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A resource-based perspective on information technology and firm performance: a meta analysis

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Abstract

Purpose – The purpose of this paper is to aggregate previous research that adopts the resource-based view (RBV) to examine whether information technology (IT) and organizational resources have significant effect on firm performance.

Design/methodology/approach – A framework that includes direct and indirect-effect models is proposed. A meta-analysis was conducted on 42 published empirical studies to examine how different factors in the RBV affect firm performance.

Findings – First, it was found that the mediated model that includes organizational capabilities as mediators between organizational resources and firm performance can better explain the value of IT than the direct-effect model without organizational capabilities. Second, technology resources can improve efficiency performance but may not enhance financial performance directly. Third, internal capabilities affect performance but it is external capabilities that affect financial performance.

Research limitations/implications – The limitation of meta-analysis is that findings are based on prior research conducted on different sources at different times. This may cause observation biases. Nonetheless, the large sample size can also increase the robust of the findings.

Practical implications – The findings indicate that companies should focus on how IT resources can be used to enhance their capabilities, which will result in better performance.

Social implications – The findings provide strong evidence that IT has contributed to both financial performance and organizational efficiency through strengthening organizational capabilities. The IT has been effectively used so far and the suspected productivity paradox does not exist.

Originality/value – The paper contributes to information management by increasing the theoretical and practical understanding of how IT resources affect organizational capabilities and firm performance. The findings provide valuable guidelines for future research on IT investment and firm performance.

Keywords Resource management, Communication technologies, Business performance

Paper type Research paper

Introduction

Information technology (IT) is a key driver of many technological innovation and organizational evolution. Understanding whether and how IT has affected firm performance is an important research issue, as it allows the manager to know the value of

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IT investment. Many studies in Information systems (ISs) have reported findings about the relationship between IT and firm performance. Several theories have been proposed to explain the widespread of IT, such as the resource-based view (RBV), transaction cost theory (Li and Ye, 1999; Subramani, 2004), media richness theory (Banker *et al.*, 2006), coordination theory (Straub *et al.*, 2004; Lai *et al.*, 2008), or social exchange theory (Goo *et al.*, 2007; Han *et al.*, 2008). These theories have different applicable research domains. For example, the transaction cost theory has been widely used to explain IT outsourcing and the media richness theory has been used to explain the selection of a particular software tool. Among them, the major theory that has been adopted to interpret the relationship between IT and firm performance is the RBV proposed by Wernerfelt (1984). The basic argument of RBV is that firm performance is determined by the resources it owns. The firm with more valuable scarce resources is more likely to generate sustainable competitive advantages. In this view, IT is considered a valuable organizational resource that can enhance organizational capabilities and eventually lead to higher performance. In a recent study, in strategic management, Crook *et al.* (2008) argued that RBV "has emerged as a key perspective guiding inquiry into the determinants of organizational performance".

Although the use of RBV in analyzing the contribution of IT to firm performance makes a great sense and a large number of papers related to this approach have been published, the findings are inconclusive (Weill, 1992; Mitra and Chaya, 1996; Li and Ye, 1999; Ray *et al.*, 2005; Wang *et al.*, 2006). In addition, the weak relationship between IT investment and financial performance even leads researchers to challenge the effect of IT on performance (Ravichandran *et al.*, 2009). Productivity paradox is often cited as a phenomenon associated with non-productive use of IT in industries. With these different views and findings, therefore, it is useful to conduct a meta-analysis that consolidate previous empirical findings and examine potential problems in this domain. Meta-analysis is a method for consolidating results from previous empirical studies on a set of related hypotheses. It is useful in providing more powerful estimates of the true effect size than a single study. It is important for business and social science research in which the findings from individual studies are often non-deterministic. King and He (2005) argued that more meta-analysis is needed in IS research.

The purpose of the paper is to report the findings from a meta-analysis on 50 papers published in major research journals. We propose an integrated model to examine both the direct effect of resources on firm performance and its indirect effect through organizational capabilities. The results indicate that the mediated model with organizational capabilities can better explain the value of IT than the direct-effect model without organizational capabilities. Our findings provide valuable insight into the effect of IT on firm performance and useful guidelines for future research in this direction.

