Transactions on Replication Research

Conceptual Replication DOI: 10.17705/1atrr.00081 ISSN 2473-3458

Revisiting the Role and Impact of Information Technology Capability

Chuan (Annie) Tian
Culverhouse College of Business
University of Alabama
actian@ua.edu

Radhika Santhanam
Division of Management Information Systems,
University of Oklahoma
radhika@ou.edu

Pascal Nitiema
Department of Information Systems,
Arizona State University
pnitiema@asu.edu

Abstract:

This study is a conceptual replication of Bharadwaj (2000) investigating the impact of IT capability on a firm's financial performance. The original study demonstrated that firms with superior IT capability will deliver superior financial performance manifested by higher profit ratios and lower cost ratios. However, conflicting findings emerged regarding the relationship between IT capability and a firm's financial performance (Chae et al., 2014). Furthermore, in the past decade, advancements in statistical analysis, such as panel data modeling techniques that were not used in these past studies have provided more robust analytical techniques to observe patterns over time. Hence, incorporating the conceptual foundations as in prior studies on IT capability (e.g., Bharadwaj, 2000; Santhanam & Hartono, 2003), we re-investigate the impact of IT capability on a firm's financial performance but do so by using a large longitudinal dataset and leveraging the power of panel data analysis. Our findings are consistent with the results of Bharadwaj (2000), Santhanam and Hartono (2003), and Choi and George (2016), suggesting that IT capability has a significant positive impact on financial performance. Our results do not support the findings of Chae et al. (2014), who found no association between IT capability and financial performance. We discuss the implications of our findings for the continued use of the theoretical framework of IT capability derived from the resource-based view.

Keywords: Resource-Based View (RBV), Information Technology (IT) Capability, Financial Performance.

The manuscript was received 01/06/2023 and was with the authors 4 months for 4 revisions.

1 Introduction

Understanding the business value of Information Technology (IT) has been a matter of great interest to Information System (IS) researchers for a long time (e.g., Choi & George, 2016; Kettinger et al., 2021). Several research streams have addressed this issue, each with its own approach, which includes among others, an investigation of the direct relationship of IT investments to firm performance (Mithas et al., 2012), an analysis using a process view of IT impact (e.g., Kohli & Devaraj, 2008), an examination of specific technologies and their impact (Mukhopadhyay et al., 1995), and the impact of IT capability on a firm's financial performance (Bharadwaj, 2000; Chan & Levallet, 2013). We pursue the research stream of understanding the impact of IT capability on firms' financial performance because it holds a prominent role in understanding the business value of IT (e.g., Bharadwaj, 2000; Chan & Levallet, 2013; Choi & George, 2016). We adopt the concept of IT capability originally proposed by Bharadwaj (2000), positing that competitive advantages are derived not from IT investment, but from IT capability, that is, how firms effectively leverage their technology. The concept of IT capability, along with the operationalization proposed by Bharadwaj (2000), has been investigated several times, with some study findings showing inconsistent results. Hence, the goal of this study is to conduct a replication study of the impact of IT capability on firms' financial performance.

IT capability refers to the organizational "ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities." (Bharadwaj, 2000, p. 171). Drawing on the resource-based view (RBV) (Barney, 1991), Bharadwaj (2000) proposed that advantages accrued through IT capability are idiosyncratic and heterogeneous, and they cannot be easily replicated by competitors; therefore, they become the source of sustained competitive advantage to a firm. Due to the strategic importance of IT capability, this topic has captivated the interest of a multitude of researchers (e.g., Bharadwaj, 2000; Chae et al., 2014; Santhanam & Hartono, 2003).

Several approaches have been adopted to frame IT capability and study its impact. A common approach, based on evaluating competitive advantages, is to compare the financial performance of those firms publicly recognized as having high IT capability with those firms in the same industry but not recognized as having higher IT capability (Choi & George, 2016; Queiroz et al., 2018). These studies found that the firms recognized as having high IT capability (IT leaders) exhibit significantly higher profit ratios and lower cost ratios compared to those not recognized as leaders (Choi & George, 2016).

Despite the findings, debates persist regarding the strategic value of IT, most notably fueled by the arguments that IT capability does not matter anymore due to factors such as easier affordability, massive adoption, standardization, and commoditization of IT artifacts (Carr, 2003; Chae et al., 2014). As this research stream on IT capability plays an important role in IS studies because it identifies the strategic value of IT, it is imperative to replicate the findings from prior studies and assess whether the impact of IT capability, as originally posited in Bharadwaj (2000), still holds today. Conceptual replications are considered the most robust form of replication for validating original findings and generalizing them to newer contexts (Dennis & Valacich, 2015). Therefore, we test the same hypotheses in Bharadwaj (2000) to examine if firms with high IT capability (proxied by IT leaders) exhibit higher profit and lower cost ratios compared to the control firms. Despite the similarity in research hypotheses, this study applies more rigorous analytical methods and incorporates a more recent data frame from 2010 to 2019, thereby presenting a more robust evaluation of the impact of IT capability on firms' financial performance. For clarification, we provide a summary of the differences between the current paper and earlier papers in Table 1.

As shown in Table 1, one of the features distinguishing this study from others is the use of panel data analysis techniques. Panel data analysis has become more prevalent in IS research in recent years because it allows for investigations of patterns in phenomenon over a period of time, unlike cross-sectional analysis methods, which focus only on one point in time. The extant studies on IT capability present investigations of the relationship between IT capability and firm outcomes using solely cross-sectional analysis methods such as t-tests, signed-rank tests for matched samples, or regression analyses, but do not use panel data analysis. IS research has shifted toward panel data analysis because it permits the observation of patterns over time and thus provides more accurate testing and inferences about the relationship between variables (Hsiao, 2007). It can provide a more robust analysis of the causal relationship among variables (Mithas et al., 2013; Yaffee, 2003).

