IT Investments, Alignment and Firm Performance: Evidence from an Emerging Economy

Completed Research Paper

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Abstract

This study presents and tests a model in which the effect of IT investments on firm revenues is associated with the dimensions of IT-business alignment in an emerging market context. We disaggregate firms' IT business alignment into three dimensions: (1) IT investment-business strategy alignment, (2) IT delivery-business priority alignment, and (3) IT change-business change alignment. Using a secondary data set comprising more than two hundred Indian companies, we find that IT delivery-business priority alignment and IT change-business change alignment more strongly moderate the relationship between IT investments and firm revenues. Specifically, firms with IT change-business change alignment and IT delivery-business priority alignment have higher revenue at higher levels of IT investment than firms that display IT investment-business strategy alignment. Our additional exploratory analyses demonstrate firms with IT change-business change alignment outperform firms that show alignment at other dimensions of IT-business alignment at the high levels of software and service investments.

Keywords: Information technology and business alignment, IT investment-business strategy alignment, IT delivery-business priority alignment, IT change-business change alignment, IT investment, Revenue

Introduction

Although IT-business alignment has received significant attention from information systems researchers and practitioners (e.g., Shpilberg et al. 2007; Tallon and Pinsonneault 2011), some consider the conceptualization as well as the operationalization of IT-business alignment as still limited (Chen et al. 2010; Wu et al. 2014). Previous studies have found that organizations which achieve better strategic alignment between IT and business extract greater strategic use from IS, thereby leading to higher performance (Chan et al. 1997; Chan et al. 2006; Oh and Pinsonneault 2007; Preston and Karahanna 2009; Tallon 2008). While prior literature has provided evidence to support the theoretical argument for aligning IT with business along intellectual and social dimensions, prior studies do not consider implications of changes in their IT environment with changes in business requirements.

In addition, scholars have noted that a marked increase in environmental volatility due to greater uncertainty in international financial markets, volatile consumer demand, intense competition, shrinking product cycles, and rapidly changing IT paradigm, has led firms to consider their ability to respond to change (Tallon and Pinsonneault 2011; Tanriverdi et al. 2010; Teece et al. 1997; Xue et al. 2011). The dynamic nature of IT and the competitive environment (Bhatt and Grover 2005), necessitates the evolution of IT to achieve alignment with increasingly turbulent and dynamic markets (Pavlou and El Sawy 2006; Sambamurthy et al. 2003; Tanriverdi et al. 2010; Viaene et al. 2010). This interplay of technology and environment is particularly noticeable in emerging economies that are undergoing fast growth amidst immense volatility. In an emerging market, environmental uncertainty brings forth more market challenges as well as more opportunities, which may emerge simultaneously (Rawski 1994). Although researchers have pointed to the need to study how firms adapt and learn in the face of environmental changes in emerging economies (Wright et al. 2005), no study does so and majority of the studies in IT-business alignment research pertain to developed economies such as the U.S., Canada and Taiwan (Wu et al. 2014; Yayla and Hu 2011). Moreover, empirical research on the performance implications of IT-business alignment has been sparse and fragmented (Sabherwal and Chan 2001).

This study poses the following research question: How do dimensions of IT-business alignment and IT investments jointly influence firm performance? To answer this question, we propose a theoretical framework where the impact of IT investment on revenue is moderated by the dimensions of IT-business alignment. We disaggregate IT-business alignment into three dimensions (i.e., IT investment-business strategy alignment, IT delivery-business priority alignment, and IT change-business change alignment) and empirically test and validate our framework by using secondary data from more than 200 Indian firms. Our key contribution is in theorizing and showing that firms' dimensions of IT-business alignment moderate the relationship between IT investment and firm performance; firms with an IT change-business change alignment compared to other IT-business alignment dimensions have higher revenues at higher levels of IT investments. This is a remarkable finding with significant managerial implications for devising an approach to IT-business alignment and for determining the appropriate dimensions of alignment given the firm's level of IT investment.

Background and Theoretical Framework

The objective of this study is to extend prior work in IS research that has explored the effects of IT-business alignment on firm performance. While previous studies demonstrate the impact of IT capability on firm performance based on resource-based view (Bharadwaj 2000; Gholami and Kohli 2012; Wang and Alam 2007), this study explores the association between dimensions of IT-business alignment and IT investments on firm revenue based on the contingency perspective. Alignment between IT strategy and business strategy has been rooted in contingency theory. Contingency theory posits that the alignment between the patterns of relevant contextual, structural, and strategic factors leads to superior firm performance whereas misalignment results in decreased performance (Mithas and Rust 2013; Oh and Pinsonneault 2007; Weill and Olson 1989).

Prior work has conceptualized IT-business alignment in several ways. Henderson and Venkatraman (1993) define alignment as the degree of strategic fit and functional integration among business strategy, IT strategy, business infrastructure, and IT infrastructure. Broadbent and Weill (1993) define alignment as "the extent to which business strategies were enabled, supported, and stimulated by information strategies" (p.164). Reich and Benbasat (1996) conceptualize alignment as "the degree to which the

mission, objectives, and plans contained in the business strategy are shared and supported by the IT strategy" (p.56). Luftman and Brier (1999) note that alignment is "applying IT in an appropriate and timely way and in harmony with business strategies, goals, and needs" (p.109). Alignment has also been referred to as fit, balance, linkage, shared understanding, and integration in previous studies (Broadbent and Weill 1993; Chan and Reich 2007; Henderson and Venkatraman 1993; Ray et al. 2007; Reich and Benbasat 1996).

