiple comparison groups, which include all firms in the same industry. As a result, contrary to findings by Chae et al. (2014), this research indicated that IT capability has a significant impact on a firm's financial performance.

Keywords: IT capability, Firm performance, IT strategy, Business value of IT, InformationWeek 500

1   Introduction

"The questions stay the same, only the answers change." (Stiglitz, 1989, p. 23)

Stiglitz's joke encapsulates what has happened to economics theories but is not only applicable to economic phenomena. The information systems (IS) research area also has a controversial and unsolved question: *Does IT capability improve firm performance?* Three *MIS Quarterly* papers have provided two different answers in the past two decades. First, the IT capability construct was defined and measured based on the data retrieved from the *InformationWeek (IW) 500* list from 1991-1994 (Bharadwaj, 2000). A matched sample comparison was conducted by selecting leading IT groups from the *IW 500* list as well as benchmark (or control) groups, whose revenue was similar (within 70%-130% of the IT leaders' revenue) to the IT leading groups but that were not on the *IW 500* list. The IT leaders realized superior firm performance as measured by several accounting ratios. Several years later, the same issue was investigated, but a different comparison method was employed (Santhanam and Hartono, 2003). Whereas Bharadwaj (2000) selected a single benchmark group of leading IT firms, Santhanam and Hartono (2003) considered multiple benchmark groups of leading IT firms in the same industry to minimize selection bias. In other words, they compared the performance of IT leaders, such as *Wal-Mart Stores, Inc.*, and the average performance of leading non-IT firms in the retail industry. The results of the second study confirmed the findings of the original investigation and revealed the robustness of the relationship between IT capability and firm performance. IT capability enhances firms' financial performance, and this influence is also sustained three years later. Until recently, the contribution of IT capability on firm

performance has been accepted as true, and the IT capability construct has been the main pillar of the business value of IS papers (Stoel and Muhanna, 2009; Tanriverdi and Uysal, 2015; Wang et al., 2012).

Recently, Chae et al. (2014) suggested that IT capability does not have any positive influence on firm performance, and there is also no sustained impact of IT capability on the performance. The central tenet of this argument is that IT resources are widely available in markets, and they are commoditized after the prevalent use of enterprise resource planning (ERP) systems and Web technologies (Wang, 2010). Thus, it is difficult to develop superior IT capability from the deployment of IT systems without improving the managerial ability to use IT and having better IT systems does not necessarily enhance firm performance. To support their argument, Chae et al. (2014) replicated the study by Bharadwaj (2000). They analyzed more recent data (2001-2004) from the *IW 500* compared to Bharadwaj (2000) and Santhanam and Hartono (2003), whose investigations used data from the *IW 500* conducted in the early 1990s (1991-1994). Chae et al. (2014) developed a single matched group of IT leaders following Bharadwaj (2000). Notably, there was no significant difference between the financial performance of IT leaders and their competing firms, while the role of IT capability in the competitive landscape of firms had largely vanished. However, this may be a hasty generalization considering that Chae et al. (2014) did not compare the performance of IT leaders with that of all firms in the same industry, and some sample firms are not suitable to be considered benchmark firms. Figure 1 illustrates the differences in the three prior studies on IT capability and firm performance and this research.

Figure 1. Comparison of This Study with Three Prior Studies

The purpose of this study is to fill in the gap which is shown in Figure 1 by replicating the results of Chae et al. (2014) using the *IW 500* list from 2001-2004 along with multiple benchmark groups, as suggested by Santhanam and Hartono (2003). This investigation differs from the prior three studies in that we built the multiple comparison groups by selecting all firms in the same industry (two-digit and four-digit SIC codes were adopted) to which leading IT firms belong, and we used data from the early 2000s. In answering the research question of the current study, *"Does IT capability have a positive impact on current and sustained firm performance?"* this work will contribute to the IS research area in several ways. First, we suggest that the positive association between IT capability and firm performance still exists. Second, we propose that the use of multiple comparison groups, considering all firms in the same industry, is preferable in empirical research in IS. Third, we provide a paradigmatic case for why replication studies in IS are required and necessary for expanding our understanding of a certain topic.

The remainder of this study is organized as follows. In the next section, the hypotheses are introduced. The research methods and results are presented, and then the implications of the study are discussed.

2　Hypotheses

We tested the eight hypotheses that Bharadwaj (2000), Santhanam and Hartono (2003), and Chae et al. (2014) examined.

Hypothesis 1: The average profit ratios of firms that have superior IT capability are higher than the average profit ratios of all other firms in the same industry.

Hypothesis 2: The average cost ratios of firms that have superior IT capability are lower than the average cost ratios of all other firms in the same industry.

Hypothesis 3: The average profit ratios of firms that have superior IT capability are higher than the average profit ratios of all other firms in the same industry over three subsequent years.

Hypothesis 4: The average cost ratios of firms that have superior IT capability are lower than the average cost ratios of all other firms in the same industry over three subsequent years.

Hypothesis 5: After controlling for prior financial performance, the average profit ratios of firms that have superior IT capability are higher than the average profit ratios of all other firms in the same industry.

Hypothesis 6: After controlling for prior financial performance, the average cost ratios of firms that have superior IT capability are lower than the average cost ratios of all other firms in the same industry.

Hypothesis 7: After controlling for prior financial performance, the average profit ratios of firms that have superior IT capability are higher than the average profit ratios of all other firms in the same industry over three subsequent years.

Hypothesis 8: After controlling for prior financial performance, the average cost ratios of firms that have superior IT capability are lower than the average cost ratios of all other firms in the same industry over three subsequent years.