Table 1. Difference Between Prior Studies and This Study

Source	Year	Independent Variable	Method	Control Sample	Findings
(Bharadwaj, 2000)	1991-1994	IW leaders, at least twice	Matched sample comparison (cross-sectional T-test)	One control firm from the same industry with a comparable size	Firms with high IT capability outperform a control sample of firms on a profit and cost-based measures.
(Santhanam & Hartono, 2003)	1991-1994	IW leaders, at least twice	Matched sample comparison (Wilcoxon signed-rank test and the non-parametric t-test)	All firms within the same industry (2-digit SIC), with revenues higher than $250 million	Firms with superior IT capability to exhibit superior firms' financial performance, even after adjusting for effects of prior firms' financial performance.
(Chae et al., 2014)	1991-2007	IW 500 leaders at least twice	Matched sample comparison and regression with cross-sectional data	One control firm from the same industry with a comparable size	No significant link between IT capability and firms' financial performance
(Choi & George, 2016)	2001-2007	IW 500, leaders at least twice	Matched sample comparison and regression with cross-sectional data	All firms within the same industry (2-digit SIC), with revenues higher than $250 million	Firms with superior IT capability exhibit superior firms' financial performance. even after adjusting for effects of prior firms' financial performance.
This study	2010-2019	IW 500, three times	Panel data regression analysis with robustness check	All firms within the same industry (2-digit SIC), with revenues higher than $250 million	The superior IT capability will be associated with significantly higher profit ratios and lower cost ratios
Note: IW – Information Week, Leader – the firms selected as IT leader firms, SIC – Standard Industry Code.					

Panel data consists of data from units/variables over many points in time; and panel data analysis provides several advantages over cross-sectional data analysis. First, panel data analysis can account for individual heterogeneity (i.e., the inherent variations or unique characteristics that exist across different individual entities), and these unobserved differences may potentially bias the estimation of the focal relationship between variables. Therefore, by accounting for this heterogeneity, panel data analysis can provide more rigorous estimates of the causal relationship between variables (Breusch & Pagan, 1979). Second, panel data analysis uses multiple observations for each entity over multiple periods, and this potentially enhances the statistical power (Baltagi & Baltagi, 2008) and allows for examining the changes in variables over time.

Based on the noted benefits of panel data analysis and the nature of our data, we applied this analytical technique rather than the cross-sectional techniques used earlier to test the relationship between IT capability and financial performance. From our analysis, we find that firms with high IT capability exhibit higher financial performance manifested in higher profit and lower cost ratios compared with the control group firms in the same industry. Our findings do not support the conclusion of Chae et al. (2014), who found no association between IT capability and firm financial performance but are in line with studies by Bharadwaj (2002), Santhanam and Hartono (2003), and Choi and George (2016) which find that superior IT capability is critical to a firm because it can elevate a firm's financial performance and reduce costs relative to comparable firms. We next present our hypotheses, followed by our results and a discussion of the findings.

2 Theoretical Background and Hypotheses Development

A firm's IT capability represents a unique strength that can provide strategic advantages beyond IT investments. IT capability is shaped by the combination of IT infrastructure, human resources, and IT-enabled intangibles as a result of a firm's management and structuration process (Bharadwaj, 2000). It is a firm-specific competence in leveraging resources to create a unique competitive advantage, that is, irreplicable due to its idiosyncratic structuration processes (Bharadwaj, 2000; Wade & Hulland, 2004). The impact of IT capability on a firm's financial performance is mainly manifested by revenue enhancements and cost reductions.

First, IT capability can promote revenue growth by, among others, fostering better customer relationship management, providing new business opportunities, improving the management of the customer lifecycle, and enabling more sophisticated customer analysis and behavioral predictions (Jayachandran et al., 2005). For instance, utilizing cutting-edge analytical capabilities such as clustering data analysis techniques could help firms identify distinct customer segments, predict the purchasing behavior of these customers, and adopt targeted marketing. Furthermore, IT capability can play a critical role in fostering the complementariness of various resources and enhancing coordination among various business functions (e.g., marketing, manufacturing, and supply chain). IT capability also facilitates knowledge sharing and consolidation across hierarchical and functional boundaries, leading to firms' superior performance relative to their competitors (Bhatt et al., 2005; Cheng et al., 2021). Additionally, recent research shows that the strength of IT-enabled data analytics can improve a firm's financial performance by facilitating optimized decision-making, enhancing operational efficiency, and increasing adaptability to market dynamics (Ashbaugh-Skaife et al., 2009; Hazen & Byrd, 2012). Therefore, in many different ways, better IT capability can generate higher revenues and profits.

Not only can profits be improved, but costs can be lowered with better IT capability as well. A superior IT capability can help firms identify the strengths and vulnerabilities of current business processes and help in reducing process costs (Vera-Baquero et al., 2013). Moreover, firms can substantially reduce customer service costs by implementing self-service technologies in the processes of checkout, order delivery, and financial transactions (Alpar & Schulz, 2016). In addition, with various analytical capabilities, firms can identify and isolate bottlenecks, detect atypical processes, and reduce system breakdowns to ensure smoother and more robust business operations, thereby reducing the costs involved in the process of manufacturing and management (Counihan et al., 2002). Moreover, adopting innovative IT technologies such as cloud computing can help firms reduce infrastructure costs, and allow firms to easily scale up and down their resource consumption based on their need (Xiao et al., 2020). From the above, the advantages afforded by superior IT capability can enable firms to achieve higher profits and lower costs.