Several prior studies have studied the effects of IT and business strategy alignment (Chan et al. 1997; Chan and Reich 2007; Irani 2002; Kearns and Lederer 2003; Tallon 2008). Floyd and Wooldridge (1990) empirically validate the indirect performance effect from business strategy and IT alignment in the banking industry. Bergeron et al. (2004) show that low-performing firms are likely to exhibit misalignment between business strategy, business structure, IT strategy, and IT structure. Chan et al.'s (1997) analysis of 170 firms from 4 industries in US and Canada also reveals that alignment has a positive impact on the perceived performance of the firm and on the perceived effectiveness of the information systems unit. Zahra and Covin (1993) survey of 103 manufacturing firms found find that business strategy moderates the link between IT strategy and firm performance. Sabherwal and Chan (2001) use the Miles et al. (1978) strategy typology to measure business strategy, predict the appropriate IT strategy, and assess alignment based on the survey of 226 firms. They reveal a positive correlation between alignment and perceived measures of firm performance for prospectors and analyzers but not for defenders (Sabherwal and Chan 2001). Combining corporate and academic institution data from Sabherwal and Kirs (1994), Sabherwal and Chan (2001), and Chan et al. (2006) show the differences in the predictive capabilities of alignment and find that defenders fail to realize any benefit from alignment. Using the same typology, Croteau and Bergeron (2001) demonstrate that IT facilitates or supports business strategy for prospectors and analyzers but has a negative effect for defenders.

Prior work suggests that IT-business alignment should be present at all levels of the organization, including the organizational level, system level, project level, and the individual level (Chan and Reich 2007). While strategy is carried out on the front line, formal strategies are often conceptualized at the upper levels of the organizations. Bleistein et al. (2006) use requirements engineering to link higher-level strategic goals to lower level, explicit organizational processes. Jenkin and Chan (2010) examine alignment at the project level and operationalize IT project alignment as the degree to which an IT project's deliverables are congruent with the organization's IT strategy and the project's objectives. Critical to project alignment is the project's response to change triggers (Jenkin and Chan 2010). Failure to respond to change triggers effectively leads to project misalignment, thereby leading to overall IT strategic misalignment (Chan and Reich 2007). In addition, not only is IT investment integral to operations at the functional-level of the firm, but it also plays an influential role in business-level strategy. IT investments facilitate improved firm performance through enhancing the firm's current capabilities and dynamic capabilities, which in turn enables the firm to create and capture value (Drnevich and Croson 2013).

In summary, our review of research on IT-business alignment suggests that the relationship between IT, business strategy, and firm performance is complex. Findings have often been inconclusive because different studies have used different approaches to conceptualize IT-business alignment and to measure its effect on organizational performance (Oh and Pinsonneault 2007). A majority of alignment studies have operationalized alignment by collapsing two or more measures into a single index. However, collapsing two or more measures into a single index presents numerous substantive and methodological problems that severely threaten the interpretability and conclusiveness of the obtained results (Edwards 1994). Thus, based on previous studies (Drnevich and Croson 2013; Henderson and Venkatraman 1993; Macehiter and Ward-Dutton 2006; Oh and Pinsonneault 2007), we conceptualize and disaggregate IT-business alignment into three dimensions; IT investment-business strategy alignment, IT delivery-business priority alignment, and IT change-business change alignment.

IT Investment-Business Strategy Alignment

IT investment-business strategy alignment is the first dimension of IT-business alignment. IT investment-business strategy alignment refers investing the right amount in the right IT asset according to business strategies (Oh and Pinsonneault 2007; Weill and Aral 2006). Previous IT-business alignment studies have shown that misalignment between IT investments and business strategies is one of the main reasons why

organizations fail to reap returns from their IT investments (Chan 2002; Chan et al. 1997; Henderson and Venkatraman 1993; Luftman and Brier 1999). Traditionally, IT investments are made to support operations and maintenance (Luftman et al. 1993). Previous studies suggest that one of the reasons for reported rising levels of IT investments was that managers were looking for ways to integrate IT into firm's business strategies (Luftman and Brier 1999). Researchers also argued that strategic alignment between IT investments and business strategies helps spur business transformation and positioning a firm for growth (Henderson and Venkatraman 1992). Ray et al. (2007) show that the effects of IT investment and other IT resources are contingent on the level of shared IT-business understanding. Weill and Aral (2006) argue that firms that link their IT investments to their business strategies are well-placed to outperform their competitors on desired performance dimensions. Moreover, IT investment-business strategy alignment is particularly important for conceptualizing and measuring the business value of IT (Oh and Pinsonneault 2007).

Following previous studies which find that strategic alignment moderates the relationship between IT investment and business performance (Byrd et al. 2006; Chan et al. 1997; Croteau and Bergeron 2001; Kearns and Lederer 2003; Ray et al. 2007), we expect that IT investment-business strategy alignment is likely to lead to better firm performance at higher levels of IT investments. However, given that the effect of IT investment-business strategy alignment has been studied earlier, in this study we use this dimension of alignment as the reference category.

IT Delivery-Business Priority Alignment

IT delivery is a fundamental part of IT ability to drive business value (Smith and McKeen 2005). Jenkin and Chan (2010) define IT project alignment as the degree to which an IT project's deliverables are congruent with the organization's IT strategy. IT delivery-business priority alignment is important to ensure that priorities are consistent, that resources are appropriately allocated, and that the sophistication of IT matches the sophistication of the firm (Luftman et al. 1993). Because firm performance is influenced more by the usage of actual applications than by the amount of IT investments (Weill 1992), researchers have argued that IT should understand the business priorities and expend its resources, pursue projects, and provide information consistent with business priorities (Shpilberg et al. 2007).

Luftman et al. (1999) suggest that IT itself cannot provide business value , instead top management should drive the realization of value from IT related projects. According to the Luftman et al. (1993), one of top management's major challenges is to establish and sustain a direction or priority set. In this role, the management team uses priorities to balance short- and long-term decisions effectively. Improper priorities may lead to misallocation of resources when iterating between business strategy and IT infrastructure and processes (Luftman et al. 1993). Business priorities should be set where value is expected to be realized and top management should set policies for the acquisition, use, and retirement of information assets. To do so, executives should concentrate on improving the relationship between the business and IT functional areas and to prioritize projects more effectively (Luftman et al. 1999).

