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INFORMATION TECHNOLOGY IMPACTS ON FIRM PERFORMANCE: AN EXTENSION OF KOHLI AND DEVARAJ (2003)[1]

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Despite the importance of investing in information technology, research on business value of information technology (BVIT) shows contradictory results, raising questions about the reasons for divergence. Kohli and Devaraj (2003) provided valuable insights into this issue based on a meta-analysis of 66 BVIT studies. This paper extends Kohli and Devaraj by examining the influences on BVIT through a meta-analysis of 303 studies published between 1990 and 2013. We found that BVIT increases when the study does not consider IT investment, does not use profitability measure of value, and employs primary data sources, fewer IT-related antecedents, and larger sample size. Considerations of IT alignment, IT adoption and use, and interorganizational IT strengthen the relationship between IT investment on BVIT, whereas the focus on environmental theories dampens the same relationship. However, the use of productivity measures of value, the number of dependent variables, the economic region, the consideration of IT assets and IT infrastructure or capability, and the consideration of IT sophistication do not affect BVIT. Finally, BVIT increases over time with IT progress. Implications for future research and practice are discussed.

Keywords: Information technology, business value of information technology, firm performance, meta-analysis, investment, payoff

Introduction

Performance consequences of information technology (IT) investments continue to be a topic of considerable importance in light of the continued development of these technologies and their growing use in global commerce. Numerous empirical studies have been conducted to investigate these performance impacts, although the findings have varied considerably. This raises the possibility that the inconsistent results may be due to the differences across the works.

Kohli and Devaraj (2003) (hereafter called K&D) recognized this issue and noted prior literature that mentioned underlying causes for the inconsistent findings, including inadequate measurement and analysis methodologies (Brynjolfsson 1993; Robey and Boudreau 1999), time lags in measuring payoff (Devaraj and Kohli 2000), and inclusion of intermediate and contextual variables (Barua et al. 1996). They conducted a

[1]Rajiv Kohli was the accepting senior editor for this paper. Stephen Kudyba served as the associate editor.

The appendices for this paper are located in the "Online Supplements" section of the *MIS Quarterly*'s website (http://www.misq.org).

meta-analysis of the literature on business value of IT (BVIT) using 66 firm-level empirical studies from 1990 to 2000. They examined how the results of an empirical study depend on the following attributes: the firm's industry sector, the sample size, the data source, the dependent variable, whether the study was cross-sectional or longitudinal, the analytical approach, and whether the study captured IT assets and IT impacts. K&D used prior literature to develop propositions about the effects of these attributes. Some of their results were as expected, showing greater IT payoff in nonprofit and government sectors, and in studies using large sample sizes, firm-level data, or productivity-based dependent variables. However, their expectations concerning the effects of the use of tests based on correlations rather than regressions or models, the use of longitudinal data, or the inclusion of process-orientation variables (i.e., IT assets or IT impacts) were not supported. K&D made valuable contributions to the literature on the firm-level performance consequences of IT.

This paper builds on K&D by extending their study in two ways. First, K&D included studies published through 2000. In light of subsequent progress in IT, the increased recognition of its strategic role, and the emergence of phenomena such as mobile computing and social media, it is important to examine whether K&D's findings continue to be supported. Accordingly, this paper includes 303 studies published through 2013. Second, this paper examines the effects of a broader set of factors than K&D by also including the theoretical lens, the number of dependent and independent variables, the nature of IT, the extent of value generation, and IT progress over time.[2] Appendix A shows a high-level comparison of our study with K&D.

Thus, this paper seeks to contribute to our understanding of the factors that affect the BVIT observed in a study. Specifically, it addresses three research questions (Figure 1):

1. How does consideration of IT investment affect the observed BVIT?

2. How do (a) the study's methodological attributes, (b) consideration of value generation, (c) value measures, and (d) value enablers affect the observed BVIT?

3. How do consideration of IT potential (alignment, sophistication, and type) and theory moderate the effect of consideration of IT investment on the observed BVIT?

The rest of the paper is organized as follows. First, we review the prior literature on BVIT. We then use this literature and K&D to propose the research model of factors affecting BVIT. Next, the research methods used in the paper are described. The results are presented and then, along with their implications, discussed.

Literature Review

Prior Research on Business Value of IT

Studies in the 1980s did not find a connection between IT investment and productivity in the U.S. economy. For example, Roach (1987) found that although computer investment per white-collar worker in the service sector increased several hundred percent from 1977 to 1989, output per worker did not rise discernibly. This situation was referred to as the "productivity paradox" (e.g., Brynjolfsson 1993; Solow 1987). Subsequent studies at the firm level have demonstrated that the impact of IT investment on firm performance is significant and positive (Kohli and Devaraj 2003; Melville et al. 2007; Melville et al. 2004). Despite opinions such as "IT doesn't matter" (Carr 2003), research evidence suggests that IT is not just a tool for automating current processes but also for enabling organizational changes that provide productivity gains (Melville et al. 2004; Mithas et al. 2012).

Melville et al. (2004) define business value of IT as "the organizational performance impacts of information technology at both the intermediate process level and the organizational-wide level, and comprising both efficiency impacts and competitive impacts" (p. 287). Similarly, Schreyn (2013) defines business value of IS (information systems) as

> the impact of investments in particular IS assets on the multidimensional performance and capabilities of economic entities at various levels, complemented by the ultimate meaning of performance in the economic environment (p. 141).

Consistent with the prior literature, and the recommendations by Kohli and Grover (2008), we view BVIT as potentially manifesting in several different ways and consider empirical BVIT research by focusing on studies that are at the organizational level[3] and include one or more IT-related independent variables and one or more dependent variables related to IT's organizational impact.

[2]We are grateful to the editors and the anonymous reviewers for suggesting several of these additional constructs.

[3]Prior BVIT research has been conducted at multiple levels, such as firm, industry, and country (Dedrick et al. 2003). We exclude studies at industry and country levels and focus on the firm level.

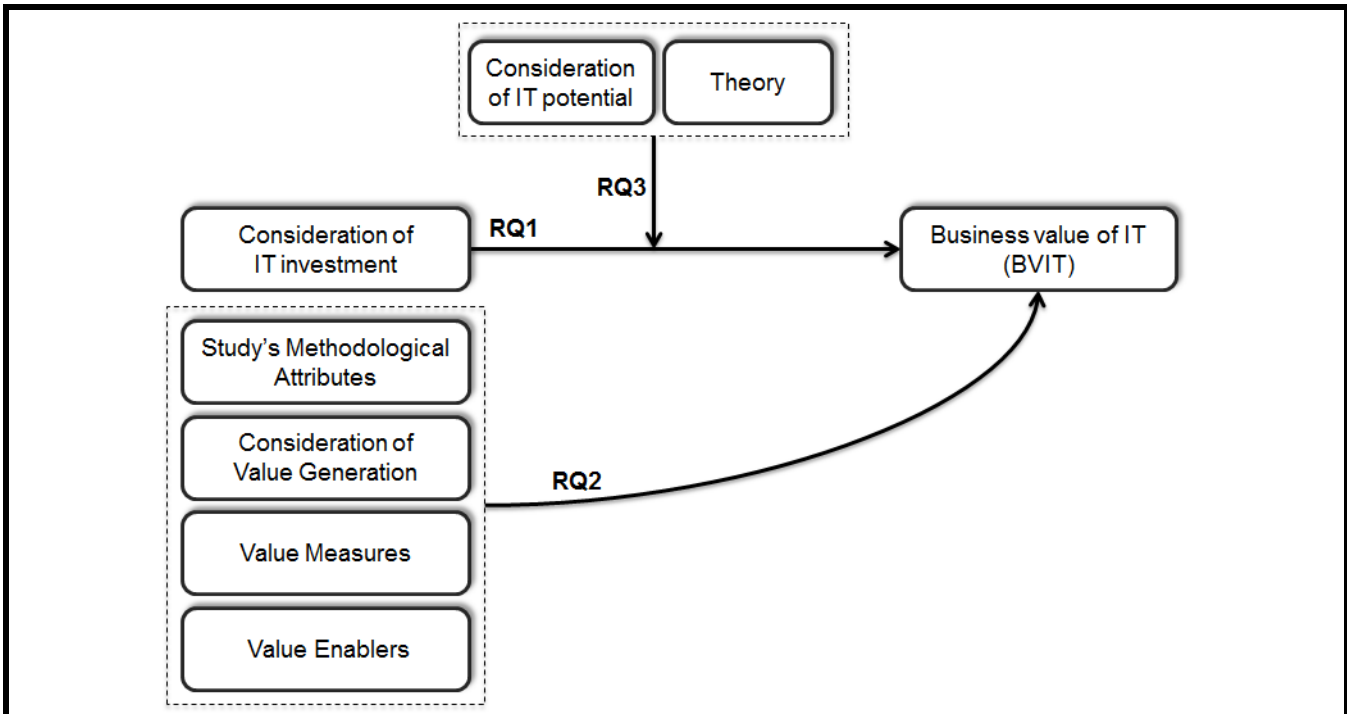


Figure 1. Theoretical Model

"Business value of IT" is similar to K&D's "IT payoff," as argued by Mukhopadhyay et al. (1995, p. 138), each being represented by a variety of similar measures. Consistent with prior literature, K&D (p. 130) viewed IT payoff to be reflected in various types of dependent variables, including financial measures (e.g., return on investment and return on assets), productivity- or output-based measures (e.g., management output and milk production), and expense-based measures (e.g., labor hours, expenses, and inventory turnover). This is similar to the multifaceted view of BVIT in prior literature (e.g., Bardhan et al. 2013; Kohli and Grover 2008; Melville et al. 2004). Kohli and Grover (2008) highlight that IT value manifests itself in many ways, including productivity gains, process improvements, profitability enhancement, increased consumer surplus, or improvements in supply chains or innovation at the interorganizational level. Bardhan et al. (2013) similarly discuss how the BVIT literature over time has focused on the linkage between IT spending and firm performance viewed using firm productivity or firm profitability measures.

Prior literature on BVIT has been based on a *diverse body of research*, including conceptual and theoretical articles, analytic modeling papers, and empirical studies. Conceptual and theoretical studies build on prior literature and theory to understand IT business value (Mata et al. 1995; Soh and Markus 1995). Analytic studies apply modeling techniques including game theory to facilitate understanding of various IT investments and competitive environments (e.g., Bakos and Nault 1997; Clemons and Kleindorfer 1992). Finally, empirical studies employ qualitative research (i.e., case studies and field interviews) (Clemons and Row 1988; Cooper et al. 2000) and quantitative research (i.e., field surveys and archival sources) (Lee and Barua 1999; Peffers and Dos Santos 1996) methods. In this paper, we focus on one specific subset of this vast body of prior literature: empirical studies that utilize quantitative methods. This is consistent with prior work based on meta-analyses regarding BVIT (e.g., Kohli and Devaraj 2003) and other areas (e.g., Sharma and Yetton 2007; Wu and Lederer 2009).

Prior Literature Reviews and Meta-Analyses

Consistent with the importance of understanding whether IT produces business impacts, a large number of empirical studies have examined BVIT under different conditions, using diverse methods and for a variety of IT types. This vast stream of research on BVIT has produced some inconsistent results, necessitating periodic retrospection in the literature. Accordingly, several meta-analyses and literature reviews have been conducted to draw conclusions based on similarities and differences across the studies. For example,

Brynjolfsson and Hitt (2000) reviewed the literature on IT impacts at the firm level and the industry level, and concluded

> Concerns about an information technology "productivity paradox" were raised in the late 1980s. Over a decade of research since then has substantially improved our understanding of the relationship between information technology and economic performance. The firm-level studies in particular suggest that, rather than being paradoxically unproductive, computers have had an impact on economic growth that is disproportionately large compared to their share of capital stock or investment (p. 45).

Dedrick et al. (2003) reviewed over 50 published articles on the relationship between IT and productivity, and used them to develop a framework for classifying the research in this area. Based on this review, they concluded that

> the productivity paradox as first formulated has been effectively refuted. At both the firm and the country level, greater investment in IT is associated with greater productivity growth (p. 1).

In another insightful review, Melville et al. (2004) used the resource-based view to integrate quantitative studies on the productivity paradox, conceptual and empirical work on the implications of IT for competitive advantage, and qualitative empirical research on IT impacts on overall performance. The review enabled them to suggest illustrative propositions and conclude that "although the focal firm bounds the locus of direct performance impacts, the external environment shapes them" (p. 311).

Literature on BVIT has also benefitted from prior *meta-analyses*. Mahmood et al. (1999) conducted an initial meta-analysis of BVIT, following which Stiroh (2002) examined the results of 20 empirical studies and found that much of the observed variation in IT impacts was due to differences in model specification and econometric techniques. Liang et al. (2010), Lim et al. (2011), and Ada et al. (2012) examined the impact of IT investment on firm performance using meta-analyses of correlations. Kohli and Devaraj (2003) conducted a thorough meta-analysis of 66 firm-level empirical studies between 1990 and 2000 to examine how the BVIT observed by a study depends on structural factors, including the attributes of the study, and concluded

> that the sample size, data source (firm-level or secondary), and industry in which the study is conducted influence the likelihood of the study finding greater improvements on firm performance. The choice of the dependent variable(s) also appears to influence the outcome (although we did not find support for process-oriented measurement), the type of statistical analysis conducted, and whether the study adopted a cross-sectional or longitudinal design (p. 127).

Other than K&D, prior meta-analyses on BVIT have employed traditional meta-analyses and not meta-regressions, which are used in both K&D and this study. Consequently, prior BVIT-related meta-analyses barring K&D have excluded empirical research that did not report correlations, and therefore dealt with a smaller number of studies in their samples.

This study seeks to extend K&D. Although similar to K&D in examining their constructs and analyses, it extends K&D by (1) including additional constructs and propositions, (2) incorporating additional factors that might affect BVIT, and (3) using a more current dataset.

The Proposed Model

Prior literature reviews (e.g., Melville et al. 2007) and meta-analyses (e.g., Kohli and Devaraj 2003) have focused on the outcome of BVIT studies as the dependent variable, and the same is done in this study. Prior studies indicate that different conclusions regarding BVIT may result from empirical studies that differ in terms of the context of the study (Farrell 2002), the research model (Jarvenpaa and Leidner 1998), or the nature of the study (Robey and Boudreau 1999). Therefore, we include several categories of variables as potentially exerting direct effects on BVIT. First, addressing RQ1, we consider the impact of whether or not the study explicitly considered the level of IT investment. Second, addressing RQ2, we examine the effects of the study's methods, including whether the study considered aspects of value generation, and the study's value measures and value enablers. Third, addressing RQ3, we examine two variables—consideration of IT potential and the theory used—that may moderate the direct effects of the consideration of IT investment on BVIT. Our research model builds upon past work that recommends considering research designs and the process of converting IT expenditure into benefits when examining BVIT (McKeen and Smith 1993; Soh and Markus 1995). These variables and their expected effects are discussed below and summarized in Figure 2.

K&D examined the effects of context (industry type), study characteristics (sample size), data source (primary or secondary), dependent variables used (productivity, profitability, or both), and data analysis (regression or correlation) on the IT payoff results. Our research model includes all of these

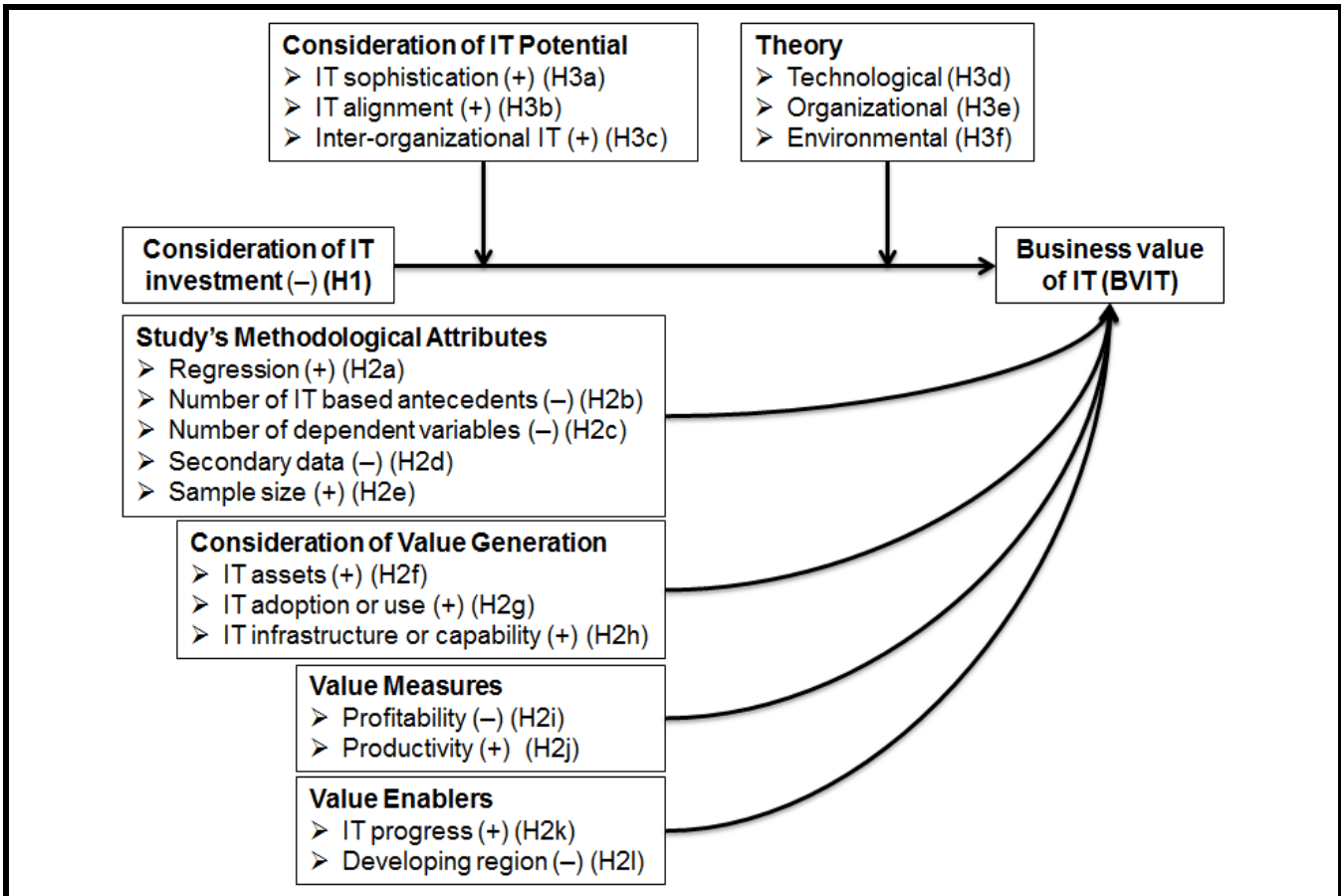


Figure 2. The Research Model

aspects except study characteristics (i.e., industry type[4]) and also includes additional antecedents of BVIT (number of IT-based antecedents, number of dependent variables, IT progress, developing region) and the moderating effects of the consideration of IT potential (IT sophistication, IT alignment, and interorganizational IT) and theory (technology-focused, organization-focused, or environment-focused theories). Appendix A includes a comparison of the research models used by K&D and in this paper.