Most research studies report a positive relationship between IT capability and a firm's financial performance, and any inconsistency in these findings is primarily attributable to the differences in the operationalization of constructs and analytical methodologies (Kohli & Devaraj, 2003). However, this was refuted by Chae et al. (2014), who indicated that IT assets are now more easily available and commoditized, and relative advantages will not accrue. Still, even today, with technologies being more commoditized, firms that can effectively and efficiently leverage innovative technologies and systems, such as enterprise systems, business analytics, and cloud computing, to configure their IT-related resources can certainly achieve resource synergies and complementarities, leading to sustainable competitive advantage and superior performance. For example, advanced business intelligence and analytical capability in concert with big data analytics can give rise to a firm's competitive advantage, and this advantage is inherently "strategic" due to the cutting-edge, idiosyncratic information processing capability (Aydiner et al., 2019; Chen et al., 2012; Leimeister et al., 2010). From the above, recent research findings, case studies, and reports in trade publications, we believe that despite the standardization and commoditization, firms that are competent in effectively leveraging IT, can still obtain a positive impact on their performance relative to their competitors. In other words, IT capability matters even today and can offer competitive advantages to firms. Therefore, we propose,

Hypothesis 1: The superior IT capability will be associated with significantly higher profit ratios.

Hypothesis 2. The superior IT capability will be associated with significantly lower cost ratios.

3 Method

We obtained the data mainly from two sources: Standard and Poor's Compustat and IW 500. We obtained the list of firms with superior IT capability from the IW 500 which past studies have used to identify firms with superior IT capabilities (Bharadwaj, 2000; Chae et al., 2014; Choi & George, 2016; Santhanam & Hartono, 2003). The financial and accounting ratios were computed based on data collected from the Compustat database, including profit measures such as Return on Asset (ROA), Return on Sales (ROS), Operating Income to Asset (OI/A), Operating Income to Sales (OI/S), Operating Income to Employee (OI/E), and cost measures such as Cost of Goods Sold to Sales (COG/S), Selling, General, and Administrative Expenses to Sales (SGA/S), Operating Expense to Sales (OPEXP/S).

3.1 Sampling Strategy and Variables

Taking a conservative and more stringent approach than earlier studies, we selected firms listed in the IW 500 three consecutive times from 2010 to 2012 as the IT leader group. We follow the selection method by Santhanam and Hartono (2003) and Choi and George (2016) to include multiple firms in the same industry indicated by the four-digit Standard Industry Code (SIC). Furthermore, we narrow down the list of IT control firms by eliminating firms whose annual revenues are less than US$ 250 million so that this set of control firms matches the eligibility requirement of firms that are included in the IW 500. After excluding firms with revenues of less than US$ 250 million, the final dataset included 46,212 observations from 2010 to 2019. Table 3b provides the total number of firms included in the sample for each year. The details of the operationalization of independent and dependent variables are listed in Table 2, and the summary of descriptive statistics of key variables and the correlation matrix are displayed in Table 3a.

Table 2. Operationalization of Variables

Categories	Constructs	Operationalization	Source
IV	IT capability	Dichotomous variable, coded as 1 if a firm appears in IW 500 for three consecutive years; coded as 0 if not in the list, and the firm's annual revenue is equal to or greater than $250 million	(Bharadwaj, 2000; Santhanam & Hartono, 2003)
DV	Profit measures	Return on assets (ROA)	(Bharadwaj, 2000; Santhanam & Hartono, 2003)
		Return on sales (ROS),	
		Operating income to assets (OIA)	
		Operating income to sales (OIS)	
		Operating income to employees (OIE)	
	Cost measures	Cost of goods sold to sales (COG/S)	
		Selling and general administrative expenses to sales (SGA/S)	
		Total operating expenses to sales (OPEXP/S)	
Controls	Size	Firm's total revenue (unit: million dollars)	(Bharadwaj, 2000; Santhanam & Harton 2003)
	R&D intensity	R&D expense divided by total revenue	(Dewan & Ren, 2011; Tian & Xu, 2015)
	Advertisement intensity	Advertisement expense divided by total revenue	(Dewan & Ren, 2011; Tian & Xu, 2015)
	PPE intensity	PPE investment divided by total revenue	(Dewan & Ren, 2011; Tian & Xu, 2015)
	Leverage	Total liability divided by total asset	(Dewan & Ren, 2011; Tian & Xu, 2015)

Table 3a. Descriptive Statistics and Correlation Table

	Variable	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	IT Leader	0.07	0.25	1.00														
2	Size	0.01	0.02	0.16	1.00													
3	ROA	-0.04	0.26	0.14	0.09	1.00												
4	ROS	-0.92	5.91	0.05	0.03	0.45	1.00											
5	OIA	0.03	0.25	0.15	0.10	0.90	0.41	1.00										
6	OIS	-0.77	5.76	0.05	0.04	0.42	0.94	0.44	1.00									
7	OIE	60.70	481.30	0.15	0.14	0.47	0.27	0.52	0.30	1.00								
8	SGA/S	0.40	0.77	-0.12	-0.10	-0.64	-0.69	-0.68	-0.70	-0.42	1.00							
9	COG/S	1.07	3.38	0.06	0.09	-0.06	-0.07	-0.04	-0.08	-0.22	-0.20	1.00						
10	OPEXP/S	1.68	5.32	-0.06	-0.04	-0.43	-0.95	-0.45	-1.00	-0.31	0.72	0.08	1.00					
11	R&D	8.33	171.75	-0.05	-0.04	-0.37	-0.82	-0.40	-0.89	-0.21	0.65	-0.08	0.89	1.00				
12	Advertise	0.04	0.34	-0.03	-0.02	-0.17	-0.68	-0.19	-0.77	-0.10	0.34	-0.10	0.75	0.70	1.00			
13	PPE	3.02	75.01	-0.03	0.01	-0.14	-0.39	-0.14	-0.40	-0.04	0.26	0.11	0.41	0.40	0.30	1.00		
14	L.ROA	-0.02	3.39	0.06	0.04	0.27	0.15	0.30	0.18	0.15	-0.25	0.00	-0.18	-0.16	-0.09	-0.10	1.00	
15	Leverage	0.58	0.47	0.06	0.06	-0.15	-0.19	-0.09	-0.18	0.02	0.08	0.04	0.19	0.15	0.22	0.13	-0.21	1.00

Note: L. means a one-year lag of the variable.