The foregoing discussion suggests that alignment between business priorities and IT delivery is important to ensure the effective and efficient deployment of IT resources. Hence, we expect that IT investment will have a higher effect on firm performance when there is an alignment between IT delivery and business priorities. Therefore:

H1: IT delivery-business priority alignment positively moderates the relationship of IT investment on firm revenues.

IT Change-Business Change Alignment

Researchers have noted that continuous changes in business environment mean that a true state of alignment may not exist at any point (Chan and Reich 2007). Chan (2002) stresses that alignment is a moving target that continuously evolves and that alignment between business strategies and IT strategies is inherently dynamic and complex. Sabherwal et al.(2001) contend that the IT-business alignment goes through cyclical phases of stability and instability. In a turbulent business environment, tightly coupled plans may have negative outcomes since such interlocking plans will likely react slower when adjusting to their new environments (Chan and Reich 2007). Therefore, a dynamic approach to alignment is necessary

(Viaene et al. 2010). Given the dynamic nature of IT and competitive environment (Bhatt and Grover 2005), IT has to evolve in order to stay aligned with increasingly turbulent and dynamic markets (El Sawy and Pavlou 2008; Pavlou and El Sawy 2006; Sambamurthy et al. 2003).

To stay responsive to their business environment, firms should develop dynamic IT capabilities (Sambamurthy et al. 2003). According to Teece et al. (1997), dynamic capabilities include the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments. Dynamic capabilities act as a buffer between firm resources and the volatile business environment and can be particularly useful in emerging markets that are undergoing fast growth with immense volatility. Given such ever changing environmental conditions, a firm's ability to change direction quickly and to reconfigure strategically is crucial to its success in achieving sustainable competitive advantage (Hitt et al. 1998). Tallon and Pinsonneault (2011) contend that the degree of change and instability in the firm's operating context impacts IT-business alignment. In times of high environmental uncertainty, organizations have a stronger need for IT (Chan and Reich 2007; El Sawy and Pavlou 2008; Mithas et al. 2013). These arguments explain why organizations must invest heavily in IT alignment during times of environmental uncertainty (Johnston and Carrico 1988) and may derive greater benefits from IT (Sabherwal and Kirs 1994).

Based on the foregoing discussion, we propose the alignment between IT change and business change as an important dimension of IT-business alignment. IT change-business change alignment confers dynamic capabilities on a firm and it may lead more opportunities in a volatile environment such as those in emerging markets (Hitt et al. 1998; Sambamurthy et al. 2003; Teece et al. 1997). If firms have the same initial level of IT investment but different levels of IT change-business change alignment, the firms with IT change-business change alignment will have more dynamic capabilities. Therefore, firms with IT change-business change alignment may be expected to attain a higher performance in environmentally volatile markets. Thus, we expect a positive moderating effect of IT change-business change alignment on the link between IT investment and firm performance. Accordingly:

H2: IT change-business change alignment positively moderates the relationship of IT investment on firm revenues.

Data and Variable Definitions

We conduct an empirical investigation using archival data collected by one of the largest international research firms well known for its IT data and research services. The research firm collected firm-level IT investment data, other IT investment-related information, along with their top IT user survey for Indian corporations in 2008. The surveys targeted chief information officers and other senior IT executives of Indian firms to collect objective metrics related to IT investments. Our final data set for this study consists of a total of 211 firms operating in India.

Table 1 presents definitions of the variables. We measure revenue (REVENUE) as the dependent variable for firm performance. Although some prior studies have used profits and Tobin's Q as dependent variables, more recent work by Mithas et al. (2012) suggests that the significant portion of the impact of IT on firm profitability is accounted for by IT enabled revenue growth but the impact of IT on firm profitability through cost reduction is not significant. Thus, IT enabled revenue growth is a key driver of the impact of IT on firm profitability. That is why we choose revenue as a measure of firm performance in this research.

We measure a firm's total IT investment (ITINVEST) and also measure a firm's IT investment on hardware (HWINVEST), software (SWINVEST), and service (SERVICEINVEST).

For the dimensions of IT-business alignment, we first measure whether firm's IT is aligned with business direction or not. If a firm's IT is aligned with business direction, we then measure (1) whether the firm's IT investment is aligned with business strategy (ITIBIZS), (2) whether IT delivery is aligned with business priorities (ITDBIZP), and, (3) whether IT change is aligned with business change (ITCBIZC). We account for firm-level heterogeneity by including relevant factors such as firm size, industry sector, and legal status of firm in our models. We control for firm size by the number of employees (SIZE), sector differences (MFG, manufacturing vs. services), and legal status of firm (PRIVATE, private vs. public) to account for difference in IT investments, business-IT alignment and firm performance.

Table 1 Variable Definition

Variable	Definition/Operationalization
REVENUE	A firm's total turnover (Rupees).
ITINVEST	A firm's total IT spending (Rupees) across all sites.
HWINVEST	A firm's IT spending on hardware (Rupees). Hardware includes PC/notebook, servers, enterprise storage, hard copy peripherals (e.g., printers/MFD/scanners), network equipment, and RFID.
SWINVEST	A firm's IT spending on software (Rupees). Software includes system infrastructure software, application development and deployment tools, and application solutions.
SERVICEINVEST	A firm's IT spending on IT service (Rupees). IT service includes consulting and system integration, information system outsourcing, desktop and network outsourcing, and maintenance and support services.
ITIBIZS	Whether IT investment is aligned with business strategies as a key priority or not (Yes=1, No=0).
ITDBIZP	Whether IT delivery is aligned with business priorities as a key priority or not (Yes=1, No=0).
ITCBIZC	Whether IT change is aligned with business changes as a key priority or not (Yes=1, No=0).
SIZE	A firm's total employees
MFG	Whether firm belongs to manufacturing or service sector (Manufacturing=1, Services=0).
PRIVATE	Whether legal status of firm is private company/multinational owned foreign subsidiary or government department/public sector (Private=1, Public=0).