Business Value of IT

Prior studies have sought to explain BVIT by examining the relationship between IT factors and their organizational impacts. IT factors in prior studies may represent various aspects such as IT investment, IT adoption, IT capability, and IT alignment (Bharadwaj 2000; Brynjolfsson and Hitt 1993; Rogers 2003; Sabherwal and Chan 2001). Some prior studies have considered these aspects when examining BVIT while others have excluded them. Moreover, organizational impacts may be described using aspects such as profitability, productivity, and performance (Banker et al. 2006; Barua et al. 2004). Since the unit of analysis in this paper is an individual study or one dataset within a study which can test multiple relationships, with each relationship being either positive, negative, or zero, the cumulative effects across all such relationships in a study may be viewed as BVIT for the study or for one sample within a study.

Consideration of IT Investments

IT investment refers to the funds that may be used by an organization to secure IT-related products and services (e.g. Ray et al. 2005). Prior studies rely on measures such as IT capital or IT budget to operationalize IT investment (e.g., Ray et al. 2009), which are essentially metrics that describe an

[4]Industry type was considered but found to be nonsignificant and excluded from our analysis.

organization's potential or plan to invest in IT. Beyond that, such measures do not provide a description of whether the investments may be in IT hardware and network infrastructure, software applications, or IT management, which are some possible areas for applying the IT resources. While IT investment can be viewed as a necessary condition, it may not be a sufficient condition for organizational impacts because organizations may have to employ IT appropriately and ensure its alignment with strategies, structures, and processes to realize payoff (Kohli and Devaraj 2003; Soh and Markus 1995).

Moreover, IT investments and BVIT are far removed from each other in the causal chain. Schryen (2013), for instance, presents a research model for BVIT that is synthesized from several models in prior literature, all of which argue for intermediate stages between IT resources and BVIT. While the prior models were proposed from different perspectives such as the production system, competitive environment, or input–process–output system, they recognize that IT resources may result in IT assets, followed by intermediate impacts that affect BVIT (Dedrick et al. 2003; Kohli and Devaraj 2004; Melville et al. 2007). Thus, a study that only considers IT investments would find lower BVIT, with the consideration of factors that represent additional details beyond IT investment such as its conversion through IT assets and adoption or use (as examined in the subsequent hypotheses) increasing their effects. Hence, we posit

> **Hypothesis 1.** Studies that explicitly consider IT investment as an independent variable will find lower BVIT than studies that do not.

Other Factors Affecting BVIT

Methodological Attributes of the Study

Regression (or correlation) analysis technique: Prior literature indicates that differences in analytic methods can lead to differences in observed outcomes (Barua and Lee 1997; Shu et al. 2001). Recognizing this, K&D classify IT payoff studies into two categories based on whether the study employed regressions (or related techniques such as structural equation modeling and production economic analysis) or simpler approaches (such as descriptive statistics and correlation-based analyses). Since most regression-based analyses test one or more underlying models, they enable greater focus and also help control for contextual factors (Kohli and Devaraj 2003). This led K&D to expect IT payoff to be greater for studies using regression-based methods. However, they do not find support for this proposition and attribute this as being possibly due to less than 20 percent of the studies in their meta-analysis being based on a correlation-based approach. They argue for collection of additional data to retest the proposition. Based on the above arguments, we posit the same proposition as K&D, and retest it using meta-analysis of a larger sample of studies.

> **Hypothesis 2a**. Studies that use regression methods will find greater BVIT than studies that use correlations.

Number of IT-related independent variables: A greater number of IT-related independent variables in the study may also reduce BVIT. This may be understood using the *omitted variable bias*: if some variables that affect a dependent variable are excluded from the analysis, and if these variables are (1) correlated with the independent variables that are included and (2) have a positive effect on the dependent variable, then the effects of the remaining independent variables will be biased upward (Studenmund 2011). In the context of this meta-analysis, if a prior empirical study had excluded IT-related independent variables that could have positively affected BVIT but included other IT-related independent variables that are positively related to these omitted variables, the observed effects would be higher. Therefore, we posit

> **Hypothesis 2b**. Studies with greater number of IT-based independent variables will find lower BVIT than studies with fewer dependent variables.

Number of dependent variables: Prior meta-analysis studies in medicine find the number of dependent variables in a study to negatively affect the focal correlations. For example, Prendergast et al. (2002, p. 61) note that "studies with a larger number of dependent variables had smaller effect sizes." Similarly, Christensen et al. (1991, pp.148-149) conclude that "as the number of dependent variables examined per study increased, the magnitude of effect size decreased." These findings can be understood by comparing a study having only one dependent variable with a study having several dependent variables. For the first study to be published, the single dependent variable may be expected to depend on the hypothesized IT-related independent variables, whereas the second study could be published even if some of the dependent variables do not depend on any IT-related independent variable. Thus, studies with fewer dependent variables would find lower BVIT.

> **Hypothesis 2c**. Studies with greater number of dependent variables will find lower BVIT than studies with fewer dependent variables.

Data sources: Data from secondary sources is more objective and easier to obtain for a greater number of firms (Kohli and

Devaraj 2003). However, secondary data may be limited in detail and may not match the exact needs of the research study. Primary data from the firm can address these limitations through additional details and contextual variables, and facilitate more uniform data definitions (Brynjolfsson and Hitt 1998; Harris and Katz 1991). As a result, if IT does impact firm performance, primary data from the firm is more likely to accurately capture these impacts. Prior literature (Hitt and Brynjolfsson 1996; Kohli and Devaraj 2003) argues that studies that use firms as the data source are likely to show a positive relationship between IT investment and firm performance due to the completeness and availability of required variables. Arguments along these lines led K&D to expect the use of primary data to positively affect IT payoff, which is supported in their meta-analysis.

> **Hypothesis 2d**. Studies using secondary data will find lower BVIT than studies using primary data.

Sample size: Prior empirical studies on BVIT vary in terms of the levels of data aggregation (e.g., month, quarter), the time period over which data were collected (e.g., over a year, or over five years), and the number of firms that are included in the study (Kohli and Devaraj 2003). Aggregation at the lower level (e.g., month rather than year), use of data over a longer period (e.g., annually for five rather than three years), and a larger number of firms all produce a larger sample and facilitate identification of significant BVIT. K&D use a variable called *sample size* to capture the number of observations and account for the aggregation and duration of the study when it is based on longitudinal or panel data. Specifically, K&D compute the value of sample size as the product of the number of time periods (one for cross-sectional studies) and the number of organizations in the study. We follow the same approach with one modification: we use the natural log of the value obtained using the same procedure as K&D. Arguing that a large sample size would reduce standard errors and make it easier to isolate IT payoff from random noise, K&D expect and find sample size to positively affect IT payoff.

> **Hypothesis 2e**. Studies with larger sample sizes will find greater BVIT than studies with smaller sample sizes.

Consideration of Value Generation

Value generation concerns potential stages in the process of deriving value from IT investments. In this study, we examine IT generation from three different perspectives: IT assets, IT adoption or use, and IT infrastructure or capability. These aspects are descriptive of the different stages at which an organization's value generation may be evaluated, as they acquire IT assets, adopt and use IT, and develop distinctive IT capabilities (e.g., Devaraj and Kohli 2003).

IT assets refer to the appraisal of an organization's tangible resources—including software, hardware, and people—that result from IT investments (Schryen 2013). IT assets may be viewed as the components needed by an organization to enable its everyday activities. Prior literature has typically captured IT assets using financial measures such as IT labor expenditure and IT application software expenditure or non-financial measures such as number of IT personnel and number of computers (Han et al. 2013).

Prior literature shows that organizations progress through several stages in assimilating new IT systems (Kwon and Zmud 1987). For instance, Fichman (2001) proposes that organizations experience the stages of awareness, interest, evaluation, commitment, limited deployment, and general deployment. Despite the differences in nomenclature, the stages described by the models are representative of two major aspects of an organization's engagement with new IT systems: adoption and use. IT adoption refers to an organization's initial decision to accept and use the new IT system to enable its operations, generally captured using a binary variable indicating whether or not an organization adopted the new IT (Aral et al. 2012). IT use describes an organization's decision to persist with the new IT system for its activities and may refer to various aspects of usage such as whether or not the organization uses IT, extent of IT use in organizational transactions, IT use in specific organizational activities, and proportion of organizational members using IT (e.g., Wang et al. 2013).

IT infrastructure represents how IT components such as hardware, software, network, and people coalesce to enable specific organizational activities. Rai et al. (2006), for instance, assess the extent to which an organization established IT infrastructure to enable the transfer of supply-chain related information across its boundaries to partners. IT infrastructure thus serves to build distinctive IT capabilities within an organization. Prior literature on IT capabilities refers to aspects such as design of IT architecture, delivery of IT services, and IT management (Bhatt and Grover 2005; Feeny and Willcocks 1998) that may be instrumental to an organization's competitive advantage, agility, and performance (Roberts and Grover 2012).

The above aspects of value generation offer explanations of how organizations may have utilized IT investments. As argued by Soh and Markus (2005), the IT investment process should be broken down further to discern BVIT. Similarly, Kohli and Devaraj (2003, p. 131) state: "It is suggested that

the process of IT investment leading to payoffs should be examined in greater detail." Consideration of the stages through which IT investments may be converted to business value would thus be expected to reveal greater BVIT. Accordingly, we posit

> **Hypothesis 2f-h**. Studies that consider IT assets (H2f), IT adoption or use (H2g), and IT infrastructure or capability (H2h) will find greater BVIT than studies that do not.

Value Measures

As discussed earlier, BVIT has been assessed using a diverse set of metrics dealing with economic value, shareholder returns, and customer satisfaction. Therefore, and consistent with prior literature (Kohli and Devaraj 2003; Mahmood and Mann 2000), we examine whether the study used profitability-based and productivity-based measures.

Profitability-based measures, such as return on investment, return on assets (ROA), and revenue (Barua et al. 1995; Radhakrishnan et al. 2008) represent the organization's overall efficiencies based on factors such as capital, assets, and sales (Barnes 1987). Since IT is only one aspect of an organization's operations, its impact on profitability measures may be confounded by other factors (Kohli and Devaraj 2003). By contrast, productivity-based measures, such as cost reduction, inventory turnover, and cycle time reduction (Kim 2005; Mukhopadhyay, Kirke, and Kalathur 1995), represent improvements in specific domains (Macher and Mowery 2009; Zhu 2004). Kohli and Devaraj (2003, p. 136) argue that "productivity-based variables also tend to be closer to the process and, therefore, less likely to be confounded by external variables." Thus, we posit

> **Hypothesis 2i**: Studies that use a profitability-based value measure will find lower BVIT than studies that do not.

> **Hypothesis 2j**: Studies that use a productivity-based value measure will find greater BVIT than studies that do not.

Value Enablers

IT progress: While the debate on the IT productivity paradox continued through the 1980s and 1990s (e.g., Brynjolfsson and Hitt 2000; Dedrick et al. 2003), the IT industry experienced considerable changes. Several new tools, platforms, and practices emerged in the areas of IT development, acquisition, and provision, transforming the capabilities and purposes of IT. In the light of these advances in IT, four distinct eras are considered for IT progress. The focus on these four eras with these specific years is based on prior literature (e.g., Evans 1992; Grossman 2012; Moschovitis et al. 1999) and relevant web sites.[5] Further, some discussions of these eras (e.g., Grossman, 2012) view them as overlapping but our analyses required mutually exclusive eras.

Mainframe computing era[6] (1965–1982): Until the advent of the personal computer, organizational computing relied on mainframe computers located in centrally managed data processing sites. During the mainframe computing era, computing cycles were limited, with departments being built around mainframe computers to operate them, ration their cycles, and provide services to end users (Grossman 2012, p. 24).

Personal computing (PC) era[7] (1983–1994): The proliferation of microcomputers in the 1980s brought the power of computing to individuals for personal and organizational use. Computers became considerably more interactive and user-friendly than the previous generations of mainframe computers. The mass-production of PCs paved the way for their adoption by organizations and the automation of organizational activities.

Network computing era[8] (1995–2002): Whereas personal computers enabled the automation of internal activities in a decentralized fashion, the next prominent IT innovation transformed the abilities to connect the internal personal computers and support external activities. The birth of the Internet in 1987 laid the foundation for the later development of the

[5] See http://en.wikipedia.org/wiki/BlackBerry#History and http://www.bbscnw.com/a-short-history-of-the-blackberry.php, both links last accessed April 13, 2015.

[6] The mainframe era was considered to have started in 1965 when IBM shipped its System 360, the first computer based on integrated circuits (Grossman 2012), although the data from studies in our sample started from 1971.

[7] 1983 was considered as the starting point for the *PC era* because this was when (1) Compaq shipped the first IBM clone and sold over $100 million of PCs (Grossman 2012) and (2) Tandy's TRS-80 Model 100, one of the first computers light enough to carry around, was introduced (http://www.computerworlduk.com/slideshow/mobile-wireless/3267504/milestones-in-the-history-of-mobile-computing/, last accessed April 13, 2015).

[8] The *network computing* era took off in 1995 when the National Science Foundation turned over the networking backbone for the Internet to commercial vendors and also introduced a research network (the very High Speed Backbone Network Service or vBNS), which later became the foundation for the next generation of the Internet (Grossman 2012, p. 25).

World Wide Web and the web browser (Moschovitis et al. 1999). As standards for the Internet, documents, and encryption were established over time, Internet-based communication between organizations and their partners became more prevalent. Further proliferation became possible with the advent of the online stores and electronic commerce systems.

Mobile computing era[9] *(2003–2013)*: Following the dot-com bust and the dearth of venture capital at the turn of the century (e.g., Nataraj and Lee 2002), the IT industry witnessed the popularization of Web 2.0 technologies that led to social networking and content sharing sites, and the convergence between mobile devices and Web technologies. These technologies have allowed organizations to generate greater business value by more effectively interacting with existing customers, more efficiently identifying new customers, and using location-based information for hyper-targeting, up-selling, and incentivizing customers.

Overall, IT progress has resulted in more complex and improved systems and processes within organizations. The organization's internal IT department managed the IT portfolio during both mainframe computing and personal computing eras but the extent of centralization reduced as IT transformed from mainframes hosting software to stand-alone computers and office productivity software such as spreadsheets. The network computing era opened up the organization's IT portfolio for connectivity and information sharing with external partners, leading to investments in software for data translation, mapping, and transmission. The mobile computing era witnessed significant changes in IT development and provision with a greater emphasis on cloud-based service-oriented systems, often in collaboration with external providers and consumers. Through this progress in IT, organizations have benefitted from the availability of more sophisticated IT and better ways to harness the increasing power of IT to obtain greater BVIT. Although competing firms would also be able to benefit from IT progress, which may limit increase in potential competitive advantage a firm might obtain over its competitors, we expect firms to obtain greater BVIT in periods with greater IT progress.

> **Hypothesis 2k**. Studies using data during periods marked by greater IT progress will find greater BVIT than studies during periods marked by less IT progress.

Developing (or developed) economic region: Prior literature suggests that BVIT might vary across different parts of the world. Economic regions have been viewed as developed regions (e.g., the United States and Canada in North America and countries in Europe) and developing regions (e.g., countries in Africa, South America, and Asia) (e.g., Dedrick et al. 2013). Considerable differences in the gross domestic product, human capital, and technology infrastructure have been argued to exist between the developed and developing regions (e.g., Dewan et al. 2010).

The effects of IT investments on economic growth and worker productivity vary across economic regions (Jorgenson and Wu 2010). Firms across different parts of the world may differ in their ability "to recognize, exploit, and internalize the knowledge underlying the new technologies" (Castaldi and Dosi 2010, p. 66). Developed regions are generally considered the source of IT advances that may later penetrate developing regions (e.g., Dedrick et al. 2013). Certain types of IT systems, such as enterprise-resource planning systems, may be developed based on the primary considerations of certain regions and may have a lesser impact in other regions (Hovelja 2009). Developed and developing regions also significantly differ in access to external financial resources and skilled IT labor (Shih et al. 2008).

> **Hypothesis 2l**. Studies set in developing economic regions will find lower BVIT than studies set in developed economic regions.

Factors Moderating the Effects of Consideration of IT Investments

Consideration of IT Potential

IT potential refers to the opportunities available for an organization to benefit from IT. Thus, under otherwise similar circumstances, an organization with a greater IT potential would benefit more from IT than one with a lower IT potential. Based on prior literature, we examine three aspects of IT potential: IT sophistication, IT alignment, and inter-organizational IT.

IT sophistication represents the maturity and flexibility of an organization's IT portfolio including planning, organization, control, and integration (Karimi et al. 2000). It indicates the extent to which an organization may have instituted plans for long-range strategic IT planning, managed IT resources consistent with its goals, integrated IT with its cross-functional

[9]The *mobile computing era* is considered to have started in 2003 with the release of the first convergent smartphone BlackBerry, supporting e-mail, mobile telephone (including built-in audio rather than needing a external headset to make phone calls), text messaging, Web browsing, and other wireless information services (see http://en.wikipedia.org/wiki/Black Berry#History; http://www.bbscnw.com/a-short-history-of-the-blackberry.php; http://www.engadget.com/2013/01/28/rim-a-brief-history-from-budgie-to-blackberry-10/, all links last accessed April 13, 2015).

and interorganizational business processes, and created scalable and modular IT infrastructures (Bhatt et al. 2010; Karimi et al. 2000; Rai et al. 2006; Saraf et al. 2007).

IT alignment reflects synergies between IT and the organization. Prior literature examines alignment between organization structure and IT structure, organization strategy and IT strategy, organization strategy and organization structure, and IT structure and IT strategy (Sabherwal and Chan 2001; Tallon and Pinsonneault 2011). Greater IT alignment implies that the IT portfolio of an organization is more consistent with its structures, processes, and strategies.

We distinguish between interorganizational IT and other IT (that may encompass intra-organizational IT, computers, IT infrastructure, or general IT). Interorganizational IT refers to complex IT systems that are used to enable data sharing, coordination, or collaboration between an organization and its supply chain partners (e.g., Grover and Saeed 2007). Examples of interorganizational ITs include electronic data interchange, business-to-business electronic commerce, and supply chain management (e.g., Yoo et al. 2011).

IT potential alone is not expected to affect BVIT. Hence, a direct effect of IT potential on BVIT is not posited. However, consideration of IT investment is expected to have greater impact on BVIT in studies that consider IT potential. Sophisticated IT enables an organization to adjust its IT portfolio to the environment by scaling its scope, integrating information from disparate systems, and applying best practices (Bhatt et al. 2010). Greater IT alignment implies that IT investments are more appropriately targeted to produce greater business value (Sabherwal and Chan 2001; Tallon and Pinsonneault 2011). Similarly, an organization that invests in interorganizational IT is likely to achieve greater BVIT through aspects such as reduced labor costs, turnaround time, and lead time, and through diminished errors. Therefore, *ceteris paribus*, a study that considers IT sophistication, IT alignment, and interorganizational IT is likely to find a stronger relationship between the consideration of IT investments and BVIT.

> **Hypothesis 3a–c**. Consideration of IT potential, represented by IT sophistication (H3a), IT alignment (H3b), and interorganizational IT (H3c) will strengthen the effect of consideration of IT investments on BVIT.

Theory

Theories embody interrelated constructs and propositions subject to certain boundary conditions and assumptions. They determine the research models that may be examined in a study, including the constructs and propositions and the hypotheses and variables (Bacharach 1989; Bhattacherjee 2012). They are typically bounded by assumptions such that they may apply to specific situations (e.g., Poole and Van de Ven 1989). For example, the resource-based view (RBV) theory argues that IT may be viewed as a resource and organizations may choose to invest in IT resources that are rare, inimitable, and non-substitutable (Bharadwaj 2000). A potential research model may comprise of one relationship—for example, the effect of IT characteristics on firm performance—and may include constructs such as rareness, substitutability, and imitability of IT, but exclude constructs such as uncertainty and culture.