The remainder of the paper is organized as follows. In Section "Literature review and research framework", we review existing literature to aggregate different independent, dependent, and mediating variables used in different papers to build our research model. The sample papers and analysis method used for the study are explained in Section "Research methodology". The results from the meta-analysis are presented in Section "Hypothesis testing". Our research findings, implications for future research, and limitations of our study are provided in Section "Discussion and conclusion".

Literature review and research framework

RBV is a major theory in strategic management. It argues that the competitive advantage of an organizational is determined by the key resources owned by the organization. Barney (1991) states that organizational resource that can create advantage must have the following attributes:

- *Valuable*. The resource can enable a firm to conceive or implement strategies that improve its efficiency or effectiveness.
- *Rare*. The valuable resource should not be possessed by a large number of competing firms.
- *Imperfectly imitable*. The valuable resource should not be easily imitated.
- *Non-substitutable*. The valuable resource should not be easily replaced by other substitutes.

RBV argues that firm resources with these attributes have the potential to generate sustained competitive advantage. This perspective is later extended to include additional elements. For instance, Milgrom and Roberts (1995) leveraged the concept of complementary to further explain the role of resources and how these resources are contributing to business value. The value of an organizational resource can increase in the presence of other complementary resources because it is difficult for competitors to copy the total effect (Bhatt and Grover, 2005; Bharadwaj *et al.*, 2007). That is, the joint value of complementary resources is higher than the total values of their individual. In IS research, IT is increasingly viewed as complementary resources that enhance the value of other organizational resources and capabilities (Bharadwaj *et al.*, 2007). For example, Melville *et al.* (2004) suggested that IT and the complementary resources of the firm affected the effectiveness of business processes with consequently improved organizational performance. The large amount of research using RBV shows the importance of the theory in IS performance research. Although the RBV has been adopted to address the impact of IT on firm performance for decades, current findings about the IT-performance relationship are far from conclusive. Hence, further investigation of the application this theory in the IS research is necessary.

There are three major constructs in the RBV mode: firm performance, organizational resources, and capabilities. The dependent construct is firm performance that has been measured from financial and operational perspectives. In other words, both financial and operational performances are expected to be enhanced by the proper use of IT (Venkatraman and Ramanujam, 1986; Saraf *et al.*, 2007). As the theory indicates, the major independent construct of the theory is organizational resources that include:

> [...] all of the asset, capability, organization process, enterprise character, information and knowledge that an enterprise is able to control, give the ruling, allocate the efficiency improving or achieve efficiency strategy (Barney, 1991).

In the IS research, IT is considered to be a valuable and not totally imitable resource for an organization.

A direct-effect model of RBV is to link the above two constructs and to investigate the direct relationship between resources and firm performance (Weill, 1992; Mitra and Chaya, 1996; Devaraj and Kohli, 2000). That means, the mechanism by which firm performance is improved is considered to be a black box. Despite a considerable amount of empirical research, results of resources on firm performance are often inconsistent.

For example, Weill (1992) reported that high investment in IT was associated with high firm performance in the valve manufacturing industry. Li and Ye (1999), however, found that IT investment was not statistically significant in improving profitability, as measured by return on assets (ROA) and return on sales (ROS), based on the secondary data from InformationWeek and CompuStat databases. From the efficiency improvement perspective, Mitra and Chaya (1996) analyzed five years' data of IT budget and firm performance of large US companies from Computerworld and CompuStat databases. They concluded that investment on IT leads to a lower average total cost per unit of output. In contrarary, Wang *et al.* (2006) reported findings that IT investment in virtual integration of supply chain is unlikely to contribute to manufacturers' cost advantage directly. Ray *et al.* (2005) also found that there were no direct effects of three different IT resources (technical skills of IT unit, managers' technology knowledge, and IT spending) on the performance of the customer service process. Given these inconsistent results, it is unclear whether direct effect exists between IT resources in organizations and their financial or operational performance.