Table 2 shows the summary statistics. In our sample, 37% firms report IT delivery-business priority alignment, 10% report IT change-business change alignment and the remaining firms (53%) report IT investment-business strategy alignment. We use IT investment-business strategy alignment as the reference group for comparing dimensions of IT-business alignment.

Table 2 Summary Statistics

	Mean	Std. Dev.	Min.	Max.	Obs.
REVENUE (million INR)	102000	700000	9000000	8900000	174
ITINVEST (million INR)	169.00	543.00	0.20	5500.00	185
HWINVEST (million INR)	59.50	156.00	0.12	1100.00	179
SWINVEST (million INR)	53.20	262.00	0.03	3300.00	180
SERVICEINVEST (million INR)	34.10	114.00	0.01	1200.00	177
ITIBIZS	0.53	0.50	0.00	1.00	189
ITDBIZP	0.37	0.48	0.00	1.00	189
ITCBIZC	0.10	0.30	0.00	1.00	189
SIZE	7433.17	19497.34	80.00	200000.00	208
MFG	0.59	0.49	0.00	1.00	206
PRIVATE	0.82	0.39	0.00	1.00	208

Table 3 provides correlations among the variables. As expected, IT investments are correlated positively and statistically significantly with revenues and firm sizes. These correlations provide preliminary support for some of our conjectures in section 2.

Table 3. Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)ln(REVENUE)								
(2)ln(ITINVEST)	0.30*							
(3)ITIBIZS	0.19*	0.15						
(4)ITDBIZP	-0.23*	-0.19*	-0.81*					
(5)ITCBIZC	0.07	0.08	-0.36*	-0.25*				
(6)ln(SIZE)	0.35*	0.44*	0.12	-0.15*	0.04			
(7)MFG	-0.17*	-0.24*	0.05	0.02	-0.11	-0.11		
(8)PRIVATE	-0.35*	-0.11	-0.03	0.14	-0.17*	-0.27*	0.18*	

Note: *p<0.05

We specify standard cross-sectional models of the form:

$$Y_i = X_i\alpha + \varepsilon_i$$

where Y represents an endogenous dependent variable, firm revenue; X represents a vector of firm characteristics such as levels of IT-business alignment, IT investments and control variables, α is a vector of the parameters to be estimated, ε is the error term associated with each observation i.

To examine the moderating effect of IT delivery-business priority alignment and IT change-business change alignment on the effect of IT investment on firm performance, we use the following empirical specification for testing hypotheses H1 and H2:

$$\begin{aligned} \ln REVENUE &= \alpha_{10} + \alpha_{11} \ln ITINVEST + \alpha_{12} ITDBIZP + \alpha_{13} ITCBIZC \\ &+ \alpha_{14} ITDBIZP \times \ln ITINVEST + \alpha_{15} ITCBIZC \times \ln ITINVEST \\ &+ \alpha_{16} \ln SIZE + \alpha_{17} MFG + \alpha_{18} PRIVATE + \varepsilon_1 \end{aligned} \quad (1)$$

We first estimate the direct effect of ITINVEST on REVENUE. Then, we estimate the model with the interaction term to examine the moderating effect of ITDBIZP and ITCBIZC.

We use ordinary least squares (OLS) to estimate Equation (1) because the focal explanatory variables (i.e., IT investments and levels of IT-business alignment) can be considered exogenous in an econometric sense (Wooldridge 2002). From a theoretical perspective, one can justify dimensions of IT-business alignment as exogenous to firm revenue but determined by firm's overall strategy, which is usually assumed to endure over long periods of time and therefore not leading to any simultaneity between firm revenue and choice of IT-business alignment. IT investment is based on the IT budget, which is planned in a previous year. Following this assumption, IT investment is a predetermined variable and therefore can be considered exogenous in our analyses.[1]

Results

Table 4 reports OLS regression results with heteroskedasticity-consistent robust standard errors. The result shown in column 1 of Table 4 suggest that IT investment is positively associated with firm revenue.

[1] We also did our analyses by centering the variables before creating the interaction variables and obtained broadly similar results for the interaction effects reported here.

A one percent increase in IT investment is associated with a 0.335 percent increase in a firm revenue ($p<0.01$).

Table 4. Estimation Results (Dependent Variable: *ln(REVENUE)*)

	(1)	(2)
ln(ITINVEST)	0.335*** (0.100)	0.131 (0.110)
ITDBIZP		-7.618* (4.093)
ITCBIZC		-10.812** (4.918)
ln(ITINVEST) ITDBIZP*		0.409** (0.245)
ln(ITINVEST) ITCBIZC*		0.577** (0.289)
ln(SIZE)	0.058 (0.144)	-0.024 (0.122)
MFG	0.051 (0.323)	0.154 (0.345)
PRIVATE	-1.470*** (0.531)	-1.295** (0.592)
Constant	17.790*** (1.490)	22.055*** (1.822)
R-Squared	0.190	0.259
Observations	145	125

Note: Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, *$p<0.1$ (One-tailed test for interaction variables, two-tailed test for other variables)

Because Hypotheses 1 and 2 postulate a moderation model which focuses attention on the interaction term between levels of IT-business alignment and IT investments, we follow Baron and Kenny's (1986) guidelines to test these hypotheses.