3　Research Method

3.1　Sample Selection

This study precisely followed the procedure carried out in the prior three relevant studies (Bharadwaj, 2000; Chae et al., 2014; Santhanam and Hartono, 2003) to identify IT leaders in the *IW 500* lists from 2001-2004. *IW 500* list is the cornerstone of this research and three prior studies to assess a firm's IT capability, and we have examined several issues of using *IW 500* list in Appendix A. During the period, the magazine announced 500 firms with a higher level of IT capability based on the assessment of editors in *InformationWeek*. The first step involved collecting data by building potential IT leaders appearing on the *IW 500* list. In total, 2,000 firms were identified. In the second step, we chose firms that were listed more than once to develop a robust sample of IT leaders (Bharadwaj, 2000). For instance, *Pfizer* was not included in the leading IT group because the firm was listed only once on the *IW 500* list in 2001. On the other hand, *Wal-Mart Stores* was regarded as an IT leader since the company was listed on the list from 2001-2003. After this step, 549 IT leaders in several industries were incorporated. In the third step, the comparison group of 549 IT leaders was assembled, and 337 industries were identified according to the standard industry classification (SIC) scheme. This study used the two-digit SIC code and the four-digit SIC code to build a comparison group. If an IT leader was the sole company in its industry, it was excluded in this step. After matching IT leaders with their rival firms, a total of 337 firms remained. These steps are summarized in Table 1.

Table 1. Three Steps of Collecting Sample Data		
Step	**Procedure**	**Number of firms**

1	Collecting firms' data on the *InformationWeek* 500 lists from 2001 to 2004	2,000
2	Identifying the IT leaders, which appeared in the lists more than once	549
3	Pairing the IT leaders with control groups	337

The biggest difference between this study and prior works (Bharadwaj, 2000; Chae et al., 2014) was that this research considered all firms in the same industry, whereas the prior two studies chose a single firm as the control group. When Bharadwaj (2000) and Chae et al. (2014) selected a control group of an IT leader, the average sales volume of the control firm was required to be within 70%-130% of that of an IT leader. In their research, four-digit SIC codes were initially adopted to build a control group, but two-digit codes were also used when there was no control group that satisfied the above requirement. In contrast, Santhanam and Hartono (2003) considered all firms in the same industry as the comparison group of an IT leader. This research follows the approach of Santhanam and Hartono (2003) because selecting a single control group can be arbitrary and reduces sample sizes.

3.2   Research Method

As prior investigations (Bharadwaj, 2000; Chae et al., 2014; Santhanam and Hartono, 2003) employed a paired matching comparison to test Hypotheses 1-4, this study followed the same procedure. Table 2 summarizes the eight profit ratios and cost ratios of the leading IT groups and comparison groups. Two statistical methods were adopted: pairwise t-test and Wilcoxon signed-rank test. The pairwise t-test assesses the difference between two groups (leading IT groups and their comparison group) by comparing the mean value of paired samples. Additionally, the Wilcoxon signed-rank test, a non-parametric statistical test used when comparing two matched samples, was conducted in this research because the Wilcoxon signed-rank test produces more robust results than pairwise t-test in samples that are not normally distributed (Bharadwaj, 2000).

Table 2. Financial Ratios for Profit and Cost		
Dependent variables	**Ratios**	**Definition**
Profit ratios	ROA	Net Income/ Total Assets
	ROS	Net Income/ Sales
	OI/A	Operating Income/ Total Assets
	OI/S	Operating Income/ Sales
	OI/E	Operating Income/ Number of Employees
Cost ratios	COG/S	Cost of Goods Sold/ Sales
	SGA/S	Selling and General Administration Expenses/ Sales
	OPEXP/S	Operating Expense/ Sales

To evaluate the possible halo effect, concerned with Hypotheses 5-8, this study adopted two regression models:

1. $Financial\ Performance_t = \alpha_0 + \alpha_1\ Financial\ Performance_{t-1}$
2. $Financial\ Performance_t = \beta_0 + \beta_1\ Financial\ Performance_{t-1} + \beta_2\ ITC$
       $where\ t = 2002 - 2007.$

The financial performance variables are profit ratios and cost ratios, and the IT capability (ITC) variable is a dummy. ITC variables are coded as 1 for leading IT firms. On the other hand, ITC variables are coded as 0 for comparison groups. The regression model 1 tests whether the financial performance of a firm in a specific year was related to the prior year's financial performance. Statistically significant coefficient α_1 indicates that the prior year's performance has a strong relationship with the current year's performance (Fama and French, 2000). The regression model 2 retests the association among financial measures but also evaluates the impact of IT capability on firm performance. If β_2 is statistically significant, then we can affirm that the IT capability has a sizable impact on firm performance. On the other hand, if β_1 is significant, but β_2 is not significant, it is difficult to deny the existence of a halo effect in selecting the leading IT firms. In other words, the firm in *IW 500* was selected due to its prior financial performance rather than its IT capability.

4 Research Result

4.1 A Comparison of Financial Performance (H1 and H2)

The results of the pairwise t-test (p-value) and Wilcoxon signed-rank test (z-value) for the 2001-2004 data are summarized in Table 3. In most cases, IT leaders realized better financial performances in profit ratios and lower values in cost ratios. In profit ratios (i.e., ROA, ROS, OI/A, OI/S, and OI/E), the mean and median values of IT leaders were higher than those of control groups. On the other hand, for cost ratios (i.e., COG/S, SGA/S, and OPEXP/S), the mean and median values of IT leaders were lower than those of the control groups. Exceptionally, there was no significant difference in OI/E ratios from 2002-2004 when considering paired t-test results, a finding that may be due to the small companies in the control group taking advantage of managing their employees. Overall, this paper argues that Hypotheses 1 and 2 were supported.