Thus, each theory offers a distinct perspective and may uncover distinct insights about organizations, how and why organizations invest in IT, and the payoff resulting from such investments (Christensen et al. 2011). Prior research has been based on several theories, including transaction cost theory (Gurbaxani and Whang 1991), agency theory (Bakos and Nault 1997), microeconomics (Brynjolfsson and Hitt 1995), and RBV (Melville et al. 2004). Different theoretical perspectives may provide varying explanations of the same phenomenon due to differences in models, factors, and underlying assumptions. Therefore, we propose that the many theoretical perspectives employed with BVIT relate to one of the three aspects of the technology–organization–environment (TOE) framework (Tornatzky and Fleisher 1990). Technological theories include theories that examine aspects such as IT implementation, IT capability, and IT strategy (e.g., Bharadwaj 2000); organizational theories encompass the resource-based view, competitive strategy, and organizational culture (e.g., Gold et al. 2001); and environmental theories include theories that examine aspects such as uncertainty, turbulence, and dynamism (e.g., Xue et al. 2012).

The effect of IT investments on BVIT may depend on the specific variables generated by the relevant theory. For instance, an organization competing in an uncertain environment may invest in IT portfolios to counter uncertainty which may enhance BVIT whereas an organization with a risk-averse culture may not invest in leading-edge IT which may reduce BVIT. Therefore, we expect the relationship between consideration of IT investments and BVIT to differ according to the theory used in the study. However, there is no *a priori* expectation on whether a particular theory would strengthen or attenuate the effect of consideration of IT investments on BVIT. Accordingly, nondirectional hypotheses are offered for the moderating effects of theory.

> **Hypothesis 3d–f**. The effect of consideration of IT investments on BVIT will differ depending on the use of technological theories (H3d), organizational theories (H3e), and environmental theories (H3f).

Studies and Data

Meta-analysis is a way of combining the quantitative results of studies with different and even potentially conflicting research methods and findings to identify the consistencies among a set of apparently inconsistent findings (Hunt 1997). The underlying idea for a meta-analysis is that a formal, quantitative analysis of the similarities and differences across studies within the same broad area in terms of their methods and results can produce new insights into underlying relationships (Kohli and Devaraj 2003; Sabherwal et al. 2006; Stiroh 2002). The specific meta-analysis approach used by K&D, called "meta-regression" (Jarrell and Stanley 1990; Stanley and Jarrell 1989), is a specific subsequent use of the estimate resulting from the meta-analysis as a dependent variable in a cross-sectional regression that uses some study-level characteristics (e.g., sample size, analytic techniques) as independent variables.

> In a meta-regression analysis, the dependent variable is a summary statistic, perhaps a regression parameter, drawn from each study, while the independent variables may include characteristics of the method, design and data used in these studies. Thus, meta-regression analysis can identify the extent to which the particular choice of methods, design and data affect reported results (Stanley 2001, pp. 131-132).

Following K&D, we employ meta-regression to examine our research propositions. Meta-regression includes the following broad steps: (1) identifying studies that examine BVIT; (2) coding results reported by the studies; and (3) conducting regressions to investigate the posited relationships between the independent variables (the four categories of variables proposed to affect BVIT) and the dependent variable (the result of BVIT from each study).

Identifying Studies

We started with the 66 studies on BVIT used by K&D and then searched for additional studies for our meta-analysis in two phases.[10] In the first phase, we duplicated K&D and searched a variety of sources (e.g., the *Social Sciences Citation Index* online database and bibliographies of previously published review papers) for relevant studies published between 1990 and 2000. Like K&D, we used search strings such as information technology, IT payoff, firm, profitability, performance, and productivity to identify potential studies.

The second phase extended K&D. We looked for studies published between 2001 and 2013, and included online sources to identify more studies. We also used these sources to identify additional studies published between 1990 and 2000. We reviewed the bibliographies of review articles to identify potential studies for the meta-analysis. Further, we obtained working papers directly from the respective authors. Our search efforts yielded more than 500 studies, of which 265 new studies made it as candidates for our meta-analysis sample.[11] In sum, we identified 331 studies (66 from K&D and 265 studies from our search) as candidates for possible inclusion in our meta-analysis sample of BVIT studies between 1990 and 2013.

Coding Studies

We coded the studies in several stages. In preparation, we reviewed K&D and identified the dependent and independent variables coded for the analysis. For each variable, we extracted the measures coded by K&D. We discussed potential variations to the coding schemes and noted the analysis methods adopted by K&D. We developed a preliminary coding sheet that could be used to uniformly code data from the studies. We began coding with the 66 studies in K&D. To train for coding, we used a strategy in which two individuals independently coded the same set of studies. We did this for three rounds with different sets of five randomly selected studies from our sample. This enabled us to evaluate the consistency across our codes and discuss any problems we encountered. The agreement between the coders increased with each round. Any discrepancy was resolved through discussion, and if needed, with a third individual. Our coding rules (see Table 1) evolved[12] during these three rounds before we finalized the coding sheet.

After establishing the reliability of the coding procedure, we divided the remaining studies from K&D's sample into two sets. Two coders independently coded the two sets and met

[10] Two individuals conducted the search for articles. To pilot-test the search procedure, both individuals independently searched for articles for a specific period. The results obtained by both individuals were identical. Subsequently, the two individuals searched for articles independently for different periods.

[11] A study was excluded at this stage, if it (1) was not about BVIT; (2) did not focus at the firm level (e.g., Carayannis 2000); (3) examined BVIT but not any IT-related antecedents (e.g., Shao and Lin 2000); (4) provided a review, theoretical assessment, or results of a qualitative research (e.g., Thatcher and Pingry 2004); or (5) employed methods that were not compatible with meta-analysis (e.g., Kohli and Devaraj 2003).

[12] For instance, the coders had trouble categorizing dependent variables such as output, sales, and revenue as profitability or productivity. Finally, it was agreed that we would have a separate category for output.

Table 1. Coding Rules

Situation	Rule
Study reported zero-order Pearson correlations as well as regression results	Code using regression results
Study reported results of different regression models, say, partial and full models	Code using results for full models
Study reported results of different regression models, say, ordinary least squares and weighted least squares	Code using results of the model that the authors argued best fit their data
Study reported results for the entire sample of organizations as well as subgroups of organizations	Code using results for the entire sample
Study reported results for several subgroups only	Code all subgroups treating each subgroup as an observation
Study reported results for an omnibus longitudinal analysis as well as cross-sectional analysis for different periods	Code using results for longitudinal analysis
Study reported results only for cross-sectional analysis for different periods	Code using consolidated results from each period

to resolve a few coding issues and consulted a third expert when needed. Seven[13] of the 66 studies were excluded during this phase due to various reasons. We next coded the 265 additional studies identified during the extended search for studies. As before, we split the studies into two sets, with one individual serving as the lead coder for each set. The coders independently coded the studies in each set and held a final round of discussion to resolve coding issues. Both coders were comfortable with the coding procedures during this phase and did not need to consult the third individual. Finally, to ensure independence of samples included in the meta-analysis, we examined the datasets used by all studies using the following criteria: the number of organizations and the time periods, the dependent variables, and the independent variables. We excluded any study that had examined the same set of organizations for the same period using the same dependent and independent variables as any other study. Of the 265 studies identified during the extended search, 21 studies were excluded for various reasons.[14]

Data

The final sample included 303 studies on firm-level BVIT, which yielded 336 observations. The publication outlets for these studies are journal articles (259), books or book chapters (7), conference proceedings (19), doctoral dissertations (16), and working papers (2). Thirty journals are represented by two to eight articles each, 68 journals by one article each, and the following journals by more than 10 articles each: *Information Systems Research* (30 articles), *MIS Quarterly* (24), *Journal of Management Information Systems* (22), *Information & Management* (18), and *Management Science* (11). Appendix B lists the BVIT studies from our sample and identifies some key attributes. Table 2 identifies the variables coded from each study for our analysis, their measures, and the descriptive statistics.

Analyses

As discussed in Appendix C, we constructed several graphs to further examine the changes in BVIT literature over time, and additional potential interactions. They indicate that

(1) The frequency of studies (Figure C1) and the observed BVIT (Figure C2) have both increased over time.

[13]They are Barua and Lee (1997) (game theoretic modeling with no empirical data); Bergeron and Dexter (1999) (no statistical analyses to code BVIT); Brynjolfsson and Hitt (2000) (literature review); Mistry and Johnston (2000) (only moderated effects); a duplicate reference to Barua et al. (1995); Panthawi (1999) (case studies); and Papp (1999) (inadequate linkage of payoff to IT investment).

[14]We excluded two studies (Chen and Zhu 2004; Shafer and Byrd 2000) as they reported BVIT results for each organization but not at the aggregate level; seven publications (Brynjolfsson and Hitt 1993, 1995; Dewan and Min 1997; Lin and Shao 2006a, 2006b; Osei-Bryson and Ko 2004; Shao and Lin 2002) as they used the same data set as Hitt and Brynjolfsson (1996) and acknowledge doing so as well; ten publications (Feng et al. 2005; Hempell 2005; Ko and Osei-Bryson 2006; Kudyba 2004; Kudyba and Diwan 2000; Mahmood and Mann 2005; Mitra 2005; Prasad and Heales 2010; Shao and Lin 2001; Shin 1999) as they used the same dataset as another paper in the sample; Menon and Lee (2000) because it used a subset of the data set from Menon et al. (2000); and Wang et al. (1997) as it reported a case study.

Table 2. Variables, Definitions, and Descriptive Statistics

Construct	Variable	Operationalization	Mean (SD[a]) or Frequency
BVIT	Continuous measure (CNTPAYOF)	$\frac{(\#PosRels - \#NegRels) * 100}{\#TotalRels}$	53.17 (M), 50.99 (SD)
	Ordinal measure (ORDPAYOF)	1 if CNTPAYOF ≤ -25 2 if -25 < CNTPAYOF ≤ +75 3 if CNTPAYOF > +75	2.63 (M), 0.57 (SD)
Study's methodological attributes	Regression	1 if study used regression-based methods for data analysis, 0 otherwise	285 (1), 51 (0)
	Number of IT-based antecedents	Number of IT-based independent variables used in study	1.47 (M), 1.16 (SD)
	Number of dependent variables	Number of dependent variables used in study	2.08 (M), 1.77 (SD)
	Secondary data	1 if study used secondary or archival databases for data collection	202 (1), 134 (0)
	Sample size (log)	Number of observations, OR product of years and organizations for panel data	5.85 (M), 1.39 (SD)
Consideration of IT investment	IT investment	1 if study examined IT investment	146 (1), 190 (0)
Consideration of value generation	IT asset	1 if study examined technology IT assets (e.g., computers) or people IT assets (e.g., number of employees)	106 (1), 230 (0)
	IT adoption or use	1 if study examined IT adoption or use	95 (1), 241 (0)
	IT infrastructure or capability	1 if study examined IT infrastructure or capability or 0 (otherwise)	78 (1), 258 (0)
Value measures[b]	Profitability	1 if the study used a profitability measure	157 (1), 179 (0)
	Productivity	1 if the study used a productivity measure	119 (1), 217 (0)
IT progress[c]	Mainframe computing era	1 if data spanned years 1971–1982	29 (1), 307 (0)
	Personal computing era	1 if data spanned years 1983–1994	109 (1), 227 (0)
	Network computing era	1 if data spanned years 1995–2002	98 (1), 238 (0)
	Mobile computing era	1 if study data spanned years 2003–2013	100 (1), 236 (0)
Economic region[d]	Developing region	1 if study examined organizations from a developing region	58 (1), 278 (0)
Consideration of IT potential	IT sophistication	1 if study examined IT sophistication	32 (1), 304 (0)
	IT alignment	1 if study examined IT alignment	32 (1), 304 (0)
	Interorganizational IT	1 if study targeted interorganizational IT	94 (1), 242 (0)
Theory	Technology theories	1 if study used technology theory	125 (1), 211 (0)
	Organization theories	1 if study used organization theory	124 (1), 212 (0)
	Environment theories	1 if study used environment theory	26 (1), 310 (0)

[a]N = 336. For binary variables, frequencies of 1's and 0's reported, with 1 and 0 in parentheses. For other variables, means and standard deviations are reported, with Mean and SD (i.e., standard deviation) in parentheses.

[b]K&D captured whether a study measured productivity, profitability, or both; we coded five binary variables, one each for profitability, productivity, output, growth, and hybrid (i.e., where the dependent variable was measured using items representing more than one of the other four types), of which only profitability and productivity were used in the analysis to avoid multicollinearity.

[c]The year for IT progress was coded as the earliest of the following for the original study: the year of IT investment or firm performance (for secondary sources), the year of data collection (for primary sources), the year the study was submitted for publication, the year the study was accepted for publication, and the year of publication.

[d]http://www.un.org/en/development/desa/policy/wesp/wesp_current/2012country_class.pdf from the United Nations served as the basis for economic regions; link last accessed April 13, 2015.

(2) BVIT studies have become more focused over time, examining a narrower set of dependent and IT-based independent variables (Figure C3).

(3) BVIT was assessed through some rather evenly distributed measures (e.g., output, market value) in the mainframe computing era, but return on assets gained prominence during PC and network computing eras before fading during the mobile computing era, and firm performance has become more prominent over time as the dependent variable, especially during the mobile computing era (Figure C4).

(4) IT-based independent variables have similarly evolved in their focus, from economic measures such as IT capital and IT budget during the mainframe computing and PC eras to measures such as IT use, IT capability, and IT alignment during the network computing and mobile computing eras (Figure C4).

(5) Technological and organizational theories have been consistently used over time, with the former being predominant, and environmental and alignment theories have only been used recently (Figure C5).

(6) Studies in developing regions have shown faster increase in BVIT over time than studies in developed regions (Figure C6).

(7) Studies relying on primary and cross-sectional data demonstrate higher levels of BVIT but slower increase over time in BVIT, than those that use secondary and longitudinal data, respectively (Figures C7 and C8).

Main Analysis

Ordinary least squares (OLS) regression is used to test the hypotheses. Consistent with K&D, the observed BVIT is recoded as a continuous BVIT variable[15] (named CNTPAYOF) as shown in Table 1 using the number of results across all relationships examined in the study (#TotalRels) in each of the categories: positive and significant (#PosRels) and/or negative and significant (#NegRels). For example, CNTPAYOF is coded as 100% in a study with all dependent variables showing positive and significant results, but a study with five dependent variables, including four positive significant and one negative significant, will produce a CNTPAYOF of 100 * (4 – 1)/5 or 60 percent. Tests for the normality of CNTPAYOF are satisfactory.[16]

Stata 12.1 was used for the analyses. Since multiple observations are taken from studies with multiple samples, we used the cluster option for variance-covariance matrix that specifies standard errors to be correlated across observations within the same group, relaxing the assumption of independent observations (Froot 1989; Wooldridge 2002). Thus, we specified independence of observations across studies but not of the multiple observations from the same study.

We test a hierarchical OLS regression model in three steps: (1) direct effects of independent variables; (2) direct effects of independent and moderating variables; and (3) all direct effects and posited interaction effects. Table 3 provides the results for the three steps. The changes in F-statistic for Models 2 and 3 show that the inclusion of moderating variables (in Model 2) and interactions (in Model 3) further explain the variance in BVIT.

Robustness Tests

We conducted several robustness tests by varying the regression options and dependent and independent variables. First, we examined the main model without the cluster option (Model 4). Next, we regressed an alternative dependent variable (an ordinal BVIT variable named ORDPAYOF, shown in Table 2) on the same independent variables as in the main model (Model 5). Finally, we used two alternative measures of IT progress with the remaining independent variables and dependent variable being the same as in the main model. The alternate measures for IT progress are (1) a classification scheme in which the eras were arbitrarily defined as different decades such as 1970s, 1980s, 1990s, 2000s, and 2010s (Model 6), and (2) a continuous measure of year in which data ranged from 1971 to 2013 (Model 7).

The results for Models 4 to 7 are given in Table 4. In total, the main analysis involved 19 tests, including 1, 12, and 6 hypotheses related to RQ1, RQ2, and RQ3, respectively. Models 4, 5, 6, and 7 produce results consistent with the main results (Model 3) in 19, 18, 18, and 18 out of 19 cases respectively. Thus, the robustness tests are consistent in 73 of 76 possible cases (73/76 = 96%), providing considerable support for the main results.

[15]K&D used logistic regression, discriminant analysis, and OLS regression. We did not use discriminant analysis as our research model includes both main and interaction effects. We use logistic regression for robustness tests.

[16]Skewness = -0.80 and kurtosis = 2.96 for the continuous dependent variable. They are below the levels of 2 and 5, respectively, that would require transformation (Akgun et al. 2006; Ghiselli et al. 1981).

Table 3. Results for Main Analysis

Construct	Variable	Model (1)[a,b]	Model (2)	Model (3)
Consideration of IT investment	IT investment	-0.13 (-2.00**)	-0.18 (-2.48**)	-0.23 (-2.34**)
Study's methodological attributes	Regression	-0.04 (-0.51)	-0.08 (-1.08)	-0.09 (-1.36)
	Number of IT-based antecedents	-0.12 (-2.70***)	-0.13 (-2.69***)	-0.12 (-2.45***)
	Number of dependent variables	-0.08 (-1.14)	-0.10 (-1.29)	-0.09 (-1.23)
	Secondary data	-0.12 (-1.83*)	-0.12 (-1.81*)	-0.11 (-1.67*)
	Sample size (log)	0.17 (3.14***)	0.16 (2.76***)	0.18 (3.22***)
Consideration of value generation	IT asset	-0.08 (-1.29)	-0.07 (-1.17)	-0.06 (-1.00)
	IT adoption or use	0.00 (0.04)	-0.05 (-0.61)	-0.05 (-0.59)
	IT infrastructure or capability	0.03 (0.38)	0.02 (0.28)	0.00 (0.00)
Value measures	Profitability	-0.12 (-1.81*)	-0.14 (-2.00**)	-0.14 (-1.96**)
	Productivity	-0.02 (-0.37)	-0.04 (-0.68)	-0.06 (-0.94)
Value enablers	*IT progress*[c] Personal computing era (1983-94)	0.19 (1.79*)	0.20 (1.86*)	0.19 (1.66*)
	Network computing era (1995-2002)	0.26 (2.40**)	0.29 (2.70**)	0.27 (2.47**)
	Mobile computing era (2003-13)	0.25 (2.24**)	0.27 (2.51**)	0.26 (2.37**)
	Developing region	0.02 (0.37)	0.02 (0.40)	0.01 (0.16)
Consideration of IT potential	IT sophistication		-0.11 (-1.86*)	-0.07 (-1.19)
	IT alignment		0.10 (1.59)	0.07 (1.01)
	Interorganizational IT (InterIT)		0.03 (0.58)	-0.03 (-0.48)
Theory	Technological theories (TT)		-0.06 (-0.86)	-0.07 (-0.92)
	Organizational theories (OT)		-0.17 (-2.35**)	-0.16 (-2.08**)
	Environmental theories (ET)		0.02 (0.25)	0.08 (1.64)
Interactions	IT investment * IT sophistication			-0.11 (-1.60)
	IT investment * IT alignment			0.10 (1.66*)
	IT investment * InterIT			0.13 (2.34**)
	IT investment * TT			0.04 (0.46)
	IT investment * OT			0.02 (0.21)
	IT investment * ET			-0.14 (-1.70*)
	R^2	0.179	0.211	0.247
	Adjusted R^2	0.141	0.159	0.180
	Model F	6.048***	4.764***	4.474***
	ΔR^2 (ΔF) from Model (1) to (2)		0.032 (1.87*)	0.032 (1.87*)
	ΔR^2 (ΔF) from Model (2) to (3)			0.035 (2.21**)

[a]N = 336. Dependent variable for all models = CNTPAYOF. All models cluster by study.