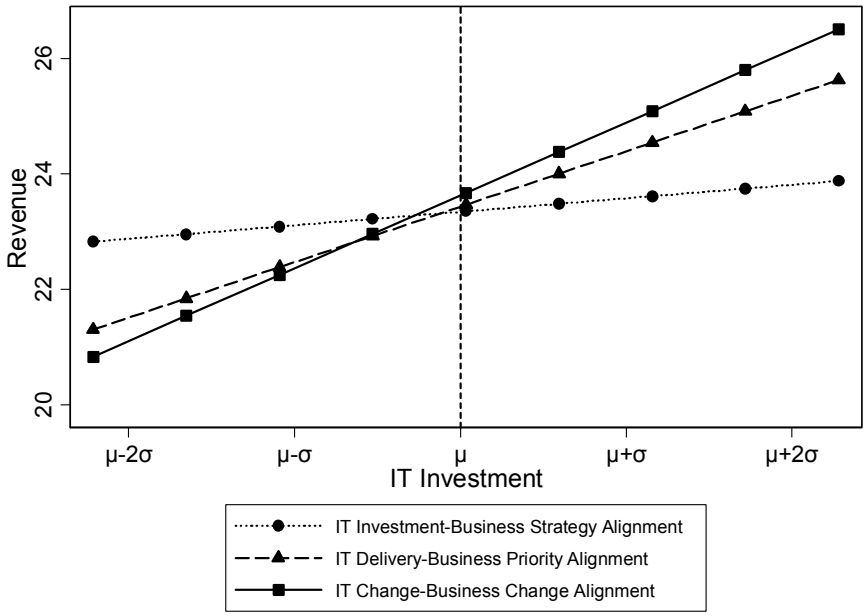
We find support for Hypothesis 1, which predicts that firms with IT delivery-business priority alignment have a positive moderating influence in the effect of IT investments on firm revenues. The estimated coefficient of the interaction term is 0.409 ($p<0.05$), which means that, on average, a one percent increase in IT investment with IT delivery-business priorities alignment is associated with an additional 0.409 percent increase in a firm's revenue.

We find support for Hypothesis 2 which predicts that firms with IT change-business change alignment have a positive moderating association in the effects of IT investments on firm revenues. The interaction between IT change-business change alignment and IT investment has a positive and statistically significant association with firm revenue ($p<0.05$). On average, a one percent increase in IT investment with IT change-business change alignment is associated with an additional 0.577 percent increase in a firm's revenue. According to the estimation of column 2 in Table 4, the direct effect of IT delivery-business priorities alignment at the mean level of IT investments is negatively associated with firm revenue ($p<0.1$). The direct effect of IT change-business change alignment at the mean level of IT investments is also negatively associated with firm revenue ($p<0.05$).

We plotted the results of column 2 in Tables 4 to show how the effect of IT investments on firm revenues varies by levels of IT-business alignment. Figure 1 shows that at the higher levels of IT investments, firms

with IT change-business change alignment or IT delivery-business priority alignment have higher revenues than that of firms with IT invest-business strategy alignment. At the mean value of IT investments, firms with IT investment-business strategy alignment have higher revenue than that of firms with other levels of IT-business alignments. Figure 1 suggests that although revenue is about the same or less at the mean value of IT investments, the differences can be quite large at higher levels of IT investments. In particular, at higher levels of IT investments, firms with IT change-business change alignment can significantly outperform other dimensions of IT-business alignment. Conversely, at low levels of IT investments, firms with IT investment-business strategy may have higher revenue than firms with other dimensions of IT-business alignment.

Figure 1. IT Investment-Revenue Relationship by Levels of IT-Business Alignment



Endogenizing IT Investment

In the analysis reported above, we treated IT investment as exogenous in the econometric sense. However, we need to account for the possibility of endogenity of IT investments that may influence the relationship between the independent variables and the dependent variable (Brynjolfsson and Hitt 2003; Brynjolfsson and Yang 1997; Kleis et al. 2012).

To account for potential endogeneity of IT investments, we used an instrumental variable approach to test for endogeneity and to estimate the model using two-stage least-squares (2SLS). For IT investment, we use hardware investment as an instrument variable because hardware investment is highly correlated with IT investment, it does not directly influence firm performance (Rai et al. 1997) except through the effect of IT investments on performance. Moreover, we used industry average IT investment per employee as another instrument variable. Industry-level variables are considered as exogenous to firms and influence firms' level of IT investments (Bartelsman et al. 1994; Hitt 1999). The criteria for a good instrument is that it should be highly correlated with the endogenous independent variable but not correlated with the error term. The correlation between IT investment and HW investment is 0.975 and the correlation between IT investment and industry average IT investment per employee is 0.189. Even in the presence of some correlation between the instruments and the second-stage variable (revenue), 2SLS provides efficient and unbiased coefficient estimates (Greene 2011).

If IT investment is endogenous, the two interaction terms are also rendered endogenous (Maddala 1983), leading to biased OLS coefficients. Following the suggestions provided by Wooldridge (2002), we devise another set of instruments by multiplying the instruments for IT investment with the exogenous moderator variables, ITDBIZP and ITCBIZC. Together, these instruments are used to identify the effects

of the interaction term on revenue. The required coefficient from Equation (1) can then be estimated using 2SLS.

The results of this procedure are shown in column 1 of Table 5. The F-statics of the excluded instrumental variable in first stage is larger than 10 (F=223.82), suggesting that we can reject the null hypothesis that the instruments are weak (Staiger and Stock 1997). With more instruments than endogenous variables, we can test the validity of the instruments. The Sargan test yields a p-value 0.895 and the Basamann test yields a p-value 0.908. Both are much larger than 10%, meaning that the over-identifying restrictions tests support the validity of the instruments (Wooldridge 2002).