Table 3. Results of Tests for Hypotheses 1 and 2											
		2001									
		Four-digit control group					**Two-digit control group**				
Ratios	**Groups**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**
ROA	IT leaders	337	0.0115	0.0261	-13.690***	5.883***	333	0.0115	0.0261	-14.967***	8.741***
	Control	337	-0.6071	-0.767			333	-0.4171	-0.3108		
ROS	IT leaders	337	0.0179	0.0315	-13.483***	5.611***	333	0.0179	0.0315	14.406***	6.265***
	Control	337	-3.0458	-0.1263			333	-1.4229	-0.3919		
OI/A	IT leaders	337	0.0742	0.0724	-13.884***	5.421***	333	0.0742	0.0724	-14.828***	9.996***
	Control	337	-0.4310	-0.0203			333	-0.2501	-0.2219		
OI/S	IT leaders	337	0.0995	0.0811	-13.554***	5.268***	333	0.0995	0.0811	-14.106***	5.787***
	Control	337	-2.5012	-0.0348			333	-1.3257	-0.3795		
OI/E	IT leaders	326	44.8777	18.7354	-8.615***	3.745***	322	44.8777	18.7354	-5.639***	0.349
	Control	326	13.4222	3.8424			322	42.1916	-4.6522		
COGS/S	IT leaders	337	0.6830	0.7242	-8.689***	-3.626***	333	0.6830	0.7242	-10.091***	-3.131***
	Control	337	2.2478	0.7985			333	1.3818	0.7747		
SGA/S	IT leaders	337	0.1638	0.1459	-12.139***	-5.420***	333	0.1638	0.1459	-12.932***	-7.307***
	Control	337	1.0511	0.2558			333	0.8246	0.2978		
OPEXP/S	IT leaders	337	0.8468	0.8768	-13.413***	-5.101***	333	0.8468	0.8768	-13.941***	-5.574***
	Control	337	3.2989	0.9982			333	2.2064	1.2515		
		2002									
		Four-digit control group					**Two-digit control group**				
Ratios	**Groups**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**
ROA	IT leaders	337	0.0228	0.0273	-11.293***	2.097**	333	0.0228	0.0273	-13.087***	5.419***
	Control	337	-1.7892	-0.0410			333	-8.1433	-0.2376		
ROS	IT leaders	337	0.0236	0.0355	-12.238***	3.620***	333	0.0236	0.0355	-14.086***	5.666***
	Control	337	-2.3910	-0.0681			333	-1.5463	-0.4741		
OI/A	IT leaders	337	0.0771	0.0724	-11.729***	1.971**	333	0.0771	0.0724	-14.890***	4.317***
	Control	337	-1.6636	0.0115			333	-5.9585	-0.1782		
OI/S	IT leaders	337	0.1051	0.0838	-11.474***	3.619***	333	0.1051	0.0838	-13.905***	5.153***
	Control	337	-1.7338	0.0086			333	-1.0558	-0.1778		
OI/E	IT leaders	334	74.5544	20.1606	-8.684***	-0.247	330	74.5544	20.1606	-5.275***	0.437

Table 3. Results of Tests for Hypotheses 1 and 2

Ratios	Groups	N	Mean	Median	Wilcoxon test	t-test	N	Mean	Median	Wilcoxon test	t-test
	Control	334	86.2548	6.2673			330	60.9632	5.4945		
COGS/S	IT leaders	337	0.6728	0.7153	-4.589***	-2.613***	333	0.6728	0.7153	-8.389***	-4.266***
	Control	337	1.9096	0.7658			333	1.3659	0.7712		
SGA/S	IT leaders	337	0.1694	0.1495	-10.215***	-4.518***	333	0.1694	0.1495	-12.746***	-5.913***
	Control	337	0.7220	0.2423			333	0.6746	0.3414		
OPEXP/S	IT leaders	337	0.8422	0.8748	-9.944***	-3.511***	333	0.8422	0.8748	-14.041***	-5.374***
	Control	337	2.6318	0.9437			333	2.0407	1.1241		

2003

		Four-digit control group					Two-digit control group				
Ratios	Groups	N	Mean	Median	Wilcoxon test	t-test	N	Mean	Median	Wilcoxon test	t-test
ROA	IT leaders	337	0.0349	0.0333	-12.035***	2.378**	337	0.0349	0.0333	-14.341***	5.936***
	Control	337	-4.7785	-0.0601			337	-5.6342	-0.2225		
ROS	IT leaders	337	0.0481	0.0446	-11.531***	5.933***	337	0.0481	0.0446	-13.401***	7.592***
	Control	337	-1.2405	-0.0336			337	-0.6600	-0.3679		
OI/A	IT leaders	337	0.0810	0.0738	-13.143***	3.231***	337	0.0810	0.0738	-15.070***	7.787***
	Control	337	-1.5414	0.0051			337	-2.3637	-0.1774		
OI/S	IT leaders	337	0.1141	0.0862	-12.214***	6.090***	337	0.1141	0.0862	-14.308***	10.326***
	Control	337	-1.1232	0.0054			337	-0.6111	-0.1277		
OI/E	IT leaders	335	83.9498	22.7162	-6.982***	0.975	335	83.9498	22.7162	-5.244***	0.113
	Control	335	63.0799	7.3867			335	81.3437	4.5113		
COGS/S	IT leaders	337	0.6667	0.7200	-7.111***	-5.122***	337	0.6667	0.7200	-10.383***	-7.551***
	Control	337	1.4186	0.7652			337	1.0232	0.7823		
SGA/S	IT leaders	337	0.1693	0.1507	-11.134***	-3.843***	337	0.1693	0.1507	-12.770***	-11.800***
	Control	337	0.6270	0.2563			337	0.5191	0.3044		
OPEXP/S	IT leaders	337	0.8361	0.8749	-12.960***	-6.118***	337	0.8361	0.8749	-14.949***	-10.423***
	Control	337	2.0456	0.9614			337	1.5422	1.0334		