[b]Each cell contains beta, with the t-statistic in parentheses. ***p < 0.01 (|t| $\geq$ 2.58), **p < 0.05 (|t| $\geq$ 1.96), *p < 0.10 (|t| $\geq$1.65).

[c]Baseline: Mainframe computing era (1971–1982).

Table 4. Results for Robustness Analysis

Construct	Variable	Model (4)[a, b]	Model (5)	Model (6)	Model (7)
Consideration of IT investment	IT investment (ITINV)	-0.23 (-2.47**)	-0.20 (-2.05**)	-0.25 (-2.64***)	-0.26 (-.268***)
Study's methodological attributes	Regression	-0.09 (-1.52)	-0.04 (-0.59)	-0.08 (-1.33)	-0.08 (-1.28)
	Number of IT-based antecedents	-0.12 (-2.46**)	-0.10 (-1.66*)	-0.11 (-2.22**)	-0.11 (-2.20**)
	Number of dependent variables	-0.09 (-1.28)	0.07 (0.84)	-0.11 (-1.42)	-0.08 (-1.16)
	Secondary data	-0.11 (-1.77*)	-0.10 (-1.52)	-0.13 (-1.98**)	-0.12 (-1.82*)
	Sample size (log)	0.18 (3.45***)	0.19 (3.10***)	0.18 (3.21***)	0.18 (3.19***)
Consideration of value generation	IT asset	-0.06 (-1.09)	-0.04 (-0.69)	-0.06 (-1.04)	-0.06 (-0.93)
	IT adoption or use	-0.05 (-0.62)	-0.00 (-0.05)	-0.06 (-0.72)	-0.06 (-0.75)
	IT infrastructure or capability	0.00 (0.00)	-0.00 (-0.03)	-0.00 (-0.02)	-0.02 (-0.21)
Value measures	Profitability	-0.14 (-2.08**)	-0.14 (-2.06**)	-0.13 (-1.81*)	-0.13 (-1.73*)
	Productivity	-0.06 (-0.95)	-0.07 (-1.13)	-0.06 (-0.89)	-0.07 (-1.05)
Value enablers	*IT progress*[c] Era 2	0.19 (1.65*)	0.21 (1.82*)	0.22 (1.78*)	
	Era 3	0.27 (2.52**)	0.27 (2.38**)	0.30 (2.06**)	
	Era 4	0.26 (2.36**)	0.30 (2.68***)	0.28 (1.85*)	
	Era 5			0.16 (2.48**)	
	Year (of data/study)				0.10 (1.59)
	Developing region	0.01 (0.16)	-0.05 (-0.97)	0.01 (0.20)	0.02 (0.31)
Consideration of IT potential	IT sophistication	-0.07 (-1.19)	-0.03 (-0.54)	-0.08 (-1.31)	-0.09 (-1.37)
	IT alignment	0.07 (1.04)	0.06 (0.80)	0.07 (0.97)	0.06 (0.86)
	Interorganizational IT (InterIT)	-0.03 (-0.50)	-0.01 (-0.10)	-0.02 (-0.39)	-0.04 (-0.61)
Theory	Technological theories (TT)	-0.07 (-1.02)	-0.01 (-0.16)	-0.06 (-0.87)	-0.07 (-0.86)
	Organizational theories (OT)	-0.16 (-2.27**)	-0.16 (-2.10**)	-0.15 (-2.03**)	-0.15 (-2.03**)
	Environmental theories (ET)	0.08 (1.69*)	0.08 (1.74*)	0.07 (1.51)	0.08 (1.62)
Interactions	ITINV*IT sophistication	-0.11 (-1.52)	-0.07 (-0.83)	-0.10 (-1.38)	-0.09 (-1.32)
	ITINV*IT alignment	0.10 (1.67*)	0.10 (1.70*)	0.09 (1.59)	0.10 (1.78*)
	ITINV*InterIT	0.13 (2.32**)	0.11 (2.01**)	0.13 (2.43**)	0.14 (2.74***)
	ITINV*TT	0.04 (0.49)	-0.01 (-0.10)	0.05 (0.62)	0.03 (0.34)
	ITINV*OT	0.02 (0.21)	0.01 (0.09)	0.01 (0.14)	0.02 (0.24)
	ITINV*ET	-0.14 (-1.70*)	-0.14 (-1.83*)	-0.15 (-1.82*)	-0.15 (-1.75*)
	R^2	0.247	0.208	0.246	0.232
	Adjusted R^2	0.180	0.138	0.177	0.170
	Model F	5.039***	2.738***	4.35***	4.27***

[a]N = 336. CNTPAYOF is the dependent variable for in all models except Model 5 that uses ORDPAYOF. All models except Model 4 cluster observations by study.

[b]Each cell contains beta, with the t-statistic in parentheses. ***p < 0.01 (|t| ≥ 2.58), **p < 0.05 (|t| ≥ 1.96), *p < 0.10 (|t| ≥ 1.65)

[c]Models 4 and 5 are similar to Models 1–3 with Eras 2, 3, and 4 representing personal computing era (1983–1994), network computing era (1995–2002), and mobile computing era (2003–2013), respectively. The baseline or Era 1 for these regressions is mainframe computing era (1971–1982). For model 6, Eras 2, 3, 4, and 5 represent the following decades respectively: 1981–1990; 1991–2000; 2001–2010; and 2011–2013 with the baseline era as the 1971–1980 decade.

Table 5. Results for *Post Hoc* Analysis and Robustness

Construct	Variable	Model (8)[a,b]	Model (9)	Model (10)	Model (11)	Model (12)
Consideration of IT investment	IT investment (ITINV)	-0.25	-0.25	-0.26	-0.28	-0.29
		(-2.47**)	(-2.61***)	(-2.57**)	(-2.87***)	(-2.88***)
Study's methodological attributes	Number of IT-based antecedents	-0.12	-0.12	-0.09	-0.10	-0.10
		(-2.46**)	(-2.47**)	(-1.65*)	(-2.20**)	(-2.19**)
	Secondary data	-0.11	-0.11	-0.10	-0.12	-0.12
		(-1.59)	(-1.67*)	(-1.47)	(-1.93*)	(-1.76*)
	Sample size (log)	0.16	0.16	0.18	0.16	0.17
		(2.92***)	(3.15***)	(2.80***)	(2.90***)	(2.94***)
Value measures	Profitability	-0.13	-0.13	-0.13	-0.12	-0.12
		(-1.87*)	(-1.96**)	(-1.93*)	(-1.68*)	(-1.63)
Value enablers	*IT progress*[c]					
	Era 2	0.20	0.20	0.21	0.24	
		(1.73*)	(1.72*)	(1.84*)	(1.91*)	
	Era 3	0.29	0.29	0.28	0.32	
		(2.59***)	(2.64***)	(2.50**)	(2.16**)	
	Era 4	0.27	0.27	0.30	0.29	
		(2.39**)	(2.38**)	(2.68***)	(1.90*)	
	Era 5				0.17	
					(2.69***)	
	Year (of data/study)					0.10
						(1.57)
Theory	Organizational theories	-0.17	-0.17	-0.16	-0.16	-0.16
		(-2.17**)	(-2.35**)	(-2.16**)	(-2.12**)	(-2.08**)
	Environmental theories	0.08	0.08	0.08	0.07	0.08
		(1.63)	(1.68*)	(1.75*)	(1.48)	(1.62)
Interactions	ITINV*IT alignment	0.10	0.10	0.11	0.09	0.10
		(1.67*)	(1.67*)	(1.80*)	(1.61)	(1.81*)
	ITINV*Interorganizational IT	0.13	0.13	0.10	0.12	0.14
		(2.17**)	(2.13**)	(1.68*)	(2.23**)	(2.57**)
	ITINV*Environmental theories	-0.14	-0.14	-0.14	-0.16	-0.15
		(-1.76*)	(-1.77*)	(-1.87*)	(-1.88*)	(-1.79*)
	ITINV*Developing region	-0.11	-0.11	-0.08	-0.12	-0.09
		(-1.66*)	(-1.59)	(-1.01)	(-1.69*)	(-1.32)
	ITINV*IT adoption or use	0.08	0.08	0.13	0.09	0.08
		(1.94*)	(1.94*)	(3.71***)	(2.20**)	(1.83*)
	R-Square	0.26	0.26	0.22	0.26	0.24
	Adjusted R^2	0.19	0.19	0.15	0.18	0.17
	F-statistics	4.80***	5.12***	3.22***	4.55***	4.53***

[a]N = 336. CNTPAYOF is the dependent variable in all models except Model 10 that uses ORDPAYOF. All models except Model 9 cluster observations by study. The results for the consistently nonsignificant effects of regression, number of dependent variables, productivity, IT assets, IT infrastructure or capability, IT alignment, interorganizational IT, developing region, technological theories, interactions of ITINV with technological theories and organizational theories are not shown above.

[b]Each cell contains beta, with the t-statistic in parentheses. ***p < 0.01 ($|t| \geq 2.58$), **p < 0.05 ($|t| \geq 1.96$), *p < 0.10 ($|t| \geq 1.65$)

[c]In Models 8–10, Eras 2, 3, and 4 represent personal computing (1983–1994), network computing (1995–2002), and mobile computing (2003–2013) respectively with mainframe computing (1971–1982) as the baseline. In Model 11, Eras 2, 3, 4, and 5 represent the decades1981–1990, 1991–2000, 2001–2010, and 2011–2013 respectively, with the baseline as the 1971–1980 decade.

Post Hoc Regressions

Since economic region and the consideration of value generation (i.e., IT asset, IT adoption or use, and IT infrastructure or capability) do not significantly affect BVIT, we conducted *post hoc* regressions to explore the possibility that economic region and consideration of IT adoption or use[17] may moderate the effect of the consideration of IT investment on BVIT. This modified model (Model 8 in Table 5) showed both moderating effects to be significant, suggesting that the consideration of IT investment has greater impact on BVIT in studies that examine IT adoption or use than in studies that do not, and in developed regions compared to developing regions.

We next conducted robustness tests for the modified model, similar to those for the main model. As may be seen from the results of these tests, given in Models 9–12 in Table 5, the moderating effect of consideration of IT adoption or use is supported in all the robustness tests, but the moderating effect of developing region is only supported in one of the four robustness tests. Also, the negative effect of the use of secondary data, which was supported in Models 3–7 receives lower support after adding these interactions; it is supported in Models 9, 11, and 12 but not in Models 8 and 10. We base our discussion on the results for this modified model.[18]

Discussion

Summary of Results

Our study extends K&D by pursuing three research questions related to (1) how the consideration of IT investment affects BVIT; (2) how the study's methodological attributes, consideration of value generation, value measures, and value enablers affect BVIT; and (3) how IT potential (i.e., IT sophistication, IT alignment, and interorganizational IT) and theory (i.e., technological, organizational, and environmental theories) moderate the relationship between consideration of IT investment and BVIT. Table 6 summarizes the findings and compares them to K&D's results. As may be seen from the table, the results of this study differ from K&D's in three respects. First, K&D found consideration of IT assets to have a negative effect on BVIT, which was contrary to their expectation of a positive effect. By contrast, this study did not find consideration of IT assets to have a significant effect on BVIT, but found consideration of IT adoption or use (which K&D had not included) to have a positive moderating effect on the relationship between consideration of IT investment and BVIT. Thus, the results of this study with respect to the process intervening between IT investment and BVIT seem consistent with K&D's *a priori* expectations but not with their empirical results. Second, K&D found the use of productivity-based measures to have a positive effect on BVIT but did not find the use of profitability-based measures to have a significant effect on BVIT. By contrast, this study has not found the use of productivity-based measures to have a significant effect on BVIT but found the use of profitability-based measures to have a negative effect on BVIT. Third, since this work is based on 303 studies instead of the 66 in K&D, we were able to examine the effects of some additional variables[19] beyond the ones considered by K&D.

Figure 3 shows the emergent model. The results are consistent across various models (reported in Tables 3, 4, and 5) except where explicitly noted and are discussed below.

Consideration of IT investment: As expected (H1), the consideration of IT investment has a negative effect on BVIT. This result may be viewed along with the somewhat inconsistent support for the negative effect of the use of secondary data on BVIT. Together, these findings suggest that studies that focus on IT investment and use objective measures of IT investment (such as through secondary data) may show lower BVIT than studies that are not restricted to IT investment and use subjective or perceptual measures (such as in questionnaire surveys).[20]

Methodological attributes: The analysis method (H2a) and the number of dependent variables (H2c) in the study do not affect BVIT. However, other study methodological attributes have expected effects. The number of IT-related independent variables has a negative effect on BVIT (supporting H2b). Studies using primary data (H2d) find greater BVIT, although this result is inconsistent when including the two additional

[17]We included moderating effect of consideration of IT adoption or use but not of consideration of IT assets and IT infrastructure or capability because t-tests found BVIT to be significantly greater ($|t| = 1.96$, $p < 0.05$) for studies that measured IT adoption or use (mean = 61.8, SD = 44.5, n = 95) than for studies that did not (mean = 49.8, SD = 53.0, n = 241) but found no significant difference in BVIT between high and low levels of consideration of IT assets and IT infrastructure or capability.

[18]We also tested some other models, including ones with interactions between IT computing eras and developing region and between consideration of IT investment and the type of the data, but they were not supported.

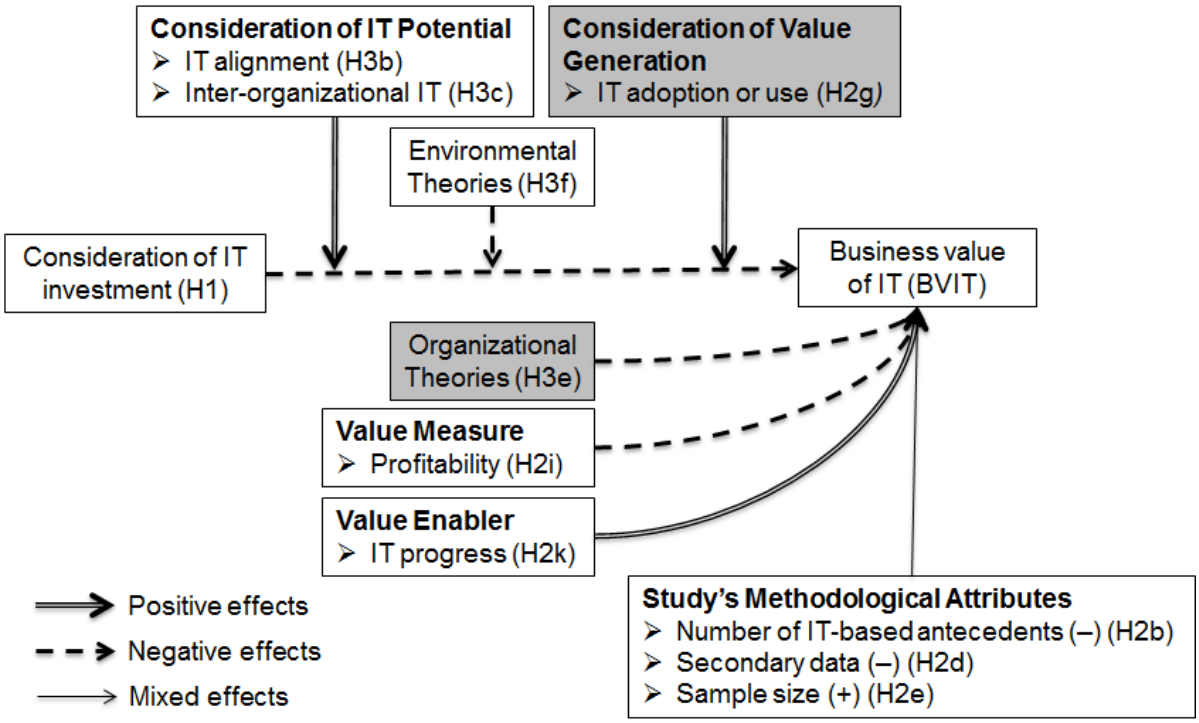
[19]Moreover, as reported in an earlier footnote, industry sector, which K&D found to have significant effect, was excluded from the reported results since it was found to have a nonsignificant effect.

[20]*Post hoc* t-test results show significant differences in BVIT ($|t| = 1.73$, $p < 0.10$) between studies using objective (mean = 35.8, SD = 5.3, n = 122) and perceptual (mean = 57.8, SD = 8.9, n = 24) measures of IT investment.

Table 6. Summary of Findings

Construct	Variable[a]	Hypothesis	K&D[b] Finding	Our Finding	Effects on BVIT
Consideration of IT investment	IT investment (ITINV)	H1		–[c]	BVIT increases when IT investment is not examined
Study's methodological attributes	Regression	H2a	n.s.	n.s.	
	Number of IT-based antecedents	H2b		–	BVIT increases when the number of IT-based independent variables decreases
	Number of dependent variables	H2c		n.s.	
	Secondary data	H2d	–	–	BVIT increases when primary data sources are used[d]
	Sample size (log)	H2e	+	+	BVIT increases when the sample size increases
Consideration of value generation	IT assets[e]	H2f	–	n.s.	*Emergent finding*: Consideration of IT investment has greater impact on BVIT in studies focusing on IT adoption or use
	IT adoption or use	H2g[f]		n.s.	
	ITINV * IT adoption or use	*None*		+	
	IT infrastructure or capability	H2h		n.s.	
Value measure	Profitability	H2i	n.s.	–	Profitability measures are less likely to demonstrate BVIT
	Productivity	H2j	+	n.s.	
Value enablers	Personal computing era	H2k		+	BVIT increases over time with IT progress (relative to the Mainframe computing era)
	Network computing era			+	
	Mobile computing era			+	
	Developing region	H2l		n.s.	
	ITINV * Developing region	*None*		n.s.	
Consideration of IT potential	ITINV * IT sophistication	H3a		n.s.	
	ITINV * IT alignment	H3b		+	Consideration of IT investment has greater impact on BVIT in studies also considering IT alignment
	ITINV * Interorganizational IT	H3c		+	Consideration of IT investment has greater impact on BVIT in studies focusing on interorganizational IT
Theory	ITINV * Technological theories	H3d		n.s.	*Emergent findings*: BVIT increases when organizational theories are not used Consideration of IT investment has greater impact on BVIT in studies not using environmental theories
	Organizational theories	H3e[g]		–	
	ITINV * Environmental theories	H3f		–	

[a]The three variables in boldface reflect results with a shift from a direct effect in hypothesized model to moderating effect in results or vice versa.
[b]K&D employed variables for IT impact and industry sector that are not shown here due to differences in our research model.
[c]n.s.: nonsignificant effect; +: significant positive effect on BVIT; –: significant negative effect on BVIT; blank cell: effect not examined.
[d]This is a somewhat inconsistent result. It is consistently supported in Tables 3 and 4 but inconsistently supported in Table 5.
[e]K&D expected a positive effect for IT assets but found a negative effect on IT payoff. We expected a positive effect for IT assets but found no significant effect.
[f]A main effect for IT adoption or use on BVIT was expected; however, IT adoption or use was found to moderate the effect of IT investment on BVIT.
[g]Organizational theories was expected to moderate the effect of IT investment on BVIT; however, it has a direct negative effect on BVIT.