Table 5. Estimation with Endogenizing of IT Investment (Dependent Variable: *ln(REVENUE)*)

	(1)	(2)	(3)
ln(ITINVEST)	0.083 (0.157)	0.082 (0.157)	0.088 (0.108)
ITDBIZP	-8.097** (3.560)	-8.099** (3.560)	-8.165** (3.958)
ITCBIZC	-12.327** (5.571)	-12.334** (5.572)	-13.118** (5.095)
ln(ITINVEST) ITDBIZP*	0.435** (0.208)	0.435** (0.208)	0.441** (0.237)
ln(ITINVEST) ITCBIZC*	0.663** (0.313)	0.664** (0.313)	0.707** (0.300)
ln(SIZE)	-0.005 (0.166)	-0.005 (0.166)	-0.015 (0.118)
MFG	0.139 (0.345)	0.139 (0.345)	0.103 (0.320)
PRIVATE	-1.279*** (0.481)	-1.279*** (0.481)	-1.269** (0.538)
Constant	22.758*** (2.692)	22.761*** (2.693)	22.771*** (1.767)
Over identification test: p-value	Sargan: 0.895 Basmann: 0.908	Anderson-Rubin: 0.895 Basmann: 0.895	Hansen's J: 0.827
White test (p-value)	0.080	0.080	
Breusch-Pagan (p-value)	0.137	0.137	
R-Squared	0.258	0.258	0.257
Observations	122	122	122

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, *p<0.1 (One-tailed test for interaction variables, two-tailed test for other variables)

The 2SLS estimation of the interaction between IT investment and IT delivery-business priority alignment is positive and statistically significant (0.435, p<0.05), consistent with the results for H1 from column 2 of Table 4. Similarly, the 2SLS estimation for the interaction between IT investment and IT change-business change alignment is 0.663 (p<0.05), also consistent with the OLS estimation results in column 2 of Table 4. In summary, the results from the 2SLS estimation provide largely consistent results with those shown in column 2 of Table 4 discussed above.

Stock and Yogo (2002) show that in the presence of weak instruments, LIML limited information maximum likelihood) is superior to 2SLS estimation. Thus, we report the LIML (estimation to deal with the potential weakness of the instrument. The second stage results of LIML estimation are reported in column 2 of Table 5. The weak identification (Cragg-Donald) test statistic (205.87) test statistic is larger than the Stock-Yogo critical value for the 10% maximal LIML size, meaning that we can reject the null hypothesis that the instruments are weak (Stock and Yogo 2002). Nevertheless, one can observe that the second-stage results of LIML estimation reported in column 2 of Table 5 are almost identical to those of 2SLS estimation in column 1 of Table 5. This is expected because when the instruments are strong the 2SLS and LIML estimations should produce similar results.

If heteroskedasticity is present, the GMM (Generalized method of moments) estimator is more efficient (Baum et al. 2003). The test of hetroskedasticity for 2SLS suggest that the White test yields a p-value 0.080 and the Breusch-Pagan test yields a p-value 0.137. White statistics reject the null hypotheses at 0.1 level. Therefore, we should use robust covariance estimation. The second-stage results of robust covariance GMM estimation are presented in column 3 of Table 5 and these results are very similar to that from 2SLS and LIML estimations in Table 5.

Supplementary Analysis

Table 6 and Table 7 show further analyses using heteroskedasticity-consistent robust standard errors. For these analysis, following prior work (Beccalli 2007; Rai et al. 1997), we disaggregate IT investment into hardware investment, software investment, and service investment.

Table 6. Supplementary Analysis Results (Dependent Variable: *ln(REVENUE)*)

	(1)	(2)	(3)
ln(SWSERVICEINVEST)	0.310***	0.129	0.088
	(0.095)	(0.117)	(0.115)
ITDBIZP		-6.921*	-8.415**
		(3.966)	(4.176)
ITCBIZC		-8.649**	-12.351**
		(4.006)	(5.636)
ln(SWSERVICEINVEST) ITDBIZP*		0.385*	0.475**
		(0.248)	(0.263)
ln(SWSERVICEINVEST) ITCBIZC*		0.471**	0.687**
		(0.248)	(0.342)
ln(SIZE)	0.070	-0.016	-0.025
	(0.143)	(0.123)	(0.124)
MFG	0.031	0.121	0.156
	(0.326)	(0.351)	(0.339)
PRIVATE	-1.552***	-1.449**	-1.393**
	(0.539)	(0.617)	(0.577)
Constant	18.421***	22.275***	22.969***
	(1.415)	(1.875)	(1.742)
R-Squared	0.186	0.241	0.238
Observations	144	124	122

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, *p<0.1 (One-tailed test for interaction variables, two-tailed test for other variables)

Earlier we used hardware investment as an instrument variable for endogenizing IT investment. Therefore, we excluded hardware investment from IT investment and explore the relationship between

software and service investment and firm's revenue. The results are shown in column 1 of Table 6. Software and service investment is positively associated with firm's revenue (0.310, p<0.001). Column 2 of Table 6 explores the moderating role of dimensions of IT-business alignment on the relationship between software and service investment on firm's revenue. In line with the results of column 2 of Table 4, both ITDBIZP and ITCBIZC negatively associated with firm's revenue (p<0.1, p<0.05 respectively) and positively moderate the effects of software and service investment on firm's revenue (column 2 of Table 6). Column 3 of Table 6 demonstrates 2SLS estimate results for endogenizing software and service investment by using hardware investment and industry IT investment per employee as instrument variables. Results are shown in Column 3 of Table 6 and are almost consistent with the estimation results of column 2 of Table 6.

Next, we also analyzed the effects of software investment and service investment separately on firm revenue. Column 1 of Table 7 presents the direct relationship of software investments on firm revenues. Column 1 of Table 7 shows that a one percent of increase in software investment is associated with a 0.253 percent increase in firm revenue (p<0.01). In line with software investment, Column 4 of Table 7 shows that service investment is positively associated with firm revenue (0.319, p<0.01).