2004

		Four-digit control group					Two-digit control group				
Ratios	Groups	N	Mean	Median	Wilcoxon test	t-test	N	Mean	Median	Wilcoxon test	t-test
ROA	IT leaders	337	0.0415	0.0443	-10.970***	5.734***	337	0.0415	0.0443	-15.119***	6.683***
	Control	337	-0.6389	0.0025			337	-0.9270	-0.3047		
ROS	IT leaders	337	0.0576	0.0532	-9.590***	3.222***	337	0.0576	0.0532	-12.389***	2.547**
	Control	337	-1.9733	0.0006			337	-1.8314	-0.1789		
OI/A	IT leaders	337	0.0906	0.0813	-11.588***	5.529***	337	0.0906	0.0813	-14.887***	6.572***
	Control	337	-0.4518	0.0161			337	-0.7206	-0.1252		
OI/S	IT leaders	337	0.1248	0.1029	-11.109***	2.471**	337	0.1248	0.1029	-13.859***	2.395**
	Control	337	-1.6184	0.0345			337	-1.7354	-0.1317		
OI/E	IT leaders	334	83.4778	30.367	-5.781***	-0.061	334	83.4778	30.3672	-4.671***	-0.170
	Control	334	85.4285	12.989			334	87.2151	10.9825		
COGS/S	IT leaders	337	0.6609	0.7161	-6.482***	-3.082***	337	0.6609	0.7161	-8.632***	-8.801***
	Control	337	1.8141	0.7504			337	0.9690	0.7709		
SGA/S	IT leaders	337	0.1692	0.141	-10.875***	-2.609***	337	0.1692	0.1410	-13.119***	-2.003**

Table 3. Results of Tests for Hypotheses 1 and 2

	Control	337	1.2512	0.2356			337	1.6867	0.3185		
OPEXP /S	IT leaders	337	0.8302	0.8655	-11.926***	-3.922***	337	0.8302	0.8655	-14.127***	-2.347**
	Control	337	3.0652	0.9536			337	2.6556	1.1490		
*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level											

4.2 A Comparison of Sustained Financial Performance (H3 and H4)

This study also examined the sustained competitive advantage of IT leaders by comparing the financial performance of two groups (IT leaders and their control groups) measured from 2005-2007. If IT capability has an impact on firms' sustained competitiveness, the financial performances of IT leaders should be superior to those of the control groups. Profit ratios and cost ratios were used to identify the difference between the two groups in sustained financial performance, and the results are summarized in Table 4. The mean and median value of the profit ratios (i.e., ROA, ROS, OI/A, and OI/S) of the IT leaders were significantly higher than those of the control groups from 2005-2007. For the cost ratios (i.e., COG/S, SGA/S, and OPEXP/S), IT leaders had lower mean and median values compared to the control group. However, there was no significant difference between the OI/E of the IT leaders and the control groups. This study identified a substantial difference in the sustained financial performance between IT leaders and control groups. Subsequently, this study argued that Hypotheses 3 and 4 were supported.

Table 4. Results of Tests for Hypotheses 3 and 4

		2005									
		Four-digit control group					**Two-digit control group**				
Ratios	**Groups**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**
ROA	IT leaders	324	0.0422	0.0454	-12.061***	5.425***	324	0.0422	0.0454	-14.316***	5.981***
	Control	324	-0.6582	-0.0148			324	-0.6012	-0.1662		
ROS	IT leaders	324	0.0542	0.0581	-10.906***	3.947***	324	0.0542	0.0581	-13.513***	5.040***
	Control	324	-3.9071	-0.0076			324	-1.9060	-0.1230		
OI/A	IT leaders	324	0.0959	0.0918	-11.442***	5.940***	324	0.0959	0.0918	-13.954***	6.398***
	Control	324	-0.3651	0.0264			324	-0.3855	-0.0736		
OI/S	IT leaders	324	0.1285	0.1098	-11.359***	3.675***	324	0.1285	0.1098	-13.209***	5.021***
	Control	324	-3.0249	0.0390			324	-1.5988	-0.1788		
OI/E	IT leaders	323	89.5065	31.1237	-7.590***	-0.863	323	89.5065	31.1237	-3.719***	-0.566
	Control	323	214.5044	13.3355			323	104.6736	7.5332		
COGS/ S	IT leaders	324	0.6645	0.7161	-5.909***	-2.930***	324	0.6645	0.7161	-8.695***	-4.517***
	Control	324	3.0428	0.7402			324	1.6562	0.7535		
SGA/S	IT leaders	324	0.1656	0.1386	-10.125***	-4.987***	324	0.1656	0.1386	-12.110***	-2.934***
	Control	324	0.9615	0.2295			324	0.8976	0.2981		
OPEXP /S	IT leaders	324	0.8301	0.8612	-11.386***	-3.678***	324	0.8301	0.8612	-13.731***	-5.042***
	Control	324	4.0043	0.9334			324	2.5538	1.1478		
		2006									
		Four-digit control group					**Two-digit control group**				
Ratios	**Groups**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**
ROA	IT leaders	313	0.0543	0.0483	-10.986***	2.385**	313	0.0543	0.0483	-10.735***	5.180***
	Control	313	-0.8522	0.0068			313	-0.8822	-0.0122		
ROS	IT leaders	313	0.0713	0.0597	-11.067***	2.899***	313	0.0713	0.0597	-13.277***	10.523***
	Control	313	-3.2437	0.0068			313	-0.7253	-0.1316		