To overcome the problem, an indirect model adopted by many recent researches includes the third construct, "organizational capabilities", as the mediator between resources and performance (Bharadwaj, 2000; Barua *et al.*, 2004; Bhatt and Grover, 2005; Banker *et al.*, 2006; Hulland *et al.*, 2007; Fink and Neumann, 2009). Organizational capabilities are certain attributes of the organization in dealing with environmental changes and management challenges. For example, organizations may need capabilities to deal with their customers or to link their vendors. The major argument is that IT resources can enhance organizational capabilities, which can then improve firm performance. In other words, organizational performance is enhanced by the integration and synergy between organizational capabilities and IT resources. As both models have been widely used in performance-related research, it would be interesting to examine whether the indirect-effect model can better interpret the relationship between IT resource and firm performance. Common definitions and measurements of the three constructs are provided below.

Firm performance

Firm performance refers to organizational effectiveness in terms of its financial and operational performance (Venkatraman and Ramanujam, 1986; Saraf *et al.*, 2007). Previous research has used a number of indicators to measure firm performance. These indicators fall into three general categories: finance, efficiency, and others. Financial indicators include commonly used measures such as return on investment (ROI) (Mahmood and Mann, 1993; Rai *et al.*, 1997), return on equity (ROE) (Rai *et al.*, 1997; Alpar and Kim, 1990; Shin, 2006), ROS (Bharadwaj, 2000; Tam, 1998; Mahmood and Mann, 1993; Tanriverdi, 2006), revenue (Francalanci and Galal, 1998; Devaraj and Kohli, 2000; Rai *et al.*, 2006), and sale (Weill, 1992; Mahmood and Mann, 1993; Rai *et al.*, 1997; Palmer and Markus, 2000; Zhuang and Lederer, 2005). These indicators usually can show the firm's capability in making profits.

In addition to financial indicators, existing research also uses efficiency-related indicators to examine the impact of IS on the operational efficiency, such as productivity (Rai *et al.*, 1997; Hitt and Brynjolfsson, 1996; Palmer and Markus, 2000; Zhuang and Lederer, 2005; Brown *et al.*, 1995; Mukhopadhyay *et al.*, 1997; Grover *et al.*, 1998), cost reduction including cost of goods sold to sales (COG/S), selling and general

administration expense to sales (SGA/S), and so on (Wang *et al.*, 2006; Bharadwaj, 2000; Mitra and Chaya, 1996; Zhu and Kraemer, 2002). There are also other special indicators that were used in certain circumstances, such as customer satisfaction (Ranganathan *et al.*, 2004; Devaraj and Kohli, 2000; Ray *et al.*, 2005), value addition (Saeed *et al.*, 2002; Osei-Bryson and Ko, 2004), Tobin' q (Tanriverdi, 2006; Saeed *et al.*, 2005), and market share (Byrd and Davidson, 2003; Barua *et al.*, 1995; Sircar *et al.*, 2000). Because some of these special indicators do not have enough quantity for meta-analysis, we only include financial and efficiency indicators in our study.

IS as organizational resource

Information technologies are valuable organizational resources that can be used to improve internal communication, enhance product design quality, reduce design cycle time, and lower product development cost. Previous research suggests that IT infrastructure is a critical enabler of firm performance (Bharadwaj, 2000; Sambamurthy *et al.*, 2003; Santhanam and Hartono, 2003; Zhu and Kraemer, 2002). Some studies have also reported that IT investment has a positive impact on firm-level performance (Weill, 1992; Barua *et al.*, 1995; Mitra and Chaya, 1996; Menon *et al.*, 2000; Kohli and Devaraj, 2003; Bardhan *et al.*, 2006). According to the above findings, we propose the first hypothesis to examine the direct effect of resource on firm performance.

Direct-effect model

H1. IT resources are positively associated with firm performance.

In previous research, IT resources were measured in different ways. Some studies chose technological indicators such as IT investment, IS adoption and IT infrastructure as resource measurement (Mitra and Chaya, 1996; Tam, 1998; Weill, 1992); while others also included related managerial resources such as management skill, staff training, and knowledge management (Byrd and Davidson, 2003; Ranganathan *et al.*, 2004; Bhatt and Grover, 2005; Ravichandran and Lertwongsatien, 2005). Bharadwaj (2000) classified IT resources as IT infrastructure, human IT resources, and IT-enabled intangibles.