Table 7. Supplementary Analysis Results (Dependent Variable: *ln(REVENUE)*)

	(1)	(2)	(3)	(4)	(5)	(6)
ln(SWINVEST)	0.253*** (0.094)	0.095 (0.129)	0.093 (0.114)			
ln(SERVICEINVEST)				0.319*** (0.090)	0.111 (0.103)	0.078 (0.117)
ITDBIZP		-5.202 (3.811)	-8.037** (4.139)		-7.258** (3.524)	-8.190** (3.972)
ITCBIZC		-5.440* (2.893)	-11.290** (5.584)		-10.476** (4.659)	-11.197** (4.961)
*ln(SWINVEST) *ITDBIZP*		0.292 (0.249)	0.476** (0.270)			
*ln(SWINVEST) *ITCBIZC*		0.302* (0.198)	0.656** (0.352)			
*ln(SERVICEINVEST) *ITDBIZP*					0.421** (0.232)	0.481** (0.263)
*ln(SERVICEINVEST) *ITCBIZC*					0.610** (0.296)	0.655** (0.322)
ln(SIZE)	0.107 (0.146)	0.044 (0.131)	-0.024 (0.128)	0.075 (0.141)	-0.005 (0.122)	-0.003 (0.125)
MFG	-0.002 (0.338)	0.086 (0.371)	0.239 (0.355)	-0.033 (0.328)	0.013 (0.355)	0.014 (0.340)
PRIVATE	-1.571*** (0.557)	-1.532** (0.650)	-1.479** (0.601)	-1.500*** (0.536)	-1.288** (0.603)	-1.278** (0.566)
Constant	19.270*** (1.372)	22.516*** (1.912)	22.954*** (1.650)	18.506*** (1.383)	22.547*** (1.691)	23.040*** (1.704)
R-Squared	0.170	0.205	0.188	0.197	0.272	0.271
Observations	142	122	120	140	120	119

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, *p<0.1 (One-tailed test for interaction variables, two-tailed test for other variables)

Column 2 and column 5 of Table 7 present the moderating role of the dimensions of IT-business alignment on the relationship between software/service investments on firm revenues. We find that IT change-business change alignment positively moderates the effects of software investments on firm revenues (0.302, $p<0.1$) but IT delivery-business priority alignment does not (0.292, ns).

For the effects of service investments on firm revenues, both IT change-business change alignment and IT delivery-business priority alignment are statistically significant at $p<0.05$. The marginal effect of service investments on firm revenues is higher for firms with IT change-business change alignment (0.655) than firms with IT delivery-business priority alignment (0.481). Therefore, consistent with column 2 of Table 4, firms with IT change-business change alignment would outperform at the high level of both software and service investments than other dimensions of IT-business alignment.

Column 3 and column 6 of Table 7 describe the 2SLS estimation results for column 2 and column 5 of Table 7, respectively. We find that our proposed instrument variables, hardware investments and industry average IT investments per employee, can be used for endogeneizing service investments (column 6 of Table 7). The 2SLS estimation results for software investment (column 3 of Table 7) are not consistent with the results of column 2 of Table 7.

Discussion

Main Findings

Our goal in this research was to study the moderating effect of the dimensions of IT-business alignment on the relationship between IT investments and firm revenues. We developed a theoretical framework positing why the dimensions of IT-business alignment moderate the effect of IT investments on firm revenue. We used secondary data on IT investments, dimensions of IT-business alignment, and revenues for more than 200 Indian firms to test the hypothesized relationships. Consistent with our expectations, we find that the dimensions of IT-business alignment play an influential role in moderating the relationship between IT investments and firm revenues.

We find empirical support for the interaction between IT delivery-business priorities alignment which moderates the positive relationship between IT investment and firm revenue (H1). Moreover, our results suggest that the interaction between IT change-business change alignment and IT investment is positively associated with a firm's revenue (H2). Previous studies did not disentangle and compare the dimensions of IT-business alignment and their effect on firm performance.

More importantly, we find that firms with IT change-business change alignment have a steeper IT investment-revenue relationship than other IT-business alignment dimensions. For a more intuitive interpretation of the results, we also plot the relationship between IT investments and firm revenue by each dimension of IT-business alignment (Figure 1). These plots underscore the need for taking into consideration the levels of IT investment in assessing how a particular dimension of IT-business alignment will affect firm performance. In general, these plots show that the IT change-business change alignment results in increased revenue when such an IT-business alignment dimension is combined with high levels of IT investments. This implies that firms in emerging markets need to grow dynamic capabilities with high levels of IT investment. At the same time, the positive impact of IT change-business change alignment on firm revenue may not be fully realized if the alignment is not supported by adequate levels of IT investment. This is because IT investment-business strategy alignment outperforms other dimensions IT-business alignment in increasing firm revenue at lower levels of IT investments.

Implications for Research

This study suggests several research implications. First, our findings suggest that the effect of IT investments on firm revenue depends on types of IT-business alignment achieved by a firm and levels of IT investments. This is one of the first studies that provide empirical evidence for the association between dimensions of IT-business alignment and IT investments on firm revenue. This study extends prior work in IS research and complements the previous alignment studies which found that organizations better alignment that align their IT strategy with their business strategy enjoy greater firm performance (Chan et al. 1997; Chan et al. 2006; Oh and Pinsonneault 2007; Preston and Karahanna 2009; Tallon 2008).