Table 4. Results of Tests for Hypotheses 3 and 4											
OI/A	IT leaders	313	0.0971	0.0866	-10.761***	3.106***	313	0.0971	0.0866	-10.288***	5.151***
	Control	313	-0.4532	0.0434			313	-0.7864	0.0274		
OI/S	IT leaders	313	0.1308	0.1036	-10.952***	2.801***	313	0.1308	0.1036	-12.304***	9.801***
	Control	313	-2.6354	0.0496			313	-0.5243	-0.0427		
OI/E	IT leaders	313	99.0485	35.3144	-5.597***	-1.067	313	99.0485	35.3144	-2.898***	-1.130
	Control	313	145.3940	19.1163			313	128.3350	18.7935		
COGS/S	IT leaders	313	0.6648	0.7184	-5.426***	-2.395**	313	0.6648	0.7184	-7.756***	-7.057***
	Control	313	2.7891	0.7542			313	1.0756	0.7514		
SGA/S	IT leaders	313	0.1667	0.1354	-9.649***	-3.725***	313	0.1667	0.1354	-11.260***	-7.627***
	Control	313	0.7223	0.2231			313	0.4077	0.2885		
OPEXP/S	IT leaders	313	0.8315	0.8626	-11.331***	-2.964***	313	0.8315	0.8626	-12.220***	-9.494***
	Control	313	3.5113	0.9361			313	1.4832	1.0281		
		2007									
		Four-digit control group					**Two-digit control group**				
Ratios	**Groups**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**	**N**	**Mean**	**Median**	**Wilcoxon test**	**t-test**
ROA	IT leaders	296	0.0450	0.0496	-10.410***	5.258***	296	0.0450	0.0496	-13.250***	8.652***
	Control	296	-0.6679	0.0041			296	-0.4603	-0.1183		
ROS	IT leaders	296	0.0518	0.055	-10.014***	4.479***	296	0.0518	0.0555	-12.523***	9.802***
	Control	296	-1.9124	0.0015			296	-0.9741	-0.0622		
OI/A	IT leaders	296	0.0895	0.0882	-10.358***	5.296***	296	0.0895	0.0882	-12.017***	10.348***
	Control	296	-0.4074	0.0403			296	-0.2479	0.0127		
OI/S	IT leaders	296	0.1192	0.1039	-10.521***	4.210***	296	0.1192	0.1039	-11.714***	9.767***
	Control	296	-1.3263	0.0461			296	-0.2479	0.0127		
OI/E	IT leaders	296	92.7738	32.7278	-4.837***	-1.654*	293	92.7738	32.7278	-2.687***	-2.009**
	Control	296	185.1624	17.248			293	180.7033	15.1232		
COGS/S	IT leaders	296	0.6719	0.7057	-4.895***	-3.308***	296	0.6719	0.7057	-7.755***	-7.514***
	Control	296	1.5545	0.7392			296	1.0405	0.7555		
SGA/S	IT leaders	296	0.1655	0.1381	-9.212***	-4.441***	296	0.1655	0.1381	-10.499***	-8.167***
	Control	296	0.5979	0.2177			296	0.5465	0.2775		
OPEXP/S	IT leaders	296	0.8374	0.8616	-10.823***	-4.269***	296	0.8374	0.8616	-11.491***	-9.002***
	Control	296	2.1524	0.9362			296	1.5870	0.9506		
*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level											

4.3   Testing for Halo Effect (H5-H8)

Two regression models 1 and 2 were tested to assess whether the halo effect was present when selecting leading IT groups. The regression results are described in Table 5. In almost all cases, prior performance had a significant impact on firm performance. For instance, the coefficient of prior year financial performance on the ROA of 2002 in the four-digit column was 0.206, which is significant at the 1% level. This means that the ROA of firms in 2002 was largely related to the ROA of firms in 2001. By the same token, the influence of IT capability on firm performance after controlling for prior firm performance can be estimated by the coefficient of IT capability. About two-thirds of the coefficients of IT capability in Table 5 were statistically significant at the 5% level. These results partially support the Hypotheses 5 and 6 in this study.