Table 3b. Number of Firms in the Samples for Each Year

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of Firms	3,311	3,514	3,728	3,999	4,327	4,684	4,969	5,390	5,901	6,389

3.2 Sampling Strategy and Variables

Given the longitudinal nature of our dataset, we used panel regression analysis to increase the robustness of the tests (see Equation 1).

$$(\text{Financial Performance})_{it} = \text{Intercept} + (\text{IT Capability})_{it} + \text{ROA}_{it-1} + (\text{Firm-level Controls})_{it} + \text{Year Dummies} + \text{Industry dummies} + \varepsilon it \quad \text{(Equation 1)}$$

Note: εit is the error term for the firm *i* at time *t*.

We conducted diagnostic tests to determine the most appropriate model for our dataset. The Breusch-Pagan test showed individual heterogeneity, and therefore models accounting for such heterogeneity (fixed-effect or random-effect models) are more appropriate than the pooled ordinary least squares model (Breusch & Pagan, 1979). Given that the IT Leader variable was time-invariant, we used between-within models to assess the relationship between the outcome variables and the regressors (Allison, 2009). First, we calculated the panel-unit specific mean (as the panel means) for all time-varying predictors (between-variables), and then we subtracted the panel-unit mean from the original values (as the within- variable). Then, we included the calculated between- and within-variables in the regression model (Allison, 2009).

Further, we winsorized the data to replace the top and bottom one percent values with the 1 and 99 percentile values to minimize the effect of outliners on the statistical results (Dewan & Ren, 2011; Kothari et al., 2002; Tian & Xu, 2015). Further, since the model may suffer from endogeneity (Wooldridge, 2009) due to: 1) self-selection bias because certain firm characteristics may impact a firm's IT capabilities status, 2) other unobserved factors or omitted variables that may impact the firm's performance, and 3) potential reverse causality, we applied several analysis methods: 1) the between-within model, 2) Heckman's two-stage model to control for self-selection bias and potential endogeneity, and 3) two-stage least squares (2SLS) for endogeneity.

Following prior literature on IT business value, our analysis includes a wide range of firm-level control variables, including the firm's size (Bharadwaj, 2000; Santhanam & Hartono, 2003), the previous year's performances (e.g., Bharadwaj 2000), R&D intensity, advertisement intensity, PPE, leverage ratio (e.g., Dewan & Ren, 2011; Dewan et al., 2007), and industry dummy. Moreover, in all our fitted models, the values for variance inflated factor (VIF) are less than 3, demonstrating the absence of multicollinearity among our models' covariates. The results of the between-within model are displayed in Table 4. For Heckman's two-stage model, the results of the probit model (stage one) are displayed in Table 5. The results of Heckman's two-stage regression are displayed in Table 6. The results of the 2SLS are reported in Table 7.

3.3 Heckman Two-Stage Model

In our research, IT capability can also be subject to endogeneity because IT capability can be a reflection of an industry's general practices or norms (Kim et al., 2017; Tian & Xu, 2015). Previous research also suggested using industry averages of endogenous variables as instrumental variables (e.g., Cassiman & Veugelers, 2002; Tian & Xu, 2015; Veugelers & Cassiman, 2005). Therefore, we used the average percentage of an industry's (represented by a 2-digit SIC code) IT leader firms as the chosen instrument variable. Prior research indicated that instrument variables should be employed if they are statistically significant while the endogenous variable is regressed on them (Wooldridge, 2010). The results of the probit model are displayed in Table 5, which shows that both instrument variables exhibit a significant impact on the endogenous variables. We then calculated the inverse Mills ratio (IMR) to be included in the two=stage regression (Heckman, 1979). The results of the Heckman model are presented in Table 6.

4 Results

We hypothesized a positive relationship between firms' IT capability and firms' profit measures and a negative relationship with firms' cost measures. Table 4 presents the outcomes of the between-within regression analysis on performance measures. The results show that IT capability has a positive, statistically significant relationship with all the profit ratios (ROA, ROS, OIA, OIS, and OIE) while having a negative, statistically significant relationship with all the cost ratios (COG/S, SGA/S, and OPEX/S). Regarding the assessment of our instrument variables, Table 5 presents the results of the probit model, indicating that both instrument variables significantly impact the IT capability. Table 6 reports the results of the Heckman model with the inclusion of the inverse Mills ratio (IMR), suggesting that the profit and cost measures are largely consistent with Table 4, although with a few exceptions, such as OIA and COG/S. However, the coefficients of IT Leader for OIA and COG/S were not statistically significant.

Additionally, Table 8 reports the test results of the instrument variables. The p-values for the under-identification test, weak identification test, and overidentification test of the instruments indicate that these two exclusive instruments are valid and appropriate. Overall, we conclude that H1 and H2, which state that superior IT capability is positively related to the profit measures and negatively related to the cost measures, respectively, are both supported. Our results are aligned with the results of prior studies conducted by Bhardwaj (2000), Santhanam and Hartono (2003), and Choi and George (2016), that IT capability is of critical importance and that IT capability can enhance a firm's performance increasing profit outcomes and reducing cost outcomes.

5 Discussion

Understanding the relationship between IT capability and a firm's financial performance has remained a matter of sustained interest to IS scholars for several decades. However, the presence of some contradictory findings in a few studies raised doubts about the enduring effect of IT capability. Hence, we

conducted a conceptual replication using the same measures as the prior studies but utilized more recent and robust statistical analyses with a large longitudinal dataset. We also included multiple control variables that have been reported to impact a firm's financial performance. Our results demonstrate that IT capability has an enduring impact, as originally proposed by Bharadwaj (2000) and reiterated in several other studies (e.g., Santhanam & Hartono, 2013; Choi & George, 2016). Any doubts about the value of IT capability due to commoditization, as suggested by Chae et al. (2014), are not warranted.