Second, our findings show that no single dimensions of IT-business alignment unconditionally dominates the others in terms of its effect on revenue generation at all levels of IT investments. At the high level of IT investments, we find that firms with an IT change-business change in IT-business alignment dimension have higher revenues than firms with an IT delivery-business priority or an IT investment-business strategy. Our findings strongly support the classical argument of contingency theory, in that there is no universal way or optimal path to adhere to in the management of organization (Fiedler 1965; Weill and Olson 1989). Moreover, the majority of previous IS studies have analyzed business-IT alignment by aggregating two or more component factors into a composite index. Collapsing two or more measures into a single index can limit our ability to understand the complex and reciprocal relationships among IT investment, business performance (i.e., firm revenues), and other contingency variables (i.e., dimensions of IT-business alignment) (Edwards 1994; Kumar and Benbasat 2006; Oh and Pinsonneault 2007). Thus, our research provides a foundation for conducting further IT-business alignment research conceptualizing and disaggregating the three IT-business alignment dimensions.

Finally, this study extends IT-business alignment theory to firms in an emerging market, especially in India. The majority previous studies in IT-business alignment have been conducted in the developed economy context (e.g., Yayla and Hu 2011). Firms in emerging markets face unique challenges including the lack of funding, inadequate technology infrastructures, and economic volatility. Given the relatively turbulent environments of emerging markets, our findings may be more critical for firms in young and growing industries than for firms in mature markets in pursuing IT-business alignment to drive revenue generation. In particular, firms with dynamic capabilities for IT-business alignment (i.e., IT change-business change alignment) outperform at the high level of IT investment in India.

Implications for Practice

The most important managerial implication of this study is that firms with IT change-business change alignment generate more revenues the more they invest in IT. At lower levels of IT investments, it is best for the firm to place emphasis on IT investment-business strategy alignment. According to a survey of more than 500 senior executives conducted by the Bain & Company, despite top managements' efforts in devoting resources and energy to align IT investments with their most important businesses, less than 20 percent felt their efforts were succeeding (Lochan and Shah 2010).

The gap between IT and business strategy may start from business units dealing with their IT strategy at too high a level, while the IT proposals are defined at too low a level. As a consequence, organizations fail to realize business value from their IT investments. Our study reveals that we need to refine our understanding of alignment by focusing on its component dimensions because it is at that level that managers can deploy resources to achieve IT-business alignment. Thus, three dimensions of IT-business alignment may help to make managerial decisions about firm's IT-business alignment.

Second, this study's findings can assist managers in formulating their IT-business alignment plans and allocating IT budget into their IT portfolio. This study provides exploratory results for the relationships among software and/or IT service investments, three dimensions of IT-business alignment, and firm revenue. The accelerating pace of business change coupled with the exploding rate of technology innovation is making it increasingly difficult for IT executives and senior IT managers to align IT and business strategies, and to achieve a desired IT investments portfolio. Our findings can help managers gauge the impacts of the various categories of the IT investments (hardware, software, and IT services) on firm's revenue generation by focusing on relevant dimensions of IT-business alignment.

Finally, our study provides empirical evidence of the interplay between IT investment and IT-business alignment on revenue generation in an emerging market. Previous studies showed that IT must evolve in order to stay aligned with increasingly turbulent and dynamic markets (Pavlou and El Sawy 2006; Sambamurthy et al. 2003). Managers in emerging markets usually have limited access to resources and consistently face high levels of uncertainty in their economic environment. Our findings emphasize that firms in emerging markets need to synchronize their IT investments with their dynamic capabilities to increase revenues.

Limitations and Further Research

While this study provides useful insights, we acknowledge that some limitations inherent in data availability and research. First, we conducted cross-sectional analysis to understand the moderating role of IT-business alignment on the relationship between IT investments and firm revenue. Longitudinal studies with several years of panel data would help to validate our findings and increase generalizability, allowing us to make stronger claims related to causality. Second, there is a need to validate our findings in other countries. Specifically, it would be interesting to study firms in other emerging markets, such as China and Brazil. Moreover, it will help to empirically validate these relationships in developed markets such as U.S. and Canada for greater generalizability.

Third, we rely on self-reported measures from chief information officers and other senior IT executives to operationalize our key construct of the primary dimensions of IT-business alignment, IT investments and related measures (such as hardware investments, software investments, and IT service investments), and firm related measures (e.g., firm revenues, and firm size). Prior studies in IS research have also used self-reported measures (Oh and Pinsonneault 2007; Pavlou and El Sawy 2006; Preston and Karahanna 2009; Tallon 2008; Tallon and Pinsonneault 2011). The strength of some of the single-item constructs lies in being concrete, straightforward, narrow, and unambiguous as interpreted by the most informative respondent (Drolet and Morrison 2001). Edwards (1994) also suggests that collapsing two or more measures into a single index presents numerous substantive and methodological problems that severely threaten the interpretability and conclusiveness of the obtained results. Despite the advantages of using a single-item measure, we acknowledge that further studies with alternative operationalization using multi-item scales or objective measures will be helpful in strengthening our results.

Finally, we call for further research to understand the types of governance mechanisms that are best suited to achieve IT change-business change alignment, IT delivery-business priority alignment and IT investment-business strategy alignment (De Haes and Van Grembergen 2009; McElheran 2012; Peterson 2004; Wu et al. 2014) and the extent to which they help to achieve cross-unit synergies (Lazic et al. 2014).

In conclusion, this research empirically tested the effect of dimensions of IT-business alignment (IT investment-business strategy alignment, IT delivery-business priority alignment, or IT change-business change alignment) and IT investments on firm revenue in an emerging market. Based on archival data covering a broad cross section of more than 200 Indian firms, we find that the dimensions of IT-business alignment play an important role in moderating the relationship between IT investments and firm revenue. Firms with IT change-business change alignment have a steeper IT-revenue relationship than that of firms with other dimensions of IT-business alignment. Overall, while this research provides useful insights on the effects of the dimensions of IT-business alignment related to IT investments on firm revenue, it implies that their effects on firm revenue can vary significantly and are conditional on the level of IT investment.

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