Table 5. Results of Tests for Hypotheses 5 and 6

Table 5. Results of Tests for Hypotheses 5 and 6									
		2002							
		Four-digit control group				**Two-digit control group**			
Ratios	**Model**	**N**	R^2	**Prior year financial performance**	**IT capability dummy**	**N**	R^2	**Prior year financial performance**	**IT capability dummy**
ROA	1	674	0.043	0.206***		670	0.000	0.010	
	2	674	0.044	0.198***	0.037	670	0.046	-0.062	0.226***
ROS	1	674	0.034	0.184***		670	0.057	0.239***	
	2	674	0.044	0.162***	0.104***	670	0.084	0.199***	0.168***
OI/A	1	674	0.031	0.175***		670	0.000	-0.011	
	2	674	0.032	0.166****	0.042	670	0.033	-0.081**	0.195***
OI/S	1	674	0.028	0.168***		670	0.052	0.227***	
	2	674	0.040	0.146***	0.109***	670	0.074	0.194***	0.154***
OI/E	1	652	0.052	0.229***		667	0.883	0.939***	
	2	652	0.055	0.233***	-0.053	667	0.885	0.940***	-0.044***
COGS/S	1	674	0.021	0.146***		670	0.000	0.016	
	2	674	0.028	0.134***	-0.082**	670	0.027	-0.003	-0.164***
SGA/S	1	674	0.026	0.162***		670	0.328	0.573***	
	2	674	0.046	0.132***	-0.144***	670	0.333	0.553***	-0.073**
OPEXP/S	1	674	0.027	0.165***		670	0.042	0.204***	
	2	674	0.038	0.145***	-0.106***	670	0.069	0.168***	-0.169***
		2003							
		Four-digit control group				**Two-digit control group**			
Ratios	**Model**	**N**	R^2	**Prior year financial performance**	**IT capability dummy**	**N**	R^2	**Prior year financial performance**	**IT capability dummy**
ROA	1	674	0.000	0.008		670	0.042	0.205***	
	2	674	0.008	0.001	0.091**	670	0.077	0.166***	0.191***
ROS	1	674	0.028	0.167***		670	0.001	0.028	
	2	674	0.068	0.138***	0.204***	670	0.081	-0.035	0.290***
OI/A	1	674	0.002	0.040		670	0.042	0.204***	
	2	674	0.016	0.031	0.121***	670	0.109	0.160***	0.264***
OI/S	1	674	0.030	0.174***		670	0.000	0.012	
	2	674	0.073	0.145***	0.208***	670	0.140	-0.063*	0.381***
OI/E	1	668	0.470	0.686***		667	0.965	0.982***	
	2	668	0.471	0.686***	0.030	667	0.965	0.983***	-0.013*
COGS/S	1	674	0.013	0.115***		670	0.001	0.024	
	2	674	0.047	0.097**	-0.185***	670	0.070	-0.020	-0.268***
SGA/S	1	674	0.022	0.148***		670	0.019	0.139***	
	2	674	0.037	0.127***	-0.124***	670	0.171	0.049	-0.400***
OPEXP/S	1	674	0.024	0.156***		670	0.005	0.074*	
	2	674	0.068	0.127***	-0.212***	670	0.136	-0.002	-0.370***
		2004							
		Four-digit control group				**Two-digit control group**			

Ratios	Model	N	R^2	Prior year financial performance	IT capability dummy	N	R^2	Prior year financial performance	IT capability dummy
				Table 5. Results of Tests for Hypotheses 5 and 6					
ROA	1	674	0.000	0.007		674	0.000	0.016	
	2	674	0.047	-0.012	0.217***	674	0.064	-0.042	0.259***
ROS	1	674	0.152	0.390***		674	0.029	0.170***	
	2	674	0.154	0.382***	0.038	674	0.032	0.155***	0.054
OI/A	1	674	0.005	0.069*		674	0.006	0.080**	
	2	674	0.046	0.044	0.204***	674	0.060	0.010	0.243***
OI/S	1	674	0.103	0.321***		674	0.065	0.255***	
	2	674	0.103	0.316***	0.023	674	0.065	0.255***	-0.001
OI/E	1	668	0.807	0.898***		671	0.912	0.955***	
	2	668	0.807	0.899***	-0.025	671	0.912	0.955***	-0.008
COGS/S	1	674	0.399	0.631***		674	0.456	0.676***	
	2	674	0.399	0.632***	0.004	674	0.472	0.641***	-0.130***
SGA/S	1	674	0.019	0.138***		674	0.122	0.349***	
	2	674	0.026	0.127***	-0.082**	674	0.127	0.381***	0.077*
OPEXP/S	1	674	0.183	0.428***		674	0.061	0.248***	
	2	674	0.186	0.415***	-0.054	674	0.061	0.248***	0.001

Coefficients of prior ratio and IT capability are standardized.
*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level

This study also examined the halo effect on the sustained financial performance of leading IT groups and their control counterparts. Table 6 displays the summarized results. Similar to the data from 2001-2004, the financial performance of firms was substantially associated with prior financial performance. The regression results also partially supported Hypotheses 7 and 8 because nearly two-thirds of the coefficients of IT capability in Table 6 were significant.

Ratios	Model	N	R^2	Prior year financial performance	IT capability dummy	N	R^2	Prior year financial performance	IT capability dummy
				Table 6. Results of Tests for Hypotheses 7 and 8					
				2005					
			Four-digit control group				Two-digit control group		
ROA	1	648	0.155	0.393***		648	0.099	0.315***	
	2	648	0.171	0.365***	0.129***	648	0.123	0.276***	0.158***
ROS	1	648	0.205	0.452***		648	0.453	0.673***	
	2	648	0.213	0.439***	0.092***	648	0.459	0.660***	0.130***
OI/A	1	648	0.154	0.393***		648	0.055	0.233***	
	2	648	0.175	0.360***	0.148***	648	0.091	0.185***	0.198***
OI/S	1	648	0.191	0.437***		648	0.521	0.722***	
	2	648	0.200	0.426***	0.091***	648	0.538	0.710***	0.128***
OI/E	1	646	0.066	0.257***		645	0.832	0.912***	
	2	646	0.067	0.257***	-0.033	645	0.832	0.912***	-0.013
COGS/S	1	648	0.314	0.560***		648	0.250	0.500***	
	2	648	0.316	0.555***	-0.048	648	0.251	0.493***	-0.026
SGA/S	1	648	0.540	0.735***		648	0.888	0.942***	