A more comprehensive approach proposed in Zhu *et al.* (2004) adopted the technology-organization-environment framework in firm performance research (Kuan and Chau, 2001; Mrenono-Cerdan, 2008), which includes technology, organization, and environment as three major dimensions for identifying related variables. They included six major factors that may affect IT payoffs in e-business environment in the study: technology readiness, firm size, global scope, financial resources, competition intensity, and regulatory environment. The findings from a survey show that technology readiness emerges as the strongest factor for e-business value, while financial resources, global scope and regulatory environment also significantly contribute to e-business value.

Since organizational resources include technological and complementary organizational resources and firm performance can be measured by financial and efficiency indicators, *H1* can be further divided into four sub-hypotheses as follows:

H1a. Technological resources are positively associated with the firm's financial performance.

H1b. Technological resources are positively associated with the firm's efficiency performance.

H1c. Organizational resources are positively associated with the firm's financial performance.

H1d. Organizational resources are positively associated with the firm's efficiency performance.

Capabilities as mediators

Although IT as a valuable resource can improve firm performance, IT resources may not be able to create sustained firm performance by themselves (Rai *et al.*, 2006). Most recent understanding is that the effect of valuable resource may go through some other factors. Major ones include resource complementary and organizational capabilities. Resource complementary argues that the integration of different complementary resources can generate synergy that can lead to better performance (Wade and Hulland, 2004; Melville *et al.*, 2004; Karimi *et al.*, 2007; Zhu, 2004). Organizational capabilities argue that IT resources can enhance critical organizational capabilities, which can enhance firm performance (Bharadwaj, 2000; Bhatt and Grover, 2005; Rai *et al.*, 2006; Brown *et al.*, 1995; Chan *et al.*, 1997; Alvarez-Suescun, 2007). Other studies also propose factors such as strategic fitness that argue the alignment between IT and business strategy can enhance firm performance (Li and Ye, 1999; Palmer and Markus, 2000; Weill, 1992). Outsourcing and innovation are also examined in a few articles.

Among those possible factors, organizational capabilities are the most liked mediators in existing literature. Organizational capabilities refer to the ability that an organization assembles, integrates, and deploys its valued resources to build unique competencies (Teece *et al.*, 1997). Makadok (2001) made a distinction between a firm's resources and its capabilities: a resource is an observable but not necessarily tangible asset that can be independently valued and traded, while a capability is unobservable and hence necessarily intangible, cannot be independently valued, and changes hands only as part of its entire unit. Simply speaking, resources are the basic units of analysis, while a capability is the capacity for resources to perform a task or activity together.

A firm with valuable IT resources may be able to leverage these resources to build its capability. Ravichandran and Lertwongsatien (2005) posited that there are positive relationships between firm's IT resources and IS capabilities. Tanriverdi (2005) indicated that the use of related and complementary IT resources can build an IT-based coordination mechanism and enhance organizational capabilities through creating cross-unit business synergies. Therefore, our indirect-effect model states that a firm's resources affect its performance through improving organizational capabilities. Accordingly, we posit the following two main hypotheses. Our research framework, as shown in Figure 1, is a combination of these two competing models.

Indirect-effect model

H2. IT resources are positively associated with a firm's capabilities.

H3. A firm's capabilities are positively associated with its performance.

Organizational capabilities may be viewed from different angles. In a comprehensive review, Wade and Hulland (2004) identified three categories of capabilities: outside-in, inside-out, and spanning:

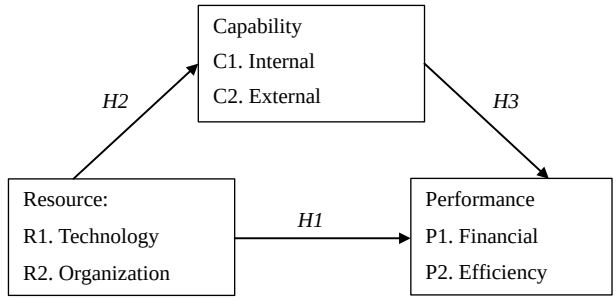

Figure 1.
Research model

Inside-out capabilities are deployed from inside the firm in response to market requirements and opportunities, and tend to be internally focused (e.g. technology development and cost controls). In contrast, outside-in capabilities are externally oriented. It focuses on the ability to anticipate market requirements, create durable customer relationships, and understand competitors (e.g. market responsiveness and managing external relationships). Finally, spanning capabilities are needed to integrate the firm's inside-out and outside-in capabilities (e.g. managing IS/business partnerships and IS management and planning).