The shaded boxes indicate situations where a variable was switched from main effect to moderating effect or vice versa. The following variables were dropped from the emergent model due to nonsignificant results: analysis technique (regression) (H2a), number of dependent variables (H2c), IT assets (H2f), IT infrastructure or capability (H2h), productivity (H2j), developing region (H2l), IT sophistication (H3a), and technological theories (H3d).

Figure 3. The Emergent Model

moderating effects (Table 5). Sample size (H2e) has a positive effect on BVIT. In longitudinal studies, BVIT increases as the number of years or the number of firms increases.[21] In cross-sectional studies, BVIT increases as the number of firms increases. Overall, these results suggest that richer studies, based on primary data, fewer independent variables, and larger sample sizes, produce greater BVIT.

Consideration of value generation: All three variables that represent the consideration of value generation in our study show nonsignificant effects on BVIT. We hypothesized positive effects of consideration of IT assets (H2f), IT adoption or use (H2g), and IT infrastructure or capability (H2h) on BVIT because they represent aspects of the process leading to BVIT; however, the effects were nonsignificant. These nonsignificant results, along with similar findings from K&D suggest that consideration of IT assets, adoption or use of IT, and development of IT infrastructures or capabilities do not directly affect BVIT. However, *post hoc* regressions (Table 5) found consistent support for the moderating effect of consideration of IT adoption or use on the relationship between consideration of IT investment and BVIT, thereby indicating that the BVIT may decrease to a lesser extent in studies that examine both IT adoption or use and IT investment compared to studies that examine IT investment but not IT adoption or use. Figure 4, showing the effects of consideration of IT investment on BVIT when IT adoption or use is examined and when it is not, supports this moderating effect. Indeed, when IT adoption or use is considered, consideration of IT investment positively affects BVIT.

Value measures: We expected profitability measures to negatively affect BVIT (H2i) and productivity measures to positively affect BVIT (H2j). These expectations are consistent with the negative effect of profitability-based measures K&D expected and the positive effect of productivity-based measures K&D found. The results show that although BVIT increases when profitability is not examined, the consideration of productivity measures does not affect BVIT.

[21]A significant difference ($|t| = 2.19$, $p < 0.05$) in BVIT was observed between cross-sectional studies (mean = 59.7, SD = 48.2, n = 154) and longitudinal studies (mean = 47.6, SD = 52.7, n = 182).

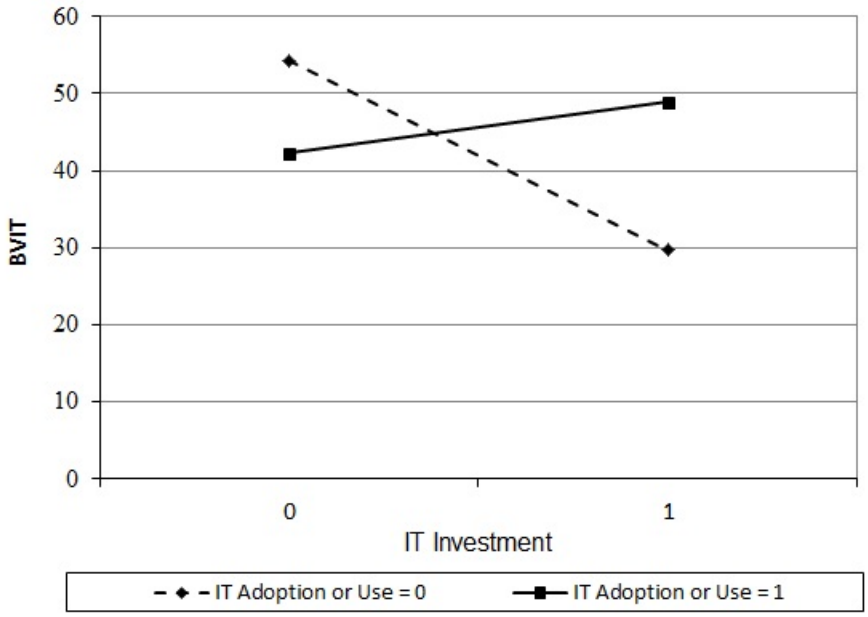


Figure 4. The Moderating Effect of IT Adoption or Use

Value enablers: According to our findings, BVIT has increased over time along with *IT progress* over time. We modeled IT progress using *period eras* that represent various advances and breakthroughs in IT over several decades. We examined IT progress using the mainframe computing era as the baseline and dummy variables for the subsequent three eras: personal computing, network computing, and mobile computing. All three dummy variables are significant and positive. The significant effects of the "later" eras along with the trend depicted in Figure C2 indicate that BVIT has increased over time with IT progress.

However, there is no significant difference in BVIT between developing and developed regions of the world based on the regression results. The *post hoc* regression analyses (Table 5) found the interaction between developing region and consideration of BVIT to receive inconsistent support. These results should be interpreted with caution[22] due to the low sample size for developing regions (n = 58).

Consideration of IT potential: The moderating effect of IT potential on the relationship between IT investment and BVIT is partially supported. Whereas the consideration of IT sophistication (H3a) does not show support for moderation effects, the consideration of IT alignment (H3b) and interorganizational IT (H3c) exert positive effects on the relationship between the consideration of IT investment and BVIT. These findings suggest that IT alignment generally increases the effect of IT investment on BVIT. Since the direct effect of IT investment on BVIT is negative (i.e., studies that did not examine IT investment demonstrated BVIT to a greater degree), the impact of IT alignment indicates that BVIT may decrease to a lesser extent in studies that examined IT alignment compared to studies that did not examine IT alignment. The left panel of Figure 5, showing the effects of consideration of IT investment on BVIT when IT alignment is considered and when it is not, supports this moderating effect. In studies that consider IT alignment, the slope of the line for the relationship between consideration of IT investment and BVIT is less negative compared to studies that do not consider IT alignment. This is as expected because greater IT alignment implies that IT investments are more appropriately targeted by the organization.

We found that interorganizational IT moderated the effects of IT investment on BVIT, which implies that BVIT may decrease to a lesser extent in studies that examined interorganizational IT compared to studies that did not examine interorganizational IT. The right panel of Figure 5, showing the effects of consideration of IT investment on BVIT when interorganizational IT is examined and when interorganiza-

[22] *Post hoc* analysis reveals no significant difference (|t| = 1.42) between BVIT for studies in the developing regions (mean = 61.8, SD = 48.5, n = 58) and for studies in the developed regions (mean = 51.4, SD = 51.4, n = 278).

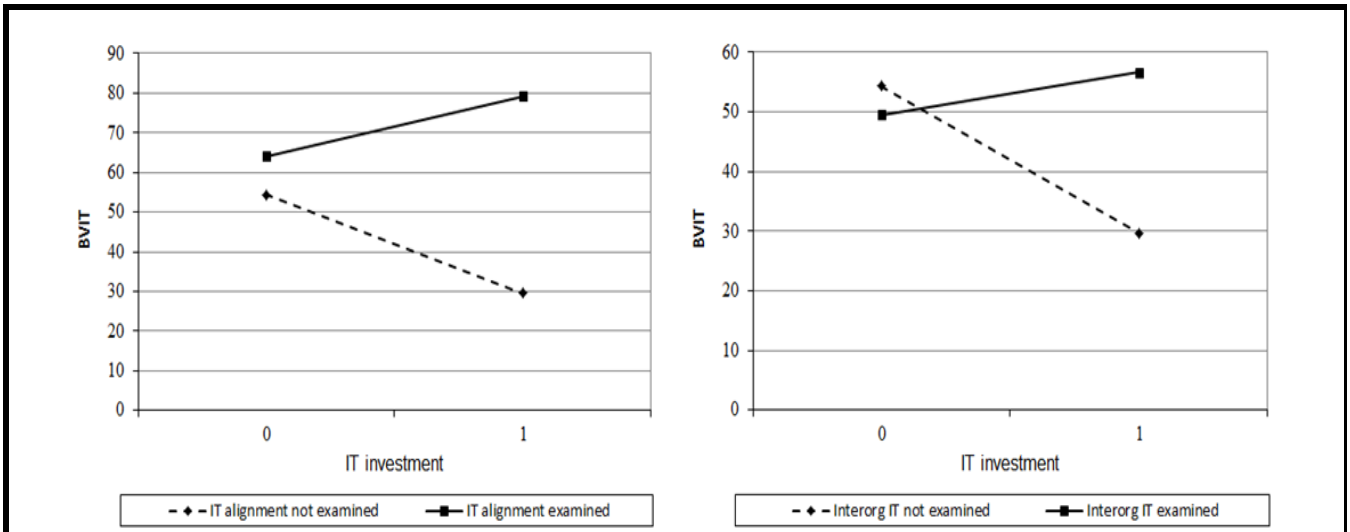


Figure 5. The Moderating Effects of IT Potential

tional IT is not examined, supports this moderating effect. In studies that focus on interorganizational IT, the slope of the line for the relationship between consideration of IT investment and BVIT is less negative compared to studies that do not focus on interorganizational IT. Indeed, in studies that focus on interorganizational IT, BVIT increases with consideration of IT investment.

Theory: Consistent with the TOE framework, we examined the effects of the technological, organizational, or environmental theories that informed the original study. We proposed nondirectional hypotheses for the moderating effects of the use of these theories on the relationship between the consideration of IT investment and BVIT. The results show that the use of environmental theories weakens the effect of the consideration of IT investment on BVIT. That is, studies that do not rely on environmental theories may find a stronger relationship between consideration of IT investments and BVIT, which may mean that studies informed by technological and organizational theories have a greater likelihood to demonstrate a link between IT investment and BVIT.

Our results also suggest that studies that do not use organizational theories find greater BVIT, although the direct effect for the use of technological theories is nonsignificant across all models and the direct effect for the use of environmental theories is positive and significant in only 4 of the 11 models (Models 2–12). Along with the other findings regarding the considerations IT alignment, interorganizational IT, IT adoption or use, these results seem to suggest that studies that aim to theorize research by appealing to the linkages between IT and the organizational and interorganizational contexts may be more likely to demonstrate BVIT rather than studies that rely primarily on organizational theories. However, these conclusions should be treated as tentative and need to be investigated further.

Limitations

The findings of our study should be interpreted in the light of its limitations. First, it focuses on quantitative empirical studies while excluding qualitative case studies, simulations, meta-analyses, and conceptual articles. Although such exclusions are due to the requirements of meta-analytic methods, this nevertheless implies a limited view of the BVIT literature.

Second, we were unable to test a complete structural model of relationships because the coding scheme for our meta-analysis largely resulted in binary variables that are not conducive to structural equation modeling techniques. Consequently, we could not allow for interdependence among the independent variables beyond the interaction effects.

Third, we examined the interaction effects of the consideration of IT investment on BVIT with several variables but not the interaction effects among those variables. For example, we did not examine the nine interactions between the theories and the period dummies in our analyses. Such interactions were excluded due to sample size constraints, the focus of the research, and space considerations, but can be considered as potential avenues for future research.

Finally, the analysis is based on data coded from prior studies. As with any meta-analysis, it was not possible to obtain all of the relevant data from all studies, which resulted in some approximations in our coded data. As an example, prior studies did not always report the year to which the data belonged or the year in which the data was gathered. In such cases, we used the year the paper was submitted for publication as the proxy.

Implications for Research

Despite its limitations, this study offers several implications for future research. First, the results provide some insights that may help in designing future studies. They highlight the importance of using richer primary data, longitudinal designs, and larger samples. They also demonstrate the merits of conducting more focused studies with fewer IT-based independent variables and fewer dependent variables. In this respect, the results show the more recent BVIT research in a positive light, with decreasing numbers of independent and dependent variables (Figure C3). It seems that the literature may be progressing toward better BVIT measures.

Second, this study reiterates the need for caution in evaluating the impacts of IT investments. Examining IT investment alone may not help discern whether the IT is of good quality and relevant to the organization, whether the IT is adopted or used effectively by the organization, or whether the IT enables the organization to perform better. Furthermore, this study highlights the importance of considering alignment, interorganizational IT, and IT adoption or use when examining the effects of IT investment. These three aspects enhance the relationship between the consideration of IT investment and BVIT.

Third, the considerations of IT sophistication, IT assets, and infrastructure or capability neither affect BVIT nor moderate the relationship between the consideration of IT investment and BVIT. IT assets and IT infrastructure or capability represent intermediate stages between IT investment and firm performance whereas IT sophistication indicates the firm's ability to leverage the IT investment. Further research is needed to examine their effects. The effects of these process aspects may be easier to detect in qualitative studies, which were excluded from the meta-analysis in this study due to their not reporting quantitative results. Future research may benefit from directly examining such intermediate stages within the same quantitative or qualitative study to better understand their effects on BVIT.

Fourth, the use of profitability measures negatively affects BVIT. As previously argued by Kohli and Devaraj (2003), profitability measures may be influenced by other factors (e.g., strategy), making it difficult to discern the impacts of IT investments. Moreover, the independent and dependent variables seem to have evolved over time from predominantly financial measures to nonfinancial measures focusing on firm performance (Figure C4). However, the results indicate that the use of productivity measures does not affect BVIT. Additional research is needed to further compare the effects of IT investment on alternative value measures in the light of the negative effect of profitability measures and the nonsignificant effect of productivity measures, which is somewhat different from K&D's findings of a nonsignificant effect of profitability measures but a positive effect of productivity measures.

Fifth, the use of organizational theories has a consistent negative and significant effect on BVIT whereas the use of environmental theories has a significant negative moderating effect on the relationship between the consideration of IT investment and BVIT. However, further research is needed to better understand the effects of alternative theoretical bases for research on BVIT. Although theories inform the research models and designs, they also constrain the research by placing focus on selected aspects of IT and organizations, which could be a potential reason for the disparity in findings related to BVIT.

Finally, this study provides inconsistent results for the effect of the economic region. We had expected studies set in developed regions to find greater BVIT than studies set in developing regions but the results do not support this hypothesis. When we examined the moderating effect of developing region on the relationship between the consideration of IT investment and BVIT, two of the five regressions (Table 5) indicated that studies that examined data from developed regions found greater effect of consideration of IT investment on BVIT. Moreover, BVIT seems to be increasing faster in studies in developing regions. These observed effects of economic region are tentative and need to be investigated in future research.

Implications for Practice

This study also provides some potentially useful insights for senior business and IT executives. First, it offers encouraging news to senior IT executives. The results reiterate the positive and significant nature of BVIT.[23] Moreover, BVIT has

[23] For each study, we computed positive (negative) BVIT relationships using the number of positive (negative) relationships between IT-related independent variables and BVIT as a percentage of total relationships between IT-related independent variables and BVIT in the study. Across the 336 samples in our study, significant differences ($|t| = 19.1$, $p < 0.01$) were found in BVIT for positive relationships (mean = 60.7, SD = 40.3) and negative relationships (mean = 7.6, SD = 19.8).

been increasing over time with progress in IT as found graphically (Figure C2) as well as through all the regression models. Together, the positive and increasing value of BVIT should provide senior IT executives with further evidence in building internal support for IT. Senior business and IT executives can be further encouraged by the apparent trend that BVIT seems to be increasing in both developing and developed regions, although more quickly in developing regions (Figure C6), indicating that they may be catching up with the developed regions.

Second, the results indicate that senior IT and business executives should not focus on IT investment alone but pay close attention to aspects that reflect how well the organization is able to convert IT investments into performance gains. Specifically, they should focus on (1) aspects that indicate how the IT investments are deployed such as IT alignment (e.g., between business and IT strategies) and interorganizational use of IT and (2) aspects that reflect the process from investment to performance, such as IT adoption and use. This recommendation is consistent with some prior calls to consider complementary assets (Devaraj and Kohli 2002; Kohli and Devaraj 2004) and take a process view of IT investments, wherein intermediate steps, such as adoption and use, are explicitly considered (Devaraj and Kohli 2002; Kohli and Devaraj 2004; Soh and Markus 1995). It also shows the recent BVIT literature in good light, marked by the increasing focus on IT capability, IT alignment, and IT use (Figure C4).

Third, the results indicate that when examining the contributions of IT to their firms, senior IT and business executives should focus on performance and capabilities rather than financial measures. Financial, profitability-based measures may be given lesser attention when evaluating the impacts of IT because they may be affected by other factors such as competing environments and customers (Kohli and Devaraj 2003). Instead, executives may attribute greater importance to non-profitability measures that focus on organizational operations such as inventory turnover, capacity utilization, and value added to better understand BVIT. Again, the recent trends in BVIT studies highlight the maturing of the field, with firm performance being the more common dependent variable in recent times departing from the earlier focus on ROA.

Finally, the results indicate that when evaluating the impacts of IT, senior and IT executives should seek richer insights into the firm's specific circumstances. To that end, they should focus on fewer variables representing IT characteristics constituting IT investment, IT alignment, and interorganizational nature of IT. Based on our findings, IT investments that are aligned with an organization's strategies and structures and that support interorganizational activities yield greater business value. In estimating BVIT, executives may attach greater importance to data from their own firms rather than other firms' experiences or secondary data about BVIT. Moreover, they should examine data over time and consider multiple perspectives in estimating BVIT rather than rely on insights from one point in time or from one perspective.

Conclusions

Seeking to advance our understanding of factors affecting BVIT, this study has examined (1) the direct effects of the consideration of IT investments on observed BVIT, (2) the direct effects of the study's methodological attributes, value generation, value measures, and value enablers on observed BVIT, and (3) the moderating effects of IT potential and theory on the relationship between consideration of IT investments and observed BVIT. Our results indicate that the observed BVIT is greater when IT investment is not explicitly considered or profitability measures are not used. We find that the observed BVIT has increased over time and that it depends on study attributes. Our results also indicate that studies which consider IT adoption or use, IT alignment, and interorganizational IT find a more positive relationship between the consideration of IT investment and BVIT. Surprisingly, the use of productivity measures, the consideration of IT assets, IT infrastructure or capability, IT sophistication, and the economic region of the firms in the study do not affect BVIT. We hope the results of this study provide some insights into BVIT and motivate further research in the area.