Table 6. Results of Tests for Hypotheses 7 and 8									
	2	648	0.554	0.723***	-0.118***	648	0.890	0.939***	-0.042***
OPEXP/S	1	648	0.228	0.477***		648	0.528	0.726***	
	2	648	0.233	0.466***	-0.073**	648	0.544	0.715***	-0.129***
2006									
		Four-digit control group				Two-digit control group			
Ratios	**Model**	**N**	R^2	**Prior year financial performance**	**IT capability dummy**	**N**	R^2	**Prior year financial performance**	**IT capability dummy**
ROA	1	626	0.001	0.038		626	0.267	0.517***	
	2	626	0.009	0.019	0.091**	626	0.281	0.544***	-0.121***
ROS	1	626	0.284	0.533***		626	0.012	0.111***	
	2	626	0.285	0.527***	0.035	626	0.013	0.115***	-0.022
OI/A	1	626	0.004	0.066		626	0.204	0.451***	
	2	626	0.017	0.040	0.115***	626	0.216	0.479***	-0.115***
OI/S	1	626	0.345	0.587***		626	0.119	0.345***	
	2	626	0.346	0.583***	0.029	626	0.124	0.358***	-0.069*
OI/E	1	626	0.697	0.835***		626	0.316	0.562***	
	2	626	0.697	0.835***	-0.009	626	0.316	0.562***	0.010
COGS/S	1	626	0.357	0.598***		626	0.015	0.123***	
	2	626	0.358	0.595***	-0.029	626	0.016	0.127***	0.022
SGA/S	1	626	0.043	0.207***		626	0.359	0.599***	
	2	626	0.055	0.185***	-0.111***	626	0.364	0.607***	0.070**
OPEXP/S	1	626	0.384	0.620***		626	0.138	0.371***	
	2	626	0.385	0.616***	-0.031	626	0.143	0.385***	0.074*
2007									
		Four-digit control group				Two-digit control group			
Ratios	**Model**	**N**	R^2	**Prior year financial performance**	**IT capability dummy**	**N**	R^2	**Prior year financial performance**	**IT capability dummy**
ROA	1	592	0.010	0.102**		592	0.005	0.067	
	2	592	0.052	0.083**	0.204***	592	0.111	0.000	0.333***
ROS	1	592	0.039	0.197***		592	0.267	0.517***	
	2	592	0.064	0.178***	0.161***	592	0.303	0.437***	0.204***
OI/A	1	592	0.027	0.165***		592	0.010	0.100**	
	2	592	0.064	0.140***	0.195***	592	0.154	0.022	0.388***
OI/S	1	592	0.036	0.189***		592	0.140	0.375***	
	2	592	0.059	0.172***	0.151***	592	0.204	0.276***	0.270***
OI/E	1	592	0.670	0.818***		589	0.799	0.894***	
	2	592	0.671	0.817***	-0.032	589	0.801	0.892***	-0.046**
COGS/S	1	592	0.083	0.289***		592	0.161	0.401***	
	2	592	0.095	0.278***	-0.109***	592	0.196	0.348***	-0.194***
SGA/S	1	592	0.216	0.465***		592	0.204	0.451***	
	2	592	0.229	0.448***	-0.114***	592	0.242	0.394***	-0.203***
OPEXP	1	592	0.093	0.306***		592	0.162	0.402***	

Table 6. Results of Tests for Hypotheses 7 and 8								
/S	2	592	0.112	0.289***	-0.138***	592	0.208	0.320***	-0.231***

Coefficients of prior ratio and IT capability are standardized.
*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level

5   Conclusion and Discussion

5.1   Discussion

We provided evidence that IT capability had a positive association with firm performance using *IW 500* data from 2001-2004 contrary to Chae et al. (2014). We considered all firms in the same industry as control groups; whereas Chae et al. (2014) identified a single matched firm as control groups. We believe that it is more appropriate to show that IT leading firms outperform average firms in the same industry, as tested in our study, than to suggest whether an IT leader maintains a superior position over a single rival firm, as examined in Chae et al. (2014). A firm's strategic actions are highly influenced by other companies in the same industry (DiMaggio and Powell, 1983), and industry membership has a critical influence on a firm's profitability (McGahan and Porter, 1997). Especially, when a firm is exposed to uncertainty, the firm is likely to decide its strategic posture, which means the intent of a strategy relative to the current and future state of an industry, by following other firms' behaviors in the same industry instead of observing a rival firm's intention (Courtney et al., 1997). Similarly, when a firm invests in IT, the firm considers industry average rather than a firm's peers (Mithas et al., 2013). In this sense, it is desirable to compare a firm's performance with industry average rather than a specific peer.

We need to apprehend what factors caused the disparate result between Chae et al. (2014) and this research. The mode of selecting the control group (i.e., a matched firm or all firms in the same industry) seems a noticeable factor, which brings about the inconsistent results. However, the possible selection bias from the choice of a single benchmark group (Santhanam and Hartono, 2003) cannot be a serious concern because Chae et al. (2014) considered 296 leader-control pairs in four years, and the sample size was large enough.

Instead, there must be moderating or mediating factors that we did not consider. For instance, the firm size of control groups might have influenced firm performance. The firms in control groups investigated in Chae et al. (2014) were generally bigger than the firms in the control groups in this study. A large body of prior research has shown that firm size has an effect on firm performance such as ROA or Tobin's q (Wiggins and Ruefli, 2002). Also, the utilization of IT is closely related to firm size (Atasoy et al., 2016). Thus, the size of control groups may have had an effect on the relationship between IT capability and firm performance.

Another possible cause for the discrepancy could be connected to the industry factors. Kohli and Devaraj (2003) proved that the type of industry had a significant moderating impact on the payoff metric. Mithas et al. (2012) showed that IT has a greater effect on firm profitability in service industries than in manufacturing industries. We may need to investigate the impact of IT capability on firm performance according to the industry sectors rather than aggregate the impact to understand the mixed results.