In later studies, the spanning capabilities were removed to simplify organizational capabilities into two categories: internal and external (Hulland *et al.*, 2007; Goh *et al.*, 2007):

(1) *Internal capability* (*IC*). This category includes the ability to utilize resources that can enhance internal controls capabilities, strengthen cooperation performance between the departments, and improve capacity of the system and development. Typical ones include the capability in managing internal relationships, IS planning, management skill, and IT experience (Hulland *et al.*, 2007). The inside-out IS resources can enhance the capabilities of internal firm operations.

(2) *External capability* (*EC*). This category includes the ability to adapt to the external environment, the ability to work with external partners (such as upstream and downstream suppliers and manufacturers) for cooperation and information sharing, the capacity of facing the market, and customer needs. They are mainly concerned with partnership management, market response, and organizational agility (Hulland *et al.*, 2007). Prior studies (Bharadwaj, 2000; Feeny and Willcocks, 1998) confirmed that outside-in IS resources enable firms to manage customer relationships and to work with suppliers and partners by supporting collaborative product development.

Given the above categorization of resources and capabilities, *H2* and *H3* can be further divided into four sub-hypotheses, respectively:

H2a. Technological resources are positively associated with the firm's IC.

H2b. Technological resources are positively associated with the firm's EC.

H2c. Organizational resources are positively associated with the firm's IC.

H2d. Organization resources are positively associated with the firm's EC.

H3a. The IC of a firm is positively associated with its financial performance.

H3b. The IC of a firm is positively associated with its efficiency performance.

H3c. The EC of a firm is positively associated with its financial performance.

H3d. The EC of a firm is positively associated with its efficiency performance.

Research methodology

This study used a meta-analysis approach to test the proposed models and hypotheses. Meta-analysis refers to a set of procedures for analyzing coefficients reported by prior published research (Sabherwal *et al.*, 2006). This technique enables researchers to cumulate findings from multiple studies to draw valid conclusions. Thus, it provides strong support for the model and explains the wide variance in prior empirical findings. This meta-analysis focused on empirical studies in which independent variables are related to IT and dependent variables are indicators of firm performance. We followed the procedures suggested by Hunter and Schmidt (2004) to calculate corrected correlations among the constructs. The research procedures are described below.

Data collection

The sample for this research includes empirical studies reported in the top ten journals in the ISs area, including *MIS Quarterly*, *Information Systems Research*, *Journal of Management Information Systems*, *Communications of the ACM*, *Decision Support Systems*, *Information & Management*, *European Journal of Information Systems*, *International Journal of Electronic Commerce*, *Journal of the Association for Information Systems*, and *Information Systems Journal*. Database search using multiple keywords, including "firm performance" or "business performance", "resource", "capability", and "competitive advantage", was conducted. A total of 118 papers were found in the initial search. We then applied three criteria to identify useful papers. First, the study must be empirical or field studies and provide quantitative data. Second, the topic of the paper must be using the RBV model to study firm performance, and the unit of analysis must be organization rather than individuals, groups, or sectors of an organization. Third, it must report the correlation between dependent and independent variables to allow for further computation. The screening process resulted in 50 studies published between 1990 and 2009. Sample papers are marked with an asterisk in the reference list.

Variable coding

The selected articles were coded based on our research framework. Two well-educated experts in the management IS area conducted the coding independently. Inconsistent coding was resolved through discussion and the participation of the third expert. The classification of organizational resources is shown in Table I. The coding of capabilities follows Hulland *et al.*'s (2007) structure to divide them into internal and external capabilities and shown in Table II. Coding of organizational performance is shown in Table III. Details in classifying individual variables are elaborated in the following.