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RESEARCH ARTICLE

INFORMATION TECHNOLOGY IMPACTS ON FIRM PERFORMANCE: AN EXTENSION OF KOHLI AND DEVARAJ (2003)

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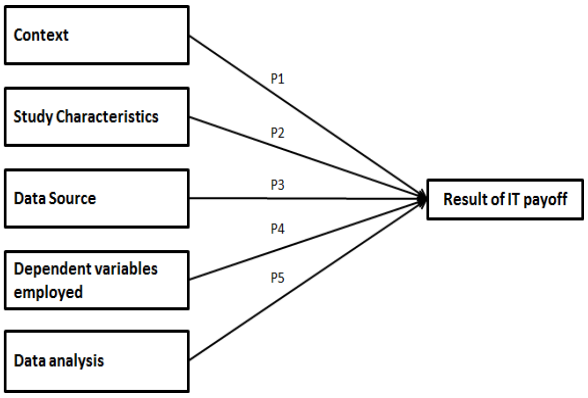
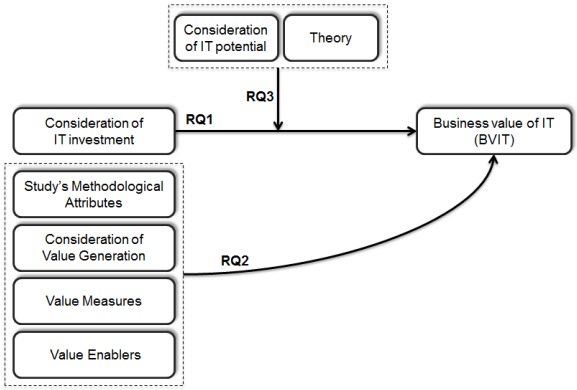
Appendix A

Further Comparison of Kohli and Devaraj (2003) and the Present Study

	Kohli & Devaraj (2003)	The Present Study
Model	 **P1**. Context represents manufacturing versus service sector **P2**. Study characteristics represents sample size **P3**. Data source represents primary versus secondary data **P4**. Dependent variables employed represents profitability versus productivity or both **P5**. Data analysis represents analytical approach (regression versus correlation analysis, as **P5A**), method (longitudinal versus cross-sectional, as **P5B**), and level of detail (IT assets and IT impacts, as **P5C**)	 **RQ1**: Consideration of IT investment represents whether the study measured IT investment **RQ2**: *Study's methodological attributes*: Sample size (**P2** in K&D); Secondary versus primary data (**P3** in K&D); Regression versus others (**P5A** in K&D); Number of IT-based antecedents; and Number of dependent variables. *Consideration of value generation*: IT assets (**P5C** in K&D); IT adoption or use; and IT infrastructure or capability *Value measures*: Profitability (**P4** in K&D) and Productivity *Value enablers*: IT progress and Developing region **RQ3**: Moderating effects *Consideration of IT potential* represents: IT sophistication, IT alignment, and Interorganizational IT *Theory*: Technological, Organizational, or Environmental theories *Note:* **P1** and **P5B** in K&D are excluded from this study.
Studies	66	303 (generating 336 samples/findings)
Period	1990–2000	1990–2013

Appendix B

Dependent and IT-Related Independent Variables in the Meta-Analysis Sample

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Floyd & Wooldridge (1990)		C-P	ROA	Product IT use, Process IT use	50.00
Venkatraman & Zaheer (1990)		L-P	Commissions, Effectiveness (# of premiums), Efficiency (# of policies), New Business Policies	IT integration	100.00
Weill (1990)		L-P	ROA, Labor productivity, Sales growth	Strategic IT investment	11.11
*Harris & Katz (1991)		L-S	Operating cost efficiency ratio	IT expense	100.00
*Weill (1992)		L-P	ROA, Labor, % change in labor, Sales growth	IT investment	0.00
*Ahituv & Giladi (1993)		L-S	Revenue per employee, Profits increase	IS budget, Staff budget, Training, Relative value of computers, PCs/employee	-10.00
Dos Santos et al. (1993)		L-S	CAR	IT investment	0.00
Mahmood (1993)		C-S	ROS, Sales/assets, Sales/employee, ROI, market value to book value, Dividend payout ratio, Total debt to equity, Working capital/ net sales, Cash flow to investment, Growth in revenue	IT budget, IT budget (revenue), IT budget (training), IT budget (staff), IT value, IT value (% revenue), Total # of PCs and terminals, # of PCs and terminals (as % of total employees)	40.00
*Mahmood & Mann (1993)		C-S	ROS, ROI, Market to book value, Sales by assets, Sales by employee, Growth in revenue	IT budget (% revenue), IT value (% revenue), IT budget (staff), IT budget (training), PCs per employee	-6.67
*Markus & Soh (1993)	1	L-S	Profitability	IT expenditure, IT portfolio	-50.00
	2	L-S	Profitability	IT expenditure, IT portfolio	0.00
	3	L-S	Profitability	IT expenditure, IT portfolio	0.00
	4	L-S	Profitability	IT expenditure, IT portfolio	0.00
*McKeen & Smith (1993)		L-S	Revenue growth	IS dollars per employee, Production hours	50.00
Sethi et al. (1993)		L-S	ROE, ROS, Sales growth	IT adoption	75.00
Brynjolfsson et al. (1994)		L-S	Value added, Sales	IT investment	-60.00
*Kelley (1994)		C-P	Production hours per unit	Programmable versus Conventional machines	100.00
*Loveman (1994)		L-S	Output	IT capital	-100.00
*Strassman (1994)		L-S	Return on Management	IT expense / revenue ratio	-100.00

[a]Studies included in Kohli and Devaraj (2003) are marked using an asterisk. The studies are sorted in the order of the year of publication, with studies published in the same year being listed in alphabetical order.
[b] Glossary of acronyms available at the bottom of the table.
[c] Where the same publication reported results for multiple samples, the results for each sample are shown in separate rows in this table, with the specific sample for each study identified in the "Sample" column.
[d] L – Longitudinal data; C – Cross-sectional data; P – Primary data source; S – Secondary data source.

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
*Barua et al. (1995)		L-S	Inventory Turnover, Capacity utilization, New products, Relative quality	IT capital	75.00
Brown et al. (1995)		L-S	ROA, ROS, Asset turnover, Inventory turnover, A/R turnover, Sales/employee, Income/employee, % change in sales	Strategic IS use	21.15
*Kivijarvi & Saarinen (1995)		C-P	Profitability, Funding position, Growth	IS cost/net sales, IS cost/employee, IS cost/office worker	11.11
*Kwon & Stoneman (1995)		L-S	Output	Technology adoption	100.00
*Lichtenberg (1995)		L-S	Revenue	Computer capital stock, # of IS employees	100.00
*Lubbe et al. (1995)		L-P	Profitability	IT investment	100.00
Mukhopadhyay et al. (1995)		L-P	Inventory turnover	EDI %	100.00
Ramamurthy (1995)		C-P	Performance	AMT (for efficiency), AMT (for flexibility)	100.00
*Rao et al. (1995)		C-P	Performance	Implementation	0.00
*Brynjolfsson & Hitt (1996)		L-S	Sales	Computer capital, IS staff	100.00
*Chen (1996)		C-S	EPS, ROS, ROA, ROE, Labor productivity - sales, Labor productivity - profit, Profit growth, Sales growth	IT budget, IT personnel	-6.25
Dos Santos et al. (1996)		L-S	ROI	IT expenses, IT budget	37.50
*Hitt & Brynjolfsson (1996)		L-S	ROA, ROE, Total return, Value added	IT stock	25.00
*Mayberry-Stewart (1996)	1	L-S	$ cost per patient discharge	IT investment intensity, IT automation intensity	-50.00
	2	L-S	$ cost per patient discharge	IT investment intensity, IT automation intensity	0.00
Mitra & Chaya (1996)		L-S	COGS/Sales, SGA/Sales	IT budget/ sales	100.00
*Peffers & Dos Santos (1996)		L-S	Performance, Market share	Adoption	43.75
*Rai et al. (1996)		L-S	ROA, ROE, Asset turnover, Labor productivity, Sales, Market share	IS budget	50.00
Rogers et al. (1996)		C-P	Cycle time reduction, Productivity improvements, Reduced waste, Reduced costs, Reliability of service, Customer satisfaction, Quality improvements	IT use	42.86
*Stoneman & Kwon (1996)		L-S	Sales	Computer adoption	100.00
*Alshilash (1997)		C-P	Overall performance	Managers' IT knowledge, Subordinates' IT knowledge	100.00
Barua & Lee (1997)		L-S	Output	IT capital	100.00
*Byrd & Marshall (1997)		L-S	Sales/total assets, Sales/employee	IT budget (staff), IT budget (training), IT processor value (% of revenue), IT budget (% of revenue), # of PCs and terminals	-20.00
Chan et al. (1997)		C-P	Business performance	IT alignment	100.00

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
*Mahmood & Mann (1997)		L-S	Performance	IT budget (revenue), IT budget (training), IT budget (staff), Market value of IT (% of revenue), Proportion of PCs and terminals to employees	80.00
*Mukhopadhyay et al. (1997)	1	L-P	Labor hours	Simple transactions, Complex transactions	100.00
	2	L-P	Total sorting performed	Level of automation	100.00
Powell & Dent-Micallef (1997)		C-P	Profitability, Sales growth, IT performance, Overall performance	IT resources	25.00
*Prasad & Harker (1997)		L-S	ROA, ROE, Output (Loans + Deposits), Output (Revenues)	IT capital, IT labor	25.00
*Prattipati & Mensah (1997)		C-S	Management productivity	IS budget, % of budget on new development, % of budget on client server apps, % of budget spent outside IS department, IS employees, PCs, Network	0.00
*Rai et al. (1997)		C-S	ROA, ROE, Value, Labor productivity, Administrative productivity, Sales	IT capital, IT budget, IS staff	50.00
Shin (1997)		L-S	Value added, Coordination costs, Sales	IT budget	33.33
*Siegel (1997)		L-S	Productivity growth	Computer expenditure	100.00
*Wang (1997)		C-P	Revenue growth rate	IT spending, IT use	100.00
*Francalanci & Galal (1998)		L-S	Operating expense to premium income, Income per employee	IT expense	0.00
*Grover et al. (1998)		C-P	Productivity	IT diffusion	100.00
*Lehr & Lichtenberg (1998)		L-S	Growth rate of output	IT capital	100.00
Sakaguchi & Dibrell (1998)		C-P	Cycle time reduction	Degree of computerization (IT investment), GLITS	100.00
*Tam (1998a)	1	L-S	Output	Computer capital	0.00
	2	L-S	Output	Computer capital	100.00
	3	L-S	Output	Computer capital	0.00
*Tam (1998b)	1	L-S	ROE, ROA, ROS, Total shareholder return, Market value	Computer capital	0.00
	2	L-S	ROE, ROA, ROS, Total shareholder return, Market value	Computer capital	60.00
	3	L-S	ROE, ROA, ROS, Total shareholder return, Market value	Computer capital	40.00
	4	L-S	ROE, ROA, ROS, Total shareholder return, Market value	Computer capital	-20.00
*Teo & Wong (1998)		C-P	Organizational impact	Intensity of IT investment, Information quality	50.00
*Van Asseldonk et al. (1998)		L-S	Production (Milk), Production (Protein), Production (Fat), Calving Interval	ACF, MPM, AM	25.00
*Xia (1998)		C-P	Organizational performance	IT capability, IT alignment	100.00
*Bharadwaj et al. (1999)		L-S	Tobin's q	IT spending ratio	100.00
*Cline (1999)		L-P	Net income/employee, Net income/revenue mile	IT investment	100.00
Dasgupta et al. (1999)	1	C-S	Net income	IT budget, IT employees	-100.00
	2	C-S	Net income	IT budget, IT employees	-100.00
Johannessen et al. (1999)		C-P	Productivity	13 IT use variables	7.69

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
*Koski (1999)		L-P	Labor productivity, Total factor productivity, Revenues	Use of technology	0.00
*Lee & Barua (1999)		L-S	Productivity	IT capital	100.00
Lehr & Lichtenberg (1999)	1	L-S	Inventory/Sales, Sales	IT%	0.00
	2	L-S	Inventory/Sales, Sales	IT%	0.00
*Li & Ye (1999)		L-S	ROA, ROS	IT investment	0.00
Smith (1999)		C-P	Performance	IT use	100.00
*Barua et al. (2000)	1	C-S	Sales per employee, Sales	IT capital	100.00
	2	C-S	Sales per employee, Sales	IT capital	0.00
Bharadwaj (2000)		L-S	ROA, ROS, COGS/Sales, SGA/Sales, OI/Sales, OI/Assets, OI/Expenses, Op Exp/Sales	IT use	62.50
*Devaraj & Kohli (2000)		L-P	Net patient revenue per day, Net patient revenue per admission, Customer satisfaction	IT capital, IT labor, IT support	55.56
Droge & Germain (2000)		C-P	Performance, Inventory	EDI (% of sales, purchases)	100.00
*Haynes & Thompson (2000)		L-S	Labor productivity	ATM adoption	100.00
Krishnan & Sriram (2000)		C-S	Market value/ book value	Y2K cost	100.00
Lee & Menon (2000)		L-S	Adjusted patient days	IT labor, IT capital	0.00
*Lee & Perry (2000)		L-S	Output	IT stock	100.00
*Menon et al. (2000)		L-P	Adjusted patient days	IT capital, Medical IT capital	100.00
Palmer & Markus (2000)		L-P	Profitability, Stock turn, Sales per square foot, Sales per employee, Sales growth	QR adoption and use	80.00
Poston & Grabski (2000)		L-S	Residual Income, SGA/Revenues, COGS/Revenues, Number of employees/ Revenues	ERP implementation	-16.67
*Ragowsky et al. (2000)		C-P	Overall benefit	Avg # of purchase orders, Avg # of sales transactions	0.00
Schwager et al. (2000)		C-P	ROS	IT factors	100.00
Sircar et al. (2000)		L-S	Assets, Equity, Net income, Sales	IT staff, IT staff training, Computer capital, PCs per employee	75.00
Stratopoulos & Dehning (2000)		L-S	ROA, ROE, ROI, Operating profit margin, Net profit margin, Gross profit margin, Fixed asset turnover, Total asset turnover, Inventory turnover, Growth in sales	IT use	18.00
Tallon et al. (2000)		C-P	Process planning and support, supplier relations, production and operations, product and service enhancement, sales and marketing, customer relations	Strategic alignment	100.00
Andersen & Segars (2001)		L-P	Performance	IT use	0.00
Bergeron et al. (2001)		C-P	Performance	Strategic IS use	100.00
Chatterjee et al. (2001)		L-S	Cumulative abnormal return	CIO adoption	100.00
Croteau (2001)		C-P	Organizational performance	IT alignment	50.00
Duliba et al. (2001)		L-S	Load factor, Operating profit, Revenue per passenger mile	System locations	66.67
Gold et al. (2001)		C-P	Organizational effectiveness	KM capability	100.00

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Hu & Plant (2001)	1	L-S	ROA, ROE, Operating cost, Productivity, Growth in sales	IT investment	-6.67
	2	L-S	ROA, ROE, Operating cost, Productivity, Growth in sales	IT investment	26.67
	3	L-S	ROA, ROE, Operating cost, Productivity, Growth in sales	IT investment	13.33
Im et al. (2001)		L-S	AS CAR	IT investment	0.00
Lesjak & Cohen (2001)		C-P	Financial performance	IT usage	100.00
Sabherwal & Chan (2001)	1	C-P	Business performance	Alignment	100.00
	2	C-P	Business performance	Alignment	100.00
Shin (2001)		L-S	Net profit, ROA, ROE	IT intensity	0.00
Baldwin & Sabourin (2002)		L-S	Productivity growth, Market share growth	Technology use	50.00
*Bresnahan et al. (2002)		L-P	Value added	IT stock	100.00
Davis et al. (2002)		C-P	Cycle time	Role of Strategic IT	100.00
Hitt et al. (2002)		L-S	Market value, value added, COGS, Sales, Output, Pretax income	ERP implementation	100.00
Konings & Roodhooft (2002)		C-P	Output	Selling online, Buying online	50.00
Kudyba & Diwan (2002)		L-S	Value added, Sales revenue	IT capital, IT labor	83.33
Ross (2002)		C-S	ROA, Operating income before depreciation, Net income, Labor productivity, Administrative productivity, Working capital, Revenue	IT budget, IT staff, IT sophistication	42.86
Sanders & Premus (2002)		C-P	Cost reduction, Cycle time reduction, Improved quality	IT use	100.00
Zhu & Kraemer (2002)	1	C-P	Profit margin, COGS, Inventory turnover	Alignment (EC*IT)	0.00
	2	C-P	Profit margin, COGS, Inventory turnover	Alignment (EC*IT)	66.67
Becchetti et al. (2003)		L-S	Capacity utilization, Sales	ICT investment	0.00
Byrd & Davidson (2003)		C-P	Firm performance	IT impact on supply chain	100.00
Dehning et al. (2003)		L-S	Mean cumulative abnormal return	IT role	33.33
*Devaraj & Kohli (2003)		L-P	Net patient revenue per day, Net patient revenue per admission	IT use (# of reports), IT use (CPU time), IT use (Disk I/O)	100.00
Drennan & McColl-Kennedy (2003)		C-P	Performance	Internet use	100.00
Kearns & Lederer (2003)		C-P	Competitive advantage	Alignment (IT versus BP), Alignment (BP versus IT)	50.00
Kudyba & Vitaliano (2003)		L-S	Gross operating margin	IT rate	66.67
Peslak (2003)	1	C-S	ROA, ROE, ROI, Tobin's q	IT budget	-50.00
	2	C-S	ROA, ROE, ROI, Tobin's q	IT budget	0.00
	3	C-S	ROA, ROE, ROI, Tobin's q	IT budget	-25.00
		C-P	ROA, ROE, Growth in revenue	IS budget, Technological integration, Functional integration, Strategic integration	100.00
Pollalis (2003)		C-P	ROA, ROE, Growth in revenue	IS budget, Technological integration, Functional integration, Strategic integration	100.00
Santhanam & Hartono (2003)		L-S	ROA, ROS, OI/A, OI/S, OI/E, COG/S, SGA/S, Op Exp/S	IT capability	100.00
Sriram & Krishnan (2003)		L-S	MV/ book value	IT/ book value	100.00
Tippins & Sohi (2003)		C-P	Performance	IT competency	0.00

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Vickery et al. (2003)		C-P	Financial performance	IT use	0.00
Barua et al. (2004)		C-P	Performance	IT capability (customers), IT capability (suppliers)	100.00
Bergeron et al. (2004)		C-P	Profitability, Sales growth	IT alignment	100.00
Chen et al. (2004)		L-S	COGS/Revenues, COGS/Sales, SGA/Revenues, SGA/Sales	KM adoption	25.00
Kim & Davidson (2004)		L-S	Profit, Total expenses, Payroll expense, Operating expense, Market share of deposits, Market share of loans, Total revenue	IT expense	-14.29
*Kohli & Devaraj (2004)		L-S	Reimbursement rate	Use of DSS	100.00
Lu & Ramamurthy (2004)		L-S	ROS, ROA, OI/A, OI/S, OI/E, COG/S, SGA/S, OpExp/S	IT capability	31.25
Morikawa (2004)	1	C-P	Profitability	IT use	100.00
	2	C-P	Profitability	IT use	100.00
	3	C-P	Profitability	IT use	0.00
	4	C-P	Profitability	IT use	0.00
	5	C-P	Profitability	IT use	0.00
Nicolaou (2004)		L-S	Delta ROA, delta ROI, delta ROS, delta Operating ROA, delta Operating income/Sales, delta ES, delta SGA/Sales, delta COGS/Sales	ERP adoption	2.50
Osei-Bryson & Ko (2004)		L-S	Adjusted patient days	IT stock	100.00
Shin (2004)		L-S	Tobin's q, ROA	IT budget	50.00
Sriram & Stump (2004)		C-P	Purchasing costs, Purchasing cycle time, Purchasing process improvements	IT investment	0.00
Yaylacicegi & Menon (2004)		L-S	Adjusted patient days	IT capital, Medical IT capital	20.00
Zhu (2004)		C-P	ROA, COGS/employee, Inventory turnover, Sales/employee	IT intensity	50.00
Arvanitis (2005)		C-P	Sales per employee	Internet use, Intranet use	80.00
Bhatt & Grover (2005)		C-P	Competitive advantage	IT infrastructure, IT expertise	50.00
Cao & Dowlatshahi (2005)		C-P	Business performance	Alignment	100.00
Coltman et al. (2005)		C-P	E-business performance	IT know-how, IT infrastructure	100.00
Doms et al. (2005)		L-S	Labor productivity, Labor productivity growth	IT share of total investment	50.00
Hales (2005)		C-P	Organizational performance	Degree of B2B implementation	0.00
Hempell (2005)		L-S	Value added	ICT capital	100.00
Huang (2005)		L-P	Output	IT capital, Computer employees	0.00
Huang & Liu (2005)		C-S	ROA, ROS	IT capital	0.00
Kim (2005)	1	L-S	Gross profit, ROA, ROI, EBITDA, Inventory Turnover, net cash flow	Structural IT investment, social IT investment, community IT investment, human IT investment	4.17
	2	L-S	Gross profit, ROA, ROI, EBITDA, Sales per employee, net cash flow	Structural IT investment	50.00
Kraemer et al. (2005)		C-P	Efficiency, Coordination, Market	B2B use, B2B use	100.00
Li (2005)		C-P	Market performance	IT use	100.00
Lu (2005)		C-P	Profit, cost, internal performance, market performance	IT budget, IT knowledge capability	62.50