Table 4. Results of the Between-within Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	**ROA**	**ROS**	**OIA**	**OIS**	**OIE**	**COG/S**	**SGA/S**	**OPEXP/S**
IT Leader	0.183***	2.201***	0.183***	2.083***	179.067***	-1.064***	-0.484***	-2.007***
	(0.015)	(0.331)	(0.015)	(0.323)	(26.274)	(0.196)	(0.060)	(0.300)
Size_between	1.311***	16.423***	1.278***	15.349***	1,495.169***	-7.526***	-3.489***	-14.751***
	(0.206)	(4.686)	(0.208)	(4.580)	(373.523)	(2.777)	(0.820)	(4.255)
Size_within	0.376**	1.097	0.387***	0.537	1,320.011***	-0.079	-0.363	-0.531
	(0.159)	(3.945)	(0.131)	(3.720)	(269.614)	(2.163)	(0.381)	(3.396)
R&D_between	-0.000***	-0.016***	-0.000***	-0.015***	-0.435***	0.009***	0.001	0.014***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.076)	(0.001)	(0.001)	(0.001)
R&D_within	-0.000***	-0.006***	-0.000***	-0.006***	-0.065***	0.003***	-0.003***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.015)	(0.000)	(0.000)	(0.000)
PPE_between	-0.000***	-0.025***	-0.000**	-0.024***	0.133	0.012***	0.011***	0.022***
	(0.000)	(0.003)	(0.000)	(0.003)	(0.238)	(0.002)	(0.002)	(0.003)
PPE_within	0.000	-0.005***	0.000	-0.005***	-0.024	0.003***	0.014***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.025)	(0.000)	(0.000)	(0.000)
Leverage_between	-0.122***	0.184	-0.085***	0.359	18.769	-0.606***	0.106**	-0.333
	(0.010)	(0.245)	(0.010)	(0.241)	(19.193)	(0.145)	(0.050)	(0.222)
Leverage_within	-0.088***	-0.184***	-0.058***	0.015	-24.426***	0.036	0.033***	-0.004
	(0.002)	(0.070)	(0.002)	(0.066)	(4.116)	(0.038)	(0.007)	(0.060)
Constant	0.047	-0.083	0.078	-0.086	33.100	0.976	0.171	1.078
	(0.072)	(1.643)	(0.072)	(1.602)	(130.379)	(0.970)	(0.274)	(1.488)
Industry effect included								
Observations	30,539	29,632	29,314	28,407	28,160	29,630	24,874	29,630
Number of firms	4,297	4,098	4,154	3,955	4,007	4,098	3,440	4,098

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. L. DA means the one-year lag of the dependent variables.

Table 5. Results of the Probit Model (Stage One)

Leader	Coef.	Std. Err.	z	P
Leader_ Industry Average	1.856***	0.371	5	<0.001
Employee Number	0.001***	0.000	6.43	<0.001
Constant	-1.164***	0.020	-58.67	<0.001

Table 6. Results of Heckman Two-Stage Between-Within Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	**ROA**	**ROS**	**OIA**	**OIS**	**OIE**	**COG/S**	**SGA/S**	**OPEXP/S**
IT Leader	0.044***	0.281**	0.024***	0.200	31.687***	-0.095	-0.041***	-0.191*
	(0.008)	(0.142)	(0.006)	(0.125)	(11.216)	(0.070)	(0.014)	(0.114)
Lambda	-0.084**	-0.569	-0.058**	-0.431	37.963	0.186	0.090	0.412
	(0.034)	(0.650)	(0.025)	(0.570)	(51.238)	(0.317)	(0.059)	(0.522)
Size_between	0.133	0.611	0.004	0.257	271.074	0.133	-0.126	-0.228
	(0.120)	(2.270)	(0.088)	(1.991)	(179.731)	(1.108)	(0.208)	(1.823)
Size_within	0.137	2.156	0.245	1.971	897.177	-0.936	-0.367	-1.844
	(0.392)	(7.171)	(0.292)	(6.225)	(567.026)	(3.359)	(0.626)	(5.707)
R&D_between	-0.002***	-0.104***	-0.001***	-0.090***	-1.561***	0.057***	0.015***	0.083***
	(0.000)	(0.005)	(0.000)	(0.005)	(0.296)	(0.003)	(0.002)	(0.004)
R&D _within	0.000	-0.009***	-0.000	-0.013***	0.427***	0.003**	0.018***	0.011***
	(0.000)	(0.002)	(0.000)	(0.002)	(0.162)	(0.001)	(0.002)	(0.002)
PPE_between	-0.000*	0.005	-0.000	0.013***	0.014	-0.011***	0.018***	-0.012***
	(0.000)	(0.004)	(0.000)	(0.003)	(0.277)	(0.002)	(0.001)	(0.003)
PPE_within	0.000***	0.007***	0.000***	0.006***	-0.006	-0.001**	0.008***	-0.005***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.098)	(0.001)	(0.001)	(0.001)
Leverage_between	-0.074***	0.271	-0.029***	0.326**	-38.075***	-0.192**	0.028	-0.296**
	(0.008)	(0.185)	(0.006)	(0.164)	(12.061)	(0.090)	(0.019)	(0.148)
Leverage_within	-0.046***	-0.369	-0.008	-0.145	26.862*	0.111	-0.047*	0.087
	(0.011)	(0.281)	(0.008)	(0.245)	(15.082)	(0.131)	(0.028)	(0.224)
L.DVs	0.529***	0.490***	0.784***	0.538***	0.790***	0.533***	0.657***	0.546***
	(0.013)	(0.013)	(0.010)	(0.011)	(0.010)	(0.011)	(0.009)	(0.011)
Constant	0.188***	0.840	0.131**	0.610	-27.483	0.103	-0.127	-0.141
	(0.073)	(1.371)	(0.053)	(1.201)	(110.383)	(0.669)	(0.127)	(1.101)
Industry effect included								
Observations	4,588	4,534	4,407	4,353	4,308	4,532	3,850	4,532
Number of firms	2,366	2,338	2,275	2,247	2,223	2,337	1,987	2,337