Bhadadwaj (2000) has been cited more than 3,500 times according to Google Scholar. The reason that the paper has such an influential position is that it provided a theoretical background to show how and why IT contributes to firm performance. Without using the concept of IT capability, it is still elusive to link IT to the economic value of a firm (e.g., profitability). Bharadwaj (2000) suggested that IT capabilities, IT resource with the ability to use them, are idiosyncratic and firm-specific resources that are not transferable to other firms and contribute to the competitiveness of firms. During the last 16 years, there were substantial changes and improvements in IT. Enterprise resource planning, e-commerce, customer relationship management, and knowledge management were introduced after the mid-1990s (Wang, 2010). It can be argued that the concept of IT capability is outdated in the sense that the construct does not reflect the newly developed IT systems. A specific method for measuring IT capability can be evolved over time and has changed to include the changing nature of IT (Lee et al., 2015; Lu and Ramamurthy, 2011). However, this study suggests that the core tenet that IT capability is the source of competitive does not change. This is the implication for the practitioners. A firm's IT applications and its ability to use them are still critical to outperform its rivals in the same industry.

We would argue the necessity of replicating studies in the IS research area. As Dennis and Valacich (2015) stated, "replication is one of the main principles of the scientific method. […] Replication will either improve confidence in our research findings or identify important boundary conditions." (p. 1) To expand our understanding of a certain topic in the IS area, we need to retest and affirm the research results of prior studies. Particularly, when mixed findings are uncovered, it becomes difficult to overemphasize the need for replications. Replication studies do not have limited theoretical contributions in the sense that a theory is iteratively improved and elaborated by developing conceptual models and supporting the models with empirical results. Also, replications are necessary to increase the generalizability of research models to other research settings (Compeau et al., 2012).

5.2   Conclusion

This study replicated and extended three prior *MIS Quarterly* studies on the contribution of IT capability on firms' financial performance. Bharadwaj (2000) and Santhanam and Hartono (2003) evidenced the positive association between IT capability and firm performance based on *IW 500* data from 1991-1994. In contrast, Chae et al. (2014) identified no relationship between IT capability and firm performance using *IW 500* data from 2001-2004. The present study similarly analyzed *IW 500* list from 2001-2004 but compared the financial performance of leading IT groups with that of all firms in the same industry, as accomplished by Santhanam and Hartono (2003). Interestingly, contrary to the results reported by Chae et al. (2014), we observed a positive impact of IT capability on firms' financial performance. We do not argue that the procedure of Chae et al. (2014) or their research results were inappropriate; instead, we contend that the research findings can be differentiated depending on the selected control group. According to the results of this study, IT capability played a critical role in developing the competitive advantage of firms and was an advantage that could be sustained over subsequent years.

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Appendix A: IT Capability and *InformationWeek* 500 list

This research and three prior *MIS Quarterly* studies measured IT capability by utilizing *InformationWeek (IW)* list. Prior studies mentioned that the criteria for identifying IT leading firms have changed, leading to inconsistent research results about the relationship between IT capability and firm performance (Chae et al., 2014, Santhanam and Hartono, 2003). We have reviewed the criteria used by *InformationWeek* in the early 1990s and 2000s. We have confirmed that there was a change in the criteria as summarized in Table A-1. In 1991-1994, IT leaders were identified based on the value of installed IT applications within firms or the revenue of the firms. On the other hand, the focus was given to the effective and efficient use of IT as well as innovative applications when *IW* editors selected IT leaders in 2001-2004. Therefore, it is not appropriate to compare directly the results of Bharadwaj (2000) and Santhanam and Hartono (2003) with the conclusion of Chae et al. (2014). However, our study and Chae et al. (2014) are using the same criteria, which were consistent in 2001-2004.

Table A-2. The Criteria for Identifying IT Leading Firms		
Years	**Criteria**	**Source**
1991-1992	IT leaders are ranked based on the value of their installed base of technology.	Chae et al. (2014) and *InformationWeek* (1991; 1992)[1]
1993-1994	Revenue and the use of technology were the key criteria for identifying IT leaders.	Chae et al. (2014) and *InformationWeek* (1993; 1994)[2]
2001-2004	*InformationWeek* editors identified innovative IT organizations based in the U.S. that demonstrated a pattern of technological, procedural, and organizational innovation. Firms are known to have successfully launched innovative or strategic applications tend to be ranked as the leaders.	Chae et al. (2014) and *InformationWeek* (2001; 2002)[3]

Another concern of using *IW 500* is whether the criteria reflect the conceptual definition of IT capability. IT capability encompasses three concepts: IT infrastructure, the managerial ability of IT, and intangible assets in IT applications (Bharadwaj, 2000). It seems that the criteria used in 1991-1992 did not fully represent the definition of IT capability since they were more concentrated on the IT infrastructure; the criteria in 1993-1994 did not measure IT but assessed a firm's financial performance. However, the criteria used for *IW* in 2001-2004 have a good fit for the definition of IT capability because the technological innovation assesses IT infrastructure, procedural innovation describes intangible aspect such as business processes, and organizational innovation evaluates the managerial aspect of IT. *IW 500* list can be used as a proxy for IT capability although survey approach (Bhatt and Grover, 2005; Lu and Ramamurthy, 2011) may complement the limit of secondary data. Other secondary variables for IT such as IT expenditure, IT assets, and IT capital may not be proper indices to measure IT capability since they only considered only one aspect of IT capability.

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[1] *InformationWeek*, Sep. 16, 1991; Sep. 21, 1992
[2] *InformationWeek*, Sep. 27, 1993; Oct. 10, 1994
[3] *InformationWeek*, Sep. 7, 2001; Sep. 23, 2002

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