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Ravichandran & Lertwongsatien (2005)		C-P	Firm performance (ROS), Firm performance (ROA), Firm performance (sales growth), Firm performance	IT capability	0.00
Ray et al. (2005)		C-P	Process performance	IT spending, IT flexibility, IT alignment (shared knowledge)	33.33
Raymond & St. Pierre (2005)		C-P	Business performance, Operational performance	AMS sophistication	100.00
Sabherwal & Sabherwal (2005)		L-S	Cumulative abnormal return	IT alignment (innovativeness and process), IT alignment (efficiency and process)	50.00
Sanders & Premus (2005)		C-P	Financial performance	IT capability	100.00
Shang & Marlow (2005)		C-P	Financial performance	Info-based capability	0.00
Wang & Chang (2005)		L-S	Performance	Innovation capital, Human capital	0.00
Zhu & Kraemer (2005)		C-P	E-business value	IT integration, IT use	100.00
Anderson et al. (2006)		L-S	Market value	Y2K spending	100.00
Ataay (2006)		C-P	Labor productivity (actual), Labor productivity (perceived)	eCRM use, EDI use, eProcurement use, eComm use, eScorecard use, eProcedure use	-16.67
Atzeni & Carboni (2006)		L-S	Partial price change	ICT capital	100.00
Banker et al. (2006)	1	L-P	Change in quality, change in time to market, change in efficiency	RPS use, OMS use, EDI use	66.67
	2	L-P	Change in cycle time, change in lead time, change in unit manufacturing cost	OMS use, EDI use	100.00
Bardhan et al. (2006)		C-P	COGS, Quality	IT spending	0.00
Byrd et al. (2006)		C-P	Revenue per employee, Profit per employee	Revenue per employee, Sales per employee	100.00
Chan et al. (2006)		C-P	Organizational success	IT alignment	100.00
Chowdhury (2006)		C-P	Internal rate of return, labor intensity and productivity	ICT capital to total capital	0.00
Cotteleer & Bendoly (2006)		L-P	Lead time	ERP implementation	100.00
Davamanirajan et al. (2006)		L-S	Average time to complete request, Productivity: Transactions per employee	Integration with general ledger, integration with funds transfer, % requests initiated electronically	50.00
Duh et al. (2006)		C-P	Performance	Extent of IT application	100.00
El-Mashaleh et al. (2006)		C-P	Profit, schedule performance, cost performance, Customer satisfaction, safety performance	IT index (degree of use)	40.00
Huang et al. (2006)		C-P	ROA, ROS	IT capability	100.00
Ismail & King (2006)		C-P	Performance	IT alignment	100.00
Lee & Kim (2006)		L-S	ROE, ROC, Profit margin, EPS growth, Sales growth	IT investment	40.00
Lee, J. J. (2006)		L-S	ROA, ROE	Hardware rate, Software rate, Training rate, Labor rate	12.50
Lee, J. N. (2006)		C-P	ROA, Sales growth, Outsourcing success	Alignment	100.00
Lin & Tseng (2006)		C-P	Organizational performance	IT application	100.00
Maliranta & Rouvinen (2006)		C-P	Labor productivity	Desktop, Laptop, Desktop w/ LAN, Laptop w/LAN, Desktop w/WLAN, Laptop w/WLAN	100.00
Mashal (2006)		L-S	ROA, ROE, net income, output	IT capital, IS labor	12.50

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Rai et al. (2006)		C-P	Firm performance	IT infrastructure, SCM integration	50.00
Ranganathan & Brown (2006)		L-S	Cumulative abnormal return	ERP adoption	100.00
Sanchez et al. (2006)		C-P	Output/ labor	IT capital	100.00
Sanchez-Rodriguez et al. (2006)		C-P	Operational performance, quality performance	IT for top management, IT for customer relations, IT for supplier relations, IT for workforce management, IT for product design, IT for process flow, IT for quality	85.71
Shin (2006)		L-S	Gross margin, ROA, ROE	IT intensity	-100.00
Stare et al. (2006)	1	L-S	Value added	ICT investment per employee	100.00
	2	L-S	Value added	ICT investment per employee	100.00
Tanrivedi (2006)		L-P	Tobin's q, Treynor ratio, ROS, ROA	IT relatedness	50.00
Wu et al. (2006)		C-P	Financial performance	IT advancement	0.00
Albadvi et al. (2007)		C-P	Performance	IT use	100.00
Aral & Weill (2007)		L-P	ROA, Tobin's q, Net margin, COGS, New products, Modified products	Transactional IT, Informational IT, Strategic IT, Infrastructure IT, IT capability	5.00
Bardhan, Krishnan, and Lin (2007)		C-P	Gross margin, On-time delivery rate	OMS use, EMS use	25.00
Bardhan, Mithas, and Lin (2007)		C-P	Project performance	IT alignment	0.00
Bhansali (2007)		L-P	Value added, gross output	IT stock	100.00
Bharadwaj et al. (2007)		C-P	Manufacturing performance	Integrated IS capability	100.00
Chari et al. (2007)		C-S	Tobin's q	IT investment	100.00
Dehning et al. (2007)		L-S	ROA, ROS, Inventory Turnover	SCM adoption	66.67
Devaraj et al. (2007)		C-P	Performance	Customer integration, supplier integration	50.00
Huang (2007)		C-P	Performance	IT investment, IT use	50.00
Hyvonen (2007)		C-P	Performance	IT use	100.00
Kearns & Sabherwal (2007)		C-P	Organizational performance	Top management in IT planning, IT management in business planning, Top management in resource allocation	100.00
Lai et al. (2007)		C-P	Performance	IT advantage	100.00
Melville et al. (2007)		L-S	Value added	IT capital	100.00
Mishra et al. (2007)		C-P	Performance	Search USE, OIC use	50.00
Neirotti & Paolucci (2007)		L-P	Loss ratio, Net premiums per employee	IT expense / employee	100.00
Oh & Pinsonneault (2007)		C-P	Profitability, Expense, Revenue	Alignment (cost reduction strategy), Alignment (quality improvement strategy), Alignment (revenue growth strategy)	-22.22
Sanders (2007)		C-P	Organizational performance	Use	100.00
Saraf et al. (2007)		C-P	Performance	IS integration (customer), IS integration (partner)	0.00
Shin (2007)		L-S	Tobin's q, ROA, Revenue per employee	IT innovation	66.67

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Tafti et al. (2007)	1	C-S	Productivity	IT use	0.00
	2	C-S	Value added	IT expenditure	100.00
Tallon (2007)		C-P	ROA, ROS, OI/A, COGS/Sales	IT alignment	100.00
Badri & Alshare (2008)		C-P	Profitability	IT capability	100.00
Baker et al. (2008)		L-S	Revenue per bed	IT spending, IT hardware, IT systems, IT personnel	75.00
Buttermann et al. (2008)		C-P	Firm performance	ERP systems, B2B integration, Supply chain analytics	100.00
Byrd et al. (2008)		C-P	ROA, TCO	IT infrastructure	0.00
Chari et al. (2008)		C-S	Tobin's q	IT investment	100.00
de Mendonca et al. (2008)		L-P	Labor productivity (VTI/PO)	IT tools adoption	100.00
Dibrell et al. (2008)		C-P	firm performance	IT investment	100.00
Jeffers et al. (2008)		C-P	Firm performance	IT applications	100.00
Kobelsky et al. (2008)		L-S	ROS, ROA	IT budget	100.00
Lee (2008)		L-S	ROA, ROE	Hardware rate, Software rate, Training rate, Labor rate	-37.50
Lin et al. (2008)		C-P	Firm performance	IT resources	100.00
Loukis & Sapounas (2008)		C-P	Value added	Computer capital	100.00
Neirotti et al. (2008)	1	L-P	SCA_ROA	IT adoption	0.00
	2	L-P	SCA_ROA	IT adoption	0.00
	3	L-P	SCA_ROA	IT adoption	0.00
	4	L-P	SCA_ROA	IT adoption	-100.00
Prasad & Heales (2008)		L-P	ROA, ROE, ROS, Labor cost/sales, Operating expense/sales, Selling and general expense/sales, Sales/total assets, Sales revenue/employee	IT investment, IT training, IT human resources, IT infrastructure	9.38
Radhakrishnan et al. (2008)		L-S	ROA, ROS, ROE, Altzman Z score	IT capability	43.75
Wang et al. (2008)		L-S	Delta ROA, delta ROI, delta ROE	IT capability	53.33
Chen et al. (2009)		C-P	Financial performance	IT capability	0.00
Dong et al. (2009)		C-P	Process performance	IT integration	100.00
Gaith et al. (2009)		C-P	Firm performance	IT investment, IT use, IT effectiveness	66.67
Ghosal & Nair-Reichert (2009)		L-S	Labor productivity	IT investment (digital)	100.00
Goeke & Faley (2009)		L-S	Profitability improvement, Inventory reduction	SAP adoption	50.00
Macher & Mowery (2009)		L-P	Cycle time, Yield (defect density)	IT adoption	100.00
Menon et al. (2009)		L-S	Labor productivity, Adjusted patient days	Clinical IT, Admin IT	-3.13
Ravichandran et al. (2009)		L-S	ROA, Tobin's q	IT intensity	-50.00
Ray et al. (2009)		L-S	COGS/Sales, SGA/Sales	IT budget	100.00
Sircar & Choi (2009)		L-S	Output	IT capital, IT labor	100.00
Tatari (2009)		C-P	Operational benefits	CEIS integration	0.00
Tugas (2009)		C-S	ROA, ROE, EPS	IT maturity	0.00

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Yao, Dresner, and Palmer (2009)		C-P	Order processing cost reduction (suppliers), Order processing cost reduction (customers), Inventory reduction	BSIT adoption (with supplier), BSIT adoption (with customer)	50.00
Yao, Sutton, and Chan (2009)		L-S	ROI, ROE, ROA, ROS, EVA	IT spending	66.67
Benitez-Amado et al. (2010)		C-P	Firm market performance	Technological IT resources, Managerial IT resources	0.00
Bhatt et al. (2010)		C-P	Competitive advantage	IT infrastructure flexibility	0.00
Chang & Wong (2010)		C-P	Firm performance	IT adoption	100.00
Ordanini & Rubera (2010)		C-P	Firm performance	IT capability	100.00
Panjamapirom (2010)		C-P	Financial performance, Productivity-relative work units	IT adoption	50.00
Rai & Tang (2010)		C-P	Competitive advantage	Alignment	100.00
Ramirez et al. (2010)		L-S	Market value, Value added	IT capital	100.00
Vijayasarathy (2010)		C-P	Supply chain performance	Technology use	100.00
Walsh et al. (2010)		C-P	Sales	IT use	100.00
Wu & Chuang (2010)		C-P	Financial performance, Non-financial performance	IT adoption	100.00
Yao et al. (2010)		L-S	Labor productivity, Administrative productivity	IT spending	100.00
Cao & Hoffman (2011)		C-P	Business performance	IT alignment	0.00
Chatzouglou et al. (2011)		C-P	Firm performance	IT alignment	100.00
DeGroote (2011)		C-P	Performance	IT use	100.00
Dewan & Ren (2011)		L-S	Return	IT stock	0.00
Ho et al. (2011)		L-S	ROA	IT investment	100.00
Leckson-Leckey et al. (2011)		L-P	ROA, ROE	IT expense	100.00
Mithas et al. (2011)		L-S	Firm performance	IT capability	100.00
Park (2011)		C-P	Firm performance	IT capability	0.00
Tallon & Pinsonneault (2011)		C-P	Firm performance	IT flexibility, IT alignment	50.00
Trainor et al. (2011)		C-P	Organizational performance	e-marketing capability	100.00
Antheaume et al. (2012)		L-S	EBITDA, Operational expenses, Sales	Internal integration, External integration	66.67
Aral et al. (2012)		L-P	Sales	IT adoption	0.00
Ayabakan et al. (2012)		L-S	Gross margin	IT spending	100.00
Benitez-Amado & Walczuch (2012)		C-S	Firm performance	IT capability	0.00
Bloom et al. (2012)	1	L-S	Gross output per employee	IT capital per employee	100.00
	2	L-S	Gross output per employee	IT capital per employee	100.00
Campbell (2012)		L-S	ROS, OI/A, COGS/Sales	IT investment intensity	13.33
Chang & Gurbaxani (2012a)	1	L-S	Value added	IT capital	100.00
	2	L-S	Value added	IT capital	0.00
Chang & Gurbaxani (2012b)	1	L-S	Efficiency	IT intensity, IT knowledge	50.00
	2	L-S	Efficiency	IT intensity, IT knowledge	0.00
Chen & Tsou (2012)		C-P	Firm performance	IT capability	0.00

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Chen (2012)		C-P	Firm performance	Human IT resource, technological IT resource	100.00
Evangelista et al. (2012)		C-P	Firm performance	IT adoption	33.33
Hah & Bharadwaj (2012)		L-S	Financial performance, Adjusted patient days, Adjusted discharges	HIT capital, IT use	100.00
Hung et al. (2012)		L-S	ROA, ROE, Net income ratio, Operating income ratio	ATM investment	100.00
Kleis et al. (2012)		L-S	Patents	IT capital	100.00
Kmieciak et al. (2012)		C-P	Income growth, Profitability growth, firm performance	IT expertise, IT alignment, IT use	0.00
Kohli et al. (2012)		C-S	Tobin's q, ROA, Operating income, Total net income, Market value	IT investment	40.00
Li & Huang (2012)		L-S	Abnormal return (short-term), Abnormal return (long-term)	IT adoption	0.00
Liu (2012)		L-S	ROA, ROS, Operating income/ assets, Operating income/sales, Operating income/employees, Operating expenses/sales	IT capability	50.00
Lu & Jinghua (2012)		L-S	ROA	ERP adoption	0.00
Mithas et al. (2012)		L-S	Profitability, Operating expense, Sales	IT investment	66.67
Otim et al. (2012)		L-S	Security return, ROA	IT strategic role	100.00
Perez-Arostegui et al. (2012)		C-P	Quality performance	IT infrastructure, IT integration, IT technical knowledge, IT managerial knowledge	75.00
Rush & Melville (2012)		L-S	Cumulative average return	IT adoption	100.00
Schaefferling et al. (2012)	1	L-S	ROA, ROS, Operating expense/ sales, SG&A/sales, COGS/sales	IT capability	80.00
	2	L-S	ROA, ROS, Operating expense to sales, SG&A to sales, COGS to sales	IT capability	80.00
Tambe et al. (2012)		L-P	Value added	IT employees	0.00
Turedi & Zhu (2012)		C-P	Added value	IT infrastructure, IT labor	0.00
Ussahawanitchakit (2012)		C-P	firm performance	Technology acceptance	100.00
Vinekar & Teng (2012)		L-S	Labor productivity: revenue per employee	IT spending	100.00
Xue et al. (2012)		L-S	Tobin's q, Inventory Turnover, Payables turnover, Receiveables turnover, Selling & admin cost	IT intensity	-20.00
Bayo-Moriones et al. (2013)		L-P	Operational performance, final performance	ICT intensity	50.00
Cao et al. (2013)		L-S	ROA	Strategic alignment	100.00
Chang & Gurbaxani (2013)		L-S	Efficiency	IT intensity	100.00
Chuang et al. (2013)		C-P	Firm performance	KMIT use	100.00
Germann et al. (2013)		C-P	Firm performance	deployment and use	100.00
Han et al. (2013)		L-S	Service expansion	Application software, infrastructure	100.00
Han & Mithas (2013)		L-S	Operating costs	IT labor, IT hardware, IT software	0.00

Study[a, b]	Sample[c]	Method - Data[d]	Dependent Variables	IT-Based Independent Variables	BVIT
Hong & Ghobakhloo (2013)		C-P	Firm marketing performance	Hardware investment, software investment	100.00
Huang & Wang (2013)		L-P	ROA, Profit margin, Total revenue	CRM use, KM use	33.33
Kalaignanam et al. (2013)		L-S	Cumulative abnormal return	IT capability (expenditure)	100.00
Karahanna & Preston (2013)		C-P	Firm financial performance	strategic alignment	100.00
Lin & Chuang (2013)		L-S	Value added	IT capital	100.00
Liu et al. (2013)		C-P	Firm performance	IT capability, IT assimilation	100.00
Mishra et al. (2013)		L-S	Stock market return	IT capability	100.00
Ong & Chen (2013)		L-S	ROA, ROS, MBE, MBA	IT capability	100.00
Rawley & Simcoe (2013)		L-S	Delta extent of vertical integration	IT adoption	100.00
Ray et al. (2013)		L-S	Vertical integration (sales), horizontal complementarity (sales), related diversification (sales), unrelated diversification (sales)	IT capital	25.00
Saldanha et al. (2013)		L-S	Labor productivity, Total inventory	IT use (for transaction), IT use (for partnering)	100.00
Tafti et al. (2013)		L-S	Tobin's q	IT intensity	0.00
Wang et al. (2013)		C-P	Manufacturing goals achievement	IT use (IT-enabled planning and control)	100.00
Wang & Huynh (2013)		C-P	Firm performance	KM adoption	100.00
Xue et al. (2013)		L-S	Cost saving, cross-selling, customization, satisfaction	IT spending, SEI use, CEI use	75.00
Zhang et al. (2013)		C-P	International performance	IT capability	100.00

Independent variables: A/R: Accounts receivables, CAR: Cumulative abnormal return, COGS: Cost of goods sold, EBITDA: Earnings before interest, taxes, depreciation, and amortization, EPS: Earnings per share, EVA: Economic value added, OI: Operating income, ROA: Return on assets, ROC: Return on capital, ROE: Return on equity, ROI: Return on investment, ROS: Return on sales, SGA: Selling, general, and administrative expenses, TCO: Total cost of ownership.

IT-related independent variables: ACF: Automated concrete feeders, AIS: Accounting IS, AM: Activity measurement, AMS: Advanced manufacturing system, AMT: Advanced manufacturing technology, ATM: Automated Teller Machine, B2B: Business-2-Business, CEI: Customer-side electronic integration, CEIS: Construction executive IS, CIO: Chief Information Officer, CRM: Customer Relationship Management, EC: Electronic Commerce, EDI: Electronic Data Interchange, EMS: Enterprise management system, ERP: Enterprise Resource Planning, HIT: Human resources IT, ICT: Information and Communication Technology, KM: Knowledge Management, LAN: Local Area Network, MPM: Measurement of milk production, OIC: Order initiation and completion, OMS: Order Management System, PC: Personal Computer, QR: Quick response, RPS: Resource planning systems, SAP: Systems, applications, and products, SEI: Supplier-side electronic integration, WLAN: Wireless LAN, Y2K: Year 2000.

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Appendix C

Graphs for Changes Over Time

Overall Trends

Figure C1 depicts how the frequency of studies on BVIT has changed over time. Figure C2 shows the change in BVIT (based on the continuous IT payoff measure) observed in the studies in our meta-analysis sample across the four eras of IT progress.