Internal capability

According to our description in the previous section, IC represents the IC within the enterprises for execution. We included measures such as capability for managing internal relationships, IS planning, and change management. Managing internal relationships mainly comes from the effect of internal use of IT resources to reduce internal communication costs, enhance efficiency, or improve the utilization rate of resources

Variables	Measurement items	Data sources
Technology resource		
IT investment	IT investment	Li and Ye (1999)
	IT budget, cost	Kivijarvi and Saarinen (1995), Prattipati and Mensah (1997), Ray *et al.* (2009), Thouin *et al.* (2009)
	IT spend, expenditure, purchase	Bardhan *et al.* (2006), Ravichandran *et al.* (2009)
IT infrastructure	IT infrastructure	Bhatt and Grover (2005), Tanriverdi (2005), Tanriverdi (2006), Eikebrokk and Olsen (2007), Karimi *et al.* (2007), Zhang *et al.* (2008), Susarla *et al.* (2009)
	Number of PC (/worker ratio)	Mahmood and Mann (1993), Sircar *et al.* (2000)
	IT readiness, dependence	Zhu *et al.* (2004), Cohen (2008)
IT assets	IT assets	Andersen and Segars (2001)
	IT resource	Devaraj and Kohli (2000)
Software, system application	System adoption (enterprise resource planning, decision support system, electronic data interchange, electronic commerce, etc.)	Truman (2000), Kohli and Devaraj (2004), Bernroider (2008), Iyer *et al.* (2009), Mouzakitis *et al.* (2009)
Organization resource		
Knowledge resource	IT knowledge assets	Zhang *et al.* (2008), Fink and Neumann (2009)
	IT labor skill	Hulland *et al.* (2007)
Human resource	Human resource	Tanriverdi (2006), Tanriverdi *et al.* (2007)
	Labor (staff, employees)	Prattipati and Mensah (1997), Li and Ye (1999), Truman (2000), Kohli and Devaraj (2004), Thouin *et al.* (2009)
	Numbers or ratio	
	Staff expenses	Mahmood and Mann (1993), Devaraj and Kohli (2000), Sircar *et al.* (2000), Ray *et al.* (2005), Byrd *et al.* (2006)
	Labor training (spending)	Häkkinen and Hilmola (2008)
Financial resource	Financial resource	Andersen and Segars (2001), Zhu *et al.* (2004)

Table I.
The coding of organizational resource

within the firm. These capabilities usually involve efficiency improvement or better coordination among different organizational units resulted from using IT in enterprises.

External capability

EC includes external relationship and market responsiveness. External relationship indicates capabilities from the infrastructure and systems that help maintain good relationship with business partners. The ability to share information in supply chain management (SCM) or customer relationship management in customer services is an example of external capabilities. Market responsiveness is also taken from Wade and Hulland (2004) and Hulland *et al.* (2007). It represents the adjustment capacity that a firm reacts to major changes in the market. IT can help an organization meet the rapid change of its external environment. The common indicators include flexibility (Wade and Hulland, 2004; Lee and Choi, 2003), agility (Sambamurthy *et al.*, 2003), quick response (Palmer and Markus, 2000) and strategic fitness. The coding is shown in Table II.