5.1 Implications to Research

Our findings suggest that IT capability is a vital source of competitive advantage, and the concept of IT capability is still relevant to IS research and practice. A firm's competence in effectively leveraging its IT resources is still critical to outperform its rivals. Using a more stringent test, we found that even in this current age of commoditized IT, firms still benefit from developing higher IT capability relative to their competitors. The outcomes of this research are significant because the effect of IT capability has been questioned in a study published recently in a major IS journal (e.g., Chae et al., 2014) suggesting no significant linkage between IT capability and a firm's financial performance. To recap, using data from

2001 to 2007, and using the same construct of IT capability as in earlier studies, Chae et al. (2014) indicated that IT products have become so standardized and commoditized that implementing IT systems would not confer any extra advantage as every firm is implementing and following the same practices. Some reports suggested that IT will no longer offer any competitive advantages because IT has become an operational necessity (e.g., Carr, 2003) and the business value provided by stronger IT capability will diminish as a result of the widespread commoditization and universal acceptance of IT (e.g., Masli et al., 2011).

Table 7. Results with 2SLS Procedure

VARIABLES	ROA	ROS	OIA	OIS	OIE	COG/S	SGA/S	OPEXP/S
l. leader	0.063***	0.903***	0.042***	0.808***	39.441***	-0.482***	-0.034***	-0.745***
	(0.006)	(0.135)	(0.005)	(0.126)	(9.154)	(0.075)	(0.012)	(0.115)
L.Size	0.079*	0.679	0.034	0.528	58.071	-0.012	-0.153*	-0.469
	(0.046)	(1.029)	(0.036)	(0.961)	(70.868)	(0.571)	(0.089)	(0.877)
L.R&D	-0.000***	0.001***	-0.000**	0.002***	-0.010	-0.001***	0.002***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.014)	(0.000)	(0.000)	(0.000)
L. Advertise	-0.014***	0.096	-0.007**	0.158*	-5.162	-0.042	0.012	-0.155*
	(0.004)	(0.097)	(0.003)	(0.091)	(6.619)	(0.054)	(0.008)	(0.083)
L.PPE	-0.000***	-0.003***	-0.000*	-0.003***	-0.018	0.000	-0.004***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.024)	(0.000)	(0.000)	(0.000)
L. Leverage	0.031***	0.248***	0.024***	0.201***	11.781***	-0.119***	-0.032***	-0.195***
	(0.002)	(0.054)	(0.002)	(0.051)	(3.426)	(0.030)	(0.005)	(0.046)
L.DVs	0.778***	0.727***	0.881***	0.751***	0.860***	0.761***	0.858***	0.757***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
Constant	3.637***	23.416	2.529***	24.647	839.742	-16.596*	-1.359	-22.278
	(0.773)	(17.561)	(0.617)	(16.735)	(1,240.026)	(9.745)	(1.586)	(14.959)
Observations	26,185	25,448	25,103	24,366	24,089	25,445	21,369	25,445
R-squared	0.607	0.567	0.755	0.602	0.733	0.597	0.806	0.611

Table 8. Test Results of Instrument Variables

Test	ROA	ROS	OIA	OIS	OIE	COGS	SGAS	OPEXPS
Underidentification test (Anderson canon. corr. LM statistic):	6839.2	6909.9	6514.12	6526.68	6676.26	6844.91	5217.0	6808.4
Chi-sq(1) P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Weak identification test (Cragg-Donald Wald F statistic):	4647.0	9378.21	4414.5	4474.2	4613.02	4701.35	3460.5	4666.94
Sargan statistic (overidentification test of all instruments):	3.703	0	4.62	0.075	3.86	0.05	0.262	0.085
Chi-sq(1) P-value	0.0543		0.0316	0.784	0.0495	0.8239	0.6086	0.7711
F-test	1699.91(p<0.001)	1408.83 (p<0.001)	3202.18 (p<0.001)	1520.19 (p<0.001)	2796.04(p<0.001)	1537.97 (p<0.001)	3709.90 (p<0.001)	1645.68 (p<0.001)

As advanced technology becomes more commoditized and affordable, all firms can access and adopt advanced IT resources more easily, leading to the disappearance of the competitive advantages derived from their IT investments. However, the essence of IT capability is not about IT investments per se, but about a firm's ability to deploy IT resources in tandem with other complementary assets (e.g., human resources, strategies) to develop a unique competitive advantage that is rare and non-substitutable by the rivals (Bharadwaj, 2000). Hence, our conceptual replication is necessary to evaluate whether, even in the age of more commoditized IT products, firms benefit by developing unique ways to deploy and leverage their IT products. Our replication findings show that the answer is definitely Yes. IT capability indicates the extent to which a firm can effectively and efficiently deploy IT resources to achieve its competitive advantage. Therefore, to achieve superior financial performance, firms need to develop their core competence by synergizing IT and their business strategy, integrating IT with other business resources, and cultivating an innovative corporate culture to integrate emerging innovation. Even if IT systems may consist of standardized products, services, and components (e.g., artificial intelligence, enterprise systems, big data analytics, and cloud computing), the extent to which the integration and complementarity of these systems combine with other tangible and intangible business resources differ across firms, thereby rendering some firms gaining competitive advantages over other firms. Therefore, our study suggests that the commoditization and standardization of IT do not necessarily prevent firms from leveraging standardized IT more competently to achieve a competitive strategy.

5.2 Implications to Practice

Our study confirmed that IT capability still matters, and a stronger IT capability can lead to superior financial performance. Therefore, firms must pay attention to developing their IT capability even if IT products and services seem commoditized and easily accessible. A firm's ability to integrate IT with other resources such as human resources, and customer relationships, and fostering a culture of learning can develop a core and unique competence reflected as a superior IT capability that can improve the firm's financial performance relative to other firms in the same industry. Even in the current digital age, firms should strategically focus on the effective integration of sophisticated IT innovations such as artificial intelligence, cloud computing, and big data analytics with other core corporate resources. By effectively leveraging innovative IT, a firm can build a unique core competence that is hard to imitate by rivals and pursue a strategic position, enhanced value chain, improved operational efficiency, and smarter and more informed business decision-making mechanisms.