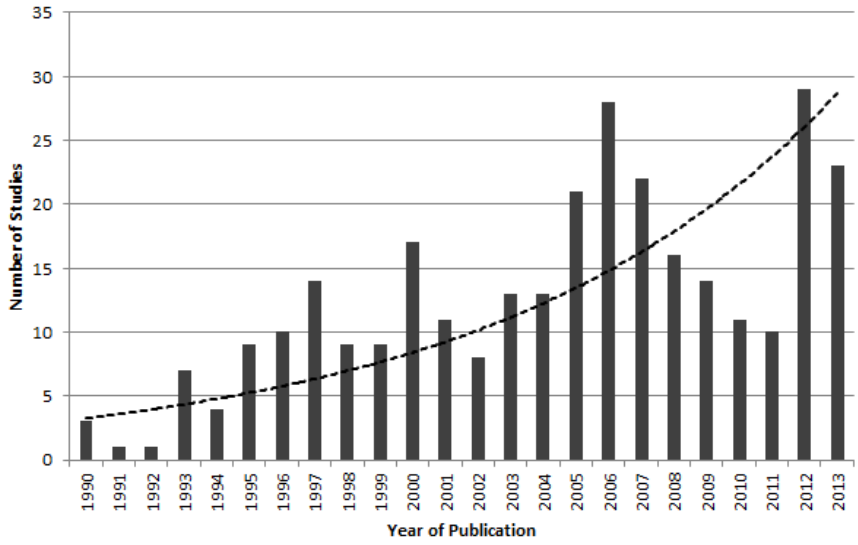

Figure C1. Number of Studies in Meta-Analysis Sample

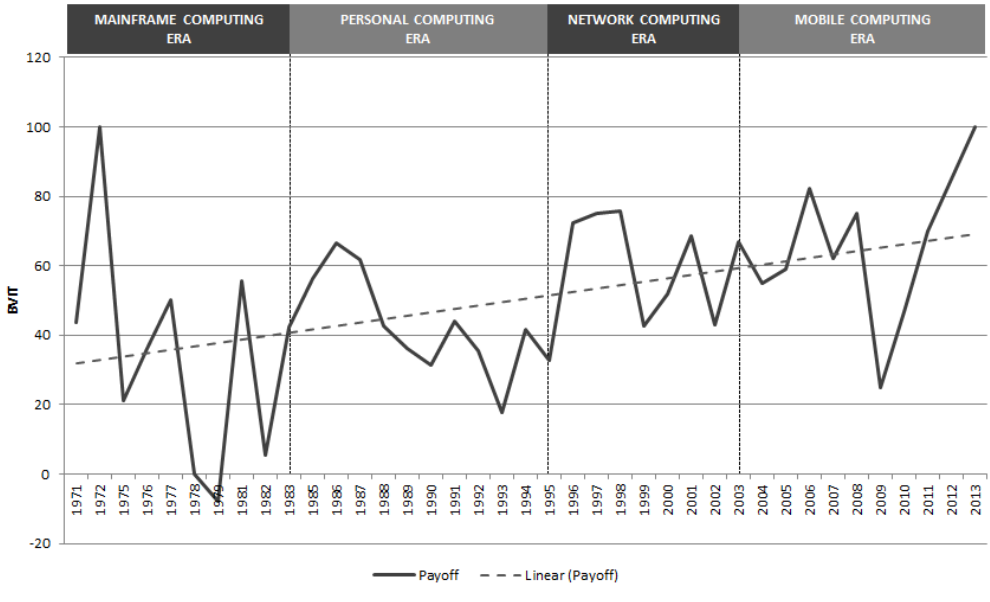

Figure C2. BVIT Over Time

Variety and Nature of Variables

Figure C3 shows the diversity of BVIT-based dependent variables and IT-based independent variables in studies over time. For each type of variables, we computed the ratio of the number of unique variables to the number of studies in each year. The ratio shows a downward trend, indicating that the more recent studies in our sample have been more focused and have examined a narrower set of dependent variables and a narrower set of independent variables compared to the studies during earlier times in the sample.

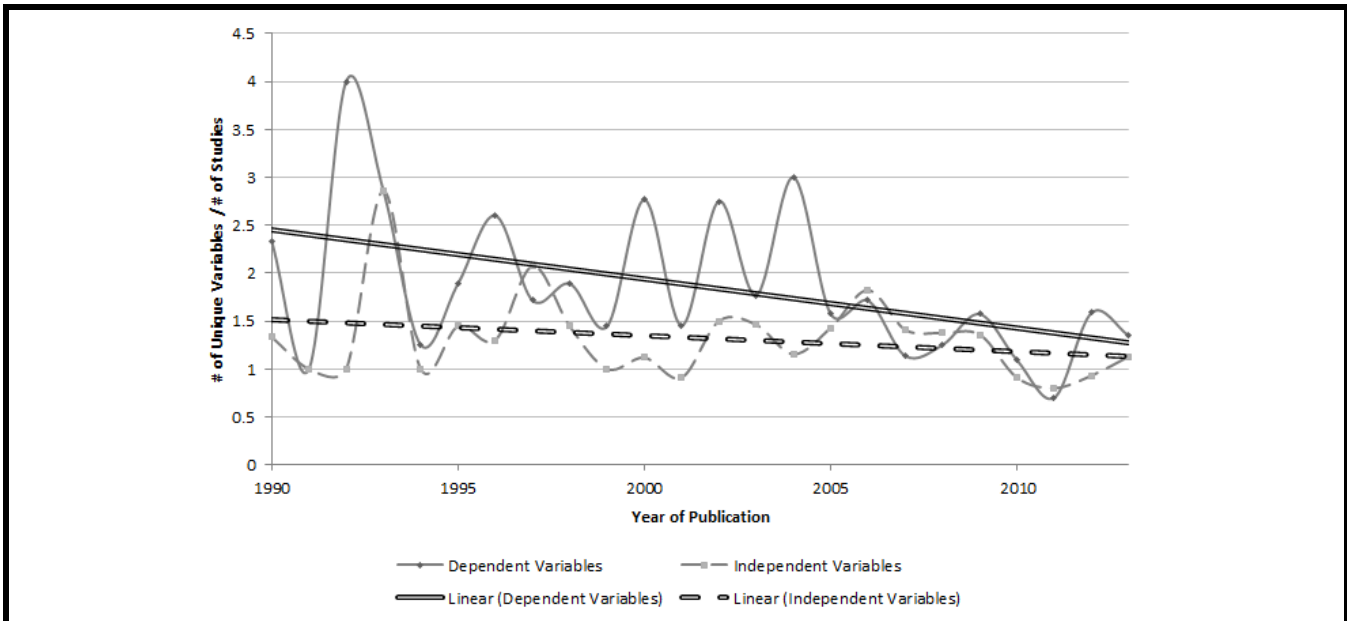

Figure C3. Variety of Variables Over Time

Figure C4 shows the evolution of BVIT-based dependent variables and IT-based independent variables in our sample. For both categories, the figure shows the variables with the higher incidences in larger text, where the incidence for each variable is computed as the frequency of occurrences of the variable across all studies in our sample. The figure also clusters the variables for the four computing eras. As can be seen from the figure, different variables gain prominence and fade away over time. For instance, ROA measures were used to some extent in the mainframe computing era, gained prominence during the personal computing and network computing eras, and faded during the mobile computing era. By contrast, firm performance has become more prominent over time, especially during the mobile computing era. Similarly, the evolution of independent variables shows that the focus has shifted from pure economic measures such as IT capital and IT budget during the mainframe computing and personal computing eras to measures that intervene between investment and performance, such as IT use, IT capability, and IT alignment, during the network computing and mobile computing eras.

Theories Used in Studies

Figure C5 shows the use of theories in studies in our sample. The graph is based on a ratio of the number of studies using a family of theories to the total number of studies in each year. Unsurprisingly, technological theories have been consistently used regardless of time in a majority of studies. Organizational theories have also been consistently used although by a smaller proportion of studies. However, environmental and alignment theories have only gained greater attention in recent times and in fewer studies.

Economic Regions

Figure C6 shows the distribution of BVIT over time in studies set in developed and developing economic regions of the world. The graph is based on the average BVIT across all the studies within each subsample in each year. The analysis indicates that studies in the developing regions demonstrated faster increase in BVIT over time than studies in developed regions although there was considerable variation in realized BVIT in each year.

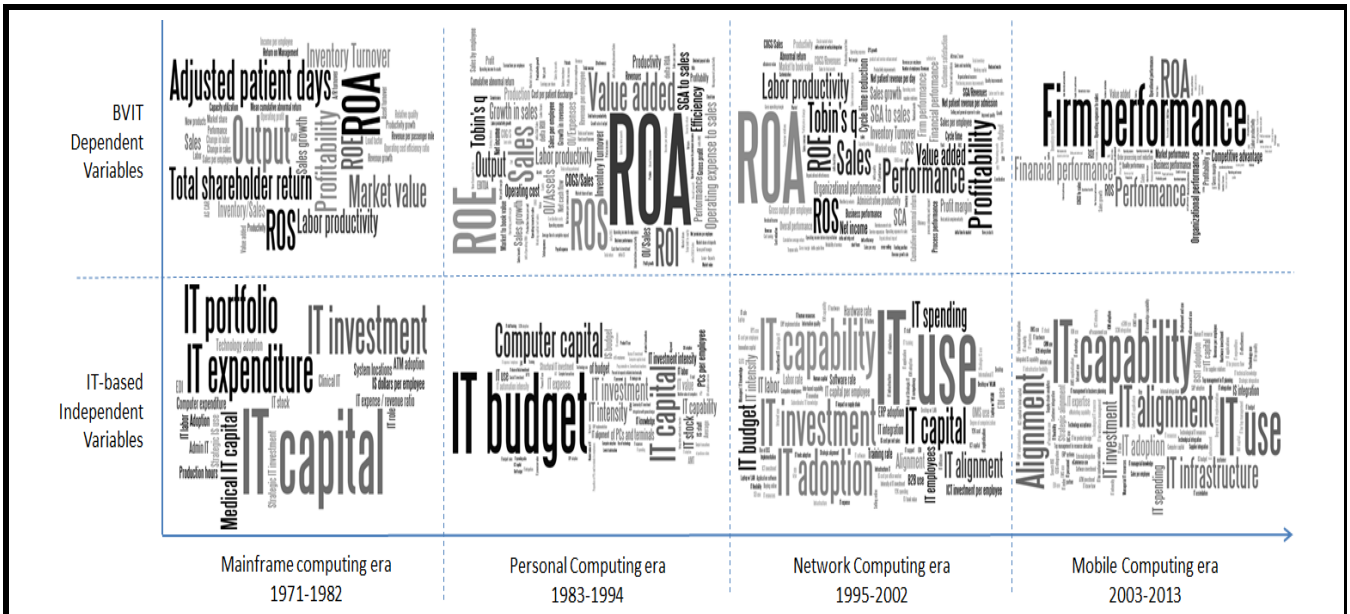

Figure C4. Evolution of Variables Over Time

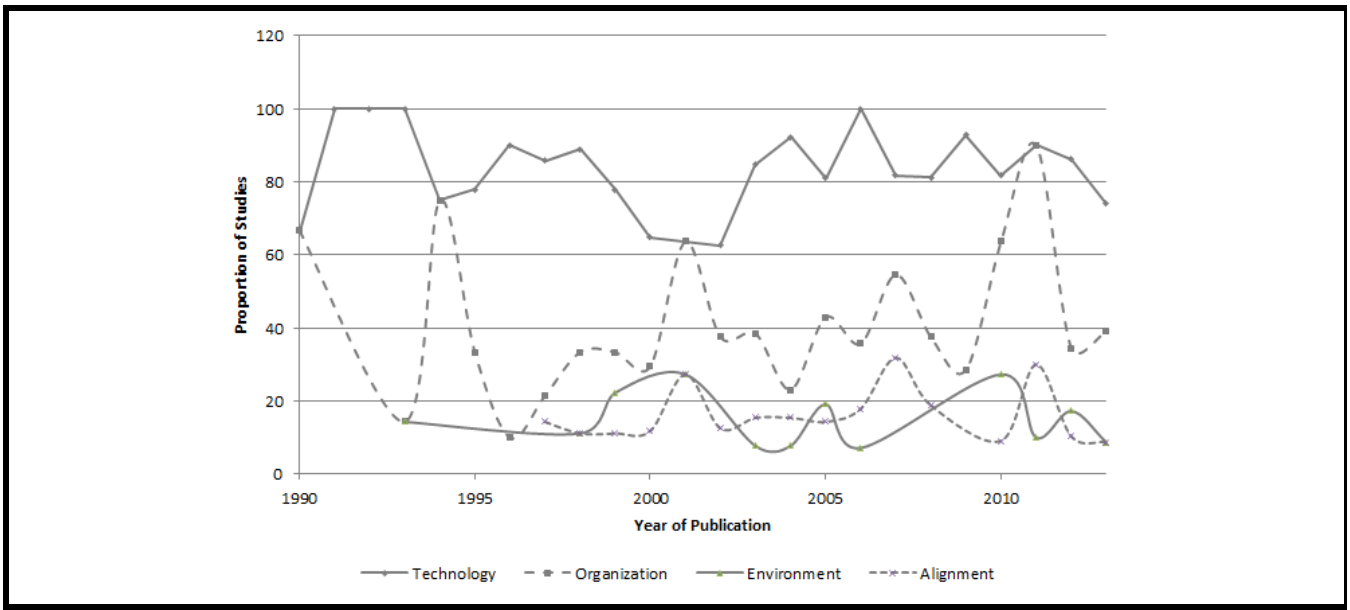

Figure C5. Theories Used Over Time

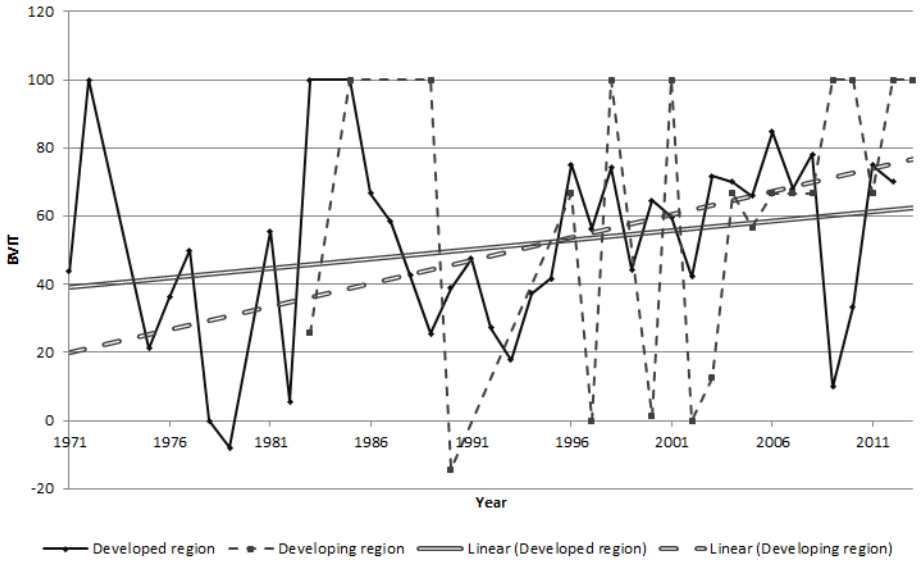

Figure C6. BVIT in Studies Set in Different Economic Regions Over Time

Analysis Methods

Figure C7 shows the distribution of BVIT over time for studies using longitudinal and cross-sectional data. The graph shows that studies using cross-sectional data find slightly greater BVIT than those using longitudinal data. However, studies using longitudinal data sources have shown a marginally faster increase in observed BVIT over time.

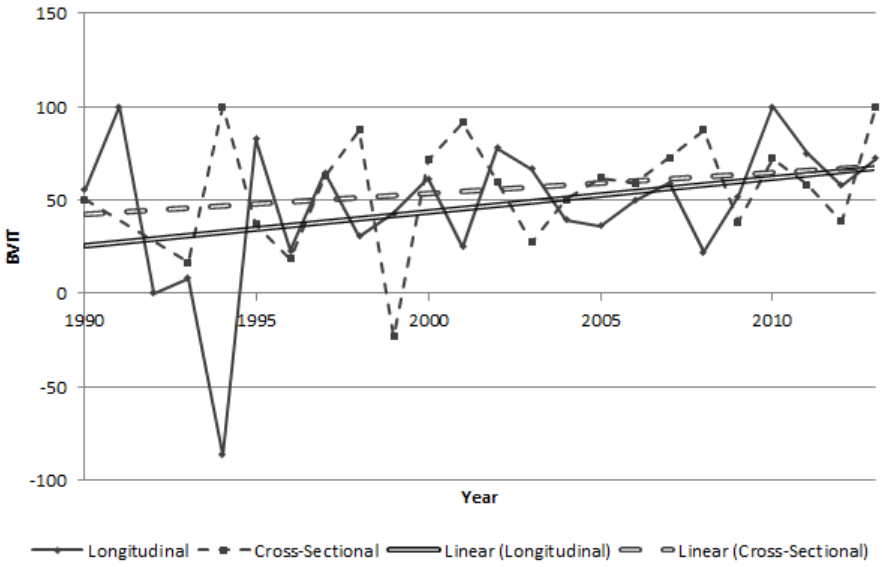

Figure C7. BVIT in Studies Using Different Analysis Methods Over Time

Data Source

Figure C8 shows the change in BVIT over time for studies using secondary and primary data. The graph shows that studies that rely on primary data demonstrate higher levels of BVIT than those that use secondary data. However, studies using secondary data sources have shown a faster increase than primary studies in observed BVIT over time.

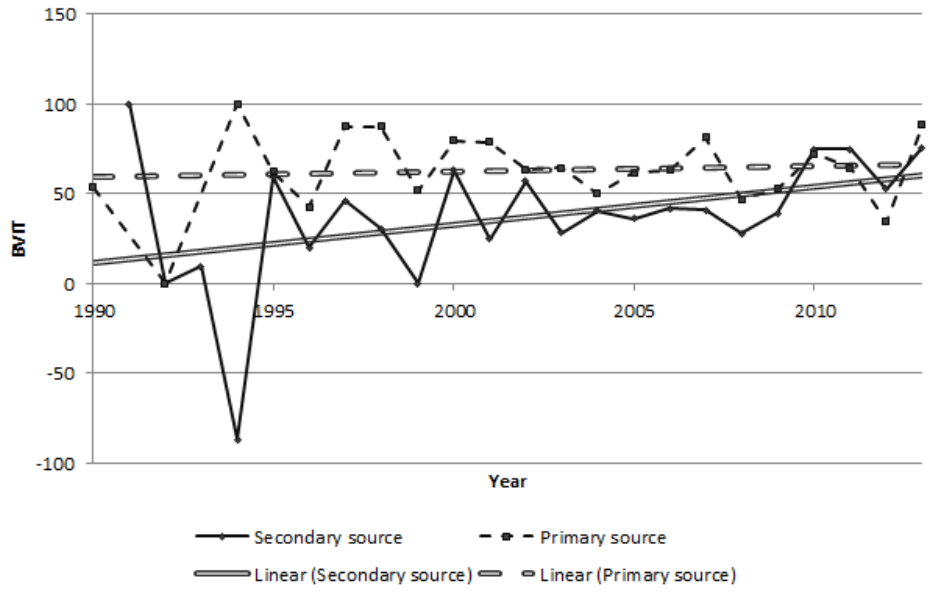

Figure C8. BVIT in Studies Using Different Data Sources Over Time