6 Limitations

Our study has some limitations that we acknowledge. First, as this study replicates earlier research, we adhere to the operationalization of the prior studies in this line of research. Although IW 500 was recognized as a good proxy even by recent research (Banker et al., 2022), it may have limitations that are worth mentioning. IW 500 was not originally designed to measure IT capability. IT leadership as collected from IW 500 is a binary variable, it may not reflect the nuances of the differences among firms recognized as IT leaders. Additionally, although Information Week states that its selection criteria for the IW 500 have been evolving each year to reflect the changing business environment and emerging technology landscape, it stopped publishing the IW 500 list after 2013. Therefore, while we acknowledge the importance of having a holistic evaluation of a firm's IT capability by taking account of a wide spectrum of factors (e.g., IT investment, innovation), we suggest that future scholars and practitioners explore alternative measurements or proxies for a firm's IT capability, such as a combination of surveys, industry reports, and text mining, which can provide more current, up-to-date insights into a firm's IT capability.

Second, our study of the impact of firms' IT capability on financial performance only focuses on the publicly traded firms in the major exchanges (e.g., NYSE, Nasdaq) of the United States. Unfortunately, data on smaller companies are not readily available, although they too probably benefit from developing their IT capability. Moreover, we further narrowed down the samples to include companies with annual revenue greater than US$ 250 million to match the selection criteria used in IW 500. Hence, our sample does not include private firms not traded in the US exchanges and public firms whose annual revenues are smaller than US$ 250 million, limiting the scope of our study findings. Given the importance of the value of IT capability, we think that future researchers could address and study IT capability effects in smaller firms. Furthermore, the extant line of research on IT capability primarily focuses on the impact of IT capability on a firm's financial performance; however, a firm's performance can be viewed using a broader range of firm outcomes such as operational performance (e.g., productivity and efficiency) (Anand

et al., 2020) and market measures (e.g., stock market return, value, and risk) (Dewan & Ren, 2007; Dewan & Ren, 2011). Hence, we call for future scholars to further contribute to the current body of IT capability literature by incorporating a wider range of firm outcomes.

References

Allison, P. D. (2009). *Fixed effects regression models*. SAGE.

Alpar, P., & Schulz, M. (2016). Self-Service business intelligence. *Business & Information Systems Engineering*, *58*(2), 151-155.

Anand, A., Sharma, R., & Kohli, R. (2020). The effects of operational and financial performance failure on BI&A-enabled search behaviors: A theory of performance-driven search. *Information Systems Research*, *31*(4), 1144-1163.

Ashbaugh-Skaife, H., Collins, D. W., Kinney Jr, W. R., & LaFond, R. (2009). The effect of sox internal control deficiencies on firm risk and cost of equity. *Journal of Accounting Research*, *47*(1), 1-43.

Aydiner, A. S., Tatoglu, E., Bayraktar, E., Zaim, S., & Delen, D. (2019). Business analytics and firm performance: The mediating role of business process performance. *Journal of Business Research,* (96), 228-237.

Baltagi, B. H., & Baltagi, B. H. (2008). *Econometric analysis of panel data*. Springer.

Banker, R. D., Frost, T. S., & Tripathi, M. K. (2022). The determinants of InformationWeek 500 selection and its implications: A textual analysis approach. *Journal of Information Systems*, 36(1), 81-109.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120.

Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: An empirical investigation. *MIS Quarterly, 24*(1), 169-196.

Bhatt, G. D., Grover, V., & Grover, V. (2005). Types of information technology capabilities and their role in competitive advantage: An empirical study. *Journal of Management Information Systems*, *22*(2), 253-277.

Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica: Journal of the Econometric Society*, *47*(5), 1287-1294.

Carr, N. G. (2003)."IT doesn't matter. *Educause Review* (38), 24-38.

Cassiman, B., & Veugelers, R. (2002). R&D cooperation and spillovers: Some empirical evidence from Belgium. *American Economic Review, 92*(4), 1169-1184.

Chae, B. K. (2014). A complexity theory approach to IT-enabled services (IESs) and service innovation: Business analytics as an illustration of IES. *Decision Support Systems* (57), 1-10.

Chae, H.-C., Koh, C. E., & Prybutok, V. R. (2014). Information technology capability and firm performance: Contradictory Findings and their possible causes. *MIS Quarterly, 38*(1), 305-326.

Chan, Y. E., & Levallet, N. (2013). IT capabilities – Quo vadis? In *Thirty Fourth International Conference on Information Systems*.

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly*, *36*(4), 1165-1188.

Cheng, Z., Rai, A., Tian, F., & Xu, S. X. (2021). Social learning in information technology investment: The role of board interlocks. *Management Science*, *67*(1), 547-576.

Choi, I., & George, J. F. (2016). One question, two answers: Mixed findings of information technology capability and firm performance and their implications. *AIS Transactions on Replication Research*, *2*(1), 3.

Counihan, A., Finnegan, P., & Sammon, D. (2002). Towards a framework for evaluating investments in data warehousing. *Information Systems Journal*, *12*(4), 321-338.

Dennis, A. R., & Valacich, J. S. (2015). A replication manifesto. *AIS Transactions on Replication Research*, *1*(1), p. 1.

Dewan, S., & Ren, F. (2007). Risk and return of information technology initiatives: Evidence from electronic commerce announcements. *Information Systems Research*, *18*(4), 370-394.

Dewan, S., & Ren, F. (2011). Information technology and firm boundaries: Impact on firm risk and return performance. *Information Systems Research*, *22*(2), 369-388.

Dewan, S., Shi, C., & Gurbaxani, V. (2007). Investigating the risk–return relationship of information technology investment: Firm-level empirical analysis. *Management Science*, *53*(12), 1829-1842.

Hazen, B. T., & Byrd, T. A. (2012). Toward creating competitive advantage with logistics information technology. *International Journal of Physical Distribution & Logistics Management*, *42*(1), 8-35.

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica: Journal of the Econometric Society, 47*(1), 153-161.

Hsiao, C. (2007). Panel data analysis—Advantages and challenges. *Test*, *16*(1), 1-22.

Jayachandran, S., Sharma, S., Kaufman, P., & Raman, P. (2005). The role of relational information processes and technology use in customer relationship management. *Journal of Marketing*, *69*(4), 177-192.

Kettinger, W. J., Ryoo, S. Y., & Marchand, D. A. (2021). We're engaged! Following the path to a successful information management capability. *The Journal of Strategic Information Systems*, *30*(3), 101681.

Kim, K., Mithas, S., & Kimbrough, M. (2017). Information technology investments and firm risk across industries: Evidence from the bond market. *MIS Quarterly*, *41*(4), 1347-1367.

Kohli, R., & Devaraj, S. (2003). Measuring information technology payoff: A meta-analysis of structural variables in firm-level empirical research. *Information Systems Research*, *14*(2), 127-145.

Kohli, R., & Devaraj, S. (2008). Realizing the business value of information technology investments: An organizational process. *MIS Quarterly Executive*, *3*(1), 6.

Kothari, S., Laguerre, T. E., & Leone, A. J. (2002). Capitalization versus expensing: Evidence on the uncertainty of future earnings from capital expenditures versus R&D outlays. *Review of Accounting Studies, 7*(4), 355-382.

Leimeister, S., Böhm, M., Riedl, C., & Krcmar, H. (2010). The business perspective of cloud computing: Actors, roles and value networks. In *ECIS 2010 Proceedings*, *56*.

Masli, A., Richardson, V. J., Sanchez, J. M., & Smith, R. E. (2011). The business value of IT: A synthesis and framework of archival research. *Journal of Information Systems*, *25*(2), 81-116.

Mithas, S., Tafti, A., Bardhan, I., & Goh, J. M. (2012). Information technology and firm profitability: Mechanisms and empirical evidence. *MIS Quarterly*, *36*(1), 205-224.

Mithas, S., Tafti, A., & Mitchell, W. (2013). How a firm's competitive environment and digital strategic posture influence digital business strategy. *MIS Quarterly, 37*(2), 511-536.

Mukhopadhyay, T., Kekre, S., & Kalathur, S. (1995). Business value of information technology: A study of electronic data interchange. *MIS Quarterly*, *19*(2), 137-156.

Queiroz, M., Tallon, P. P., Sharma, R., & Coltman, T. (2018). The role of IT application orchestration capability in improving agility and performance. *The Journal of Strategic Information Systems*, *27*(1), 4-21.

Santhanam, R., & Hartono, E. (2003). Issues in linking information technology capability to firm performance. *MIS Quarterly*, *27*(1), 125-153.

Tian, F., and Xu, S. X. (2015). How do enterprise resource planning systems affect firm risk? Post-implementation impact. *MIS Quarterly*, *39*(1), 39-60.

Vera-Baquero, A., Colomo-Palacios, R., & Molloy, O. (2013). Business process analytics using a big data approach. *IT Professional, 15*(6), 29-35.

Veugelers, R., & Cassiman, B. (2005). R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing. *International Journal of Industrial Organization*, *23*(5-6), 355-379.

Wade, M., & Hulland, J. (2004). The resource-based view and information systems research: Review, extension, and suggestions for future research. *MIS Quarterly*, *28*(1), 107-142.

Wooldridge, J. M. (2009). On estimating firm-level production functions using proxy variables to control for unobservables. *Economics Letters*, *104*(3), 112-114.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT Press.

Xiao, X., Sarker, S., Wright, R. T., Sarker, S., & Mariadoss, B. J. (2020). Commitment and replacement of existing SAAS-delivered applications: A mixed-methods investigation. *MIS Quarterly*, *44*(4), 1811-1857.

Yaffee, R. (2003). A primer for panel data analysis. *Connect: Information Technology at NYU*, *8*(3), 1-11.

About the Authors

Chuan (Annie) Tian is an Assistant Professor of Management Information Systems at the Culverhouse College of Business School of the University of Alabama. She holds a Ph.D. in Management Information System from the University of Oklahoma. Dr. Tian's research interests include cybersecurity, IT business strategy, IT innovation and diffusion, and computer-mediated communication. Dr. Tian also had expertise in a wide range of research methodologies such as econometrics, data mining, topic modeling, and experimental approach. Her research has been published in premier journals such as MIS Quarterly, and Computers and Security.

Radhika Santhanam is the Michael F. Price Chair in MIS, and the Director of the MIS Division, at the Price College of Business, University of Oklahoma. Her research focus is to enhance human- technology interactions, particularly in work environments, and her teaching interests are in Business Analytics and Modeling. From a micro-perspective, her research examines how user learning and training coupled with system design enhances individual employee competencies and augments their interactions with technology. From a macro perspective, her research identifies ways by which organizations can accrue value from implementing technologies and support employees in collectively appropriating their benefits. Her recent research explores gamifying systems to improve employee experiences during learning and work. Her research findings are published in a variety of leading journals. She has served as a Senior Editor for Information Systems Research, the Journal of AIS, and Senior Editor for a special issue of MIS Quarterly. She is the Program Co-Chair for the International Conference on Information Systems 2023.

Pascal Nitiema is an assistant professor in the Department of Information Systems at W. P. Carey School of Business. He earned his Doctorate in Medicine from the University of Ouagadougou in Burkina Faso, and his PhD in Management Information Systems from the University of Oklahoma. He has worked previously as a physician in Burkina Faso and as a research biostatistician at the College of Medicine of the University of Oklahoma Health Sciences Center. His research interests include the impact of information technology on organizational performance; the use of information systems clinical care and disease surveillance; and the psychological impact of the use of information technology and communication devices (e.g., technostress, techno-addiction), as well as how individuals' mental health may influence their use of technology.