Variables	Measurement items	Data sources
IC		
Managing internal relationship	System integration, collaboration	Truman (2000), Barua *et al.* (2004), Tanriverdi (2005), Anthony Byrd *et al.* (2006), Banker *et al.* (2006), Rai *et al.* (2006), Wang *et al.* (2006), Bharadwaj *et al.* (2007), Eikebrokk and Olsen (2007), Häkkinen and Hilmola (2008), Zhang *et al.* (2008), Mouzakitis *et al.* (2009)
	Information (knowledge) sharing	Straub *et al.* (2004), Tanriverdi (2005)
	IT, IS capability	Karimi *et al.* (2007), Han *et al.* (2008), Mithas *et al.* (2008), Dale Stoel and Muhanna (2009), Fink and Neumann (2009), Susarla *et al.* (2009)
IS planning and changing management	IS experience, planning	Kivijarvi and Saarinen (1995), Bhatt and Grover (2005), Kearns and Sabherwal (2007), Cohen (2008)
	IS productivity, performance	Prattipati and Mensah (1997), Cohen (2008)
	IS maturity	Armstrong and Sambamurthy (1999)
	IS flexibility	Ray *et al.* (2005)
	Process impact, improve	Devaraj and Kohli (2000), Subramani (2004), Malhotra *et al.* (2005), Byrd *et al.* (2006), Banker *et al.* (2006), Pavlou and El Sawy (2006), Tanriverdi *et al.* (2007)
	IT relatedness	Tanriverdi (2005), Tanriverdi (2006)
EC		
External relationship	Customer or supply side capability	Barua *et al.* (2004), Ray *et al.* (2005), Rai *et al.* (2006), Dale Stoel and Muhanna (2009), Klein and Rai (2009)
	Relationship management, integration	Bhatt and Grover (2005), Saraf *et al.* (2007), Han *et al.* (2008), Zhang *et al.* (2008), Ray *et al.* (2009)
	Supplier responsiveness	Wang *et al.* (2006)
Market responsiveness	Customer, marketing responsiveness	Armstrong and Sambamurthy (1999)
	Online performance	Hulland *et al.* (2007)

Table II.
Coding of organizational capabilities

Firm performance

Firm performance measures were coded into financial performance and efficiency performance. Financial indicators are common measures in performance-related research, such as ROA, ROI, ROE, ROS, sale (growth), and stock share returns were coded into this category. Efficiency indicators are those related to the non-financial productivity of the organization. The coding is shown in Table III.

Data analysis

A total of 119 usable relationships were identified from coding the 50 published studies. Table IV shows the descriptive statistics of the coding result. As shown in the table,

Variables	Measurement items	Data sources
Financial performance		
Financial indicator	Financial, firm performance	Kivijarvi and Saarinen (1995), Andersen and Segars (2001), Barua *et al.* (2004), Straub *et al.* (2004), Saraf, *et al.* (2007), Zhang *et al.* (2008), Iyer *et al.* (2009)
	ROI, ROA, ROS	Mahmood and Mann (1993), Li and Ye (1999), Tanriverdi (2005), Tanriverdi (2006), Dale Stoel and Muhanna (2009), Ravichandran *et al.* (2009)
	Sale, income, revenue growth	Armstrong and Sambamurthy (1999), Devaraj and Kohli (2000), Sircar *et al.* (2000), Truman (2000), Kohli and Devaraj (2004), Bhatt and Grover (2005), Rai *et al.* (2006), Mithas *et al.* (2008), Ray *et al.* (2009), Thouin *et al.* (2009)
Profitable and benefit	e-Business value, benefit	Zhu *et al.* (2004), Bernroider (2008)
	Profitable	Byrd *et al.* (2006)
	Business effect	Kearns and Sabherwal (2007)
Efficiency performance		
Cost indicator	Operational (production) cost reduce	Subramani (2004), Malhotra *et al.* (2005), Banker *et al.* (2006), Rai *et al.* (2006), Wang *et al.* (2006), Hulland *et al.* (2007), Tanriverdi *et al.* (2007), Lai *et al.* (2008), Fink and Neumann (2009), Iyer *et al.* (2009), Ray *et al.* (2009)
	COGS/S, SGA/S	Bardhan *et al.* (2006), Dale Stoel and Muhanna (2009)
Productivity	Production manufacturing effectiveness	Pavlou and El Sawy (2006), Bharadwaj *et al.* (2007), Karimi *et al.* (2007), Häkkinen and Hilmola (2008)
	e-Business effectiveness	Eikebrokk and Olsen (2007)

Table III.
Coding of firm performance

the number of studies that can be used to test each relationship varies from five to 16. A preliminary examination of the result shows an overwhelming positive relationship but inconsistent findings do exist in published literature. For example, the relationship between organization resources and internal capabilities has nine positively correlations, three low correlations, and two negatively correlations.

Hypothesis testing

Methods commonly used in meta-analysis include Hunter and Schmidt (1990), Hedges and Olkin (1985) and Rosenthal (1991). In this study, we use the average plot of product moment correlation r as the fundamental basis of meta-analysis and combined Fisher's Z scores and Fail-safe N (Rosenthal, 1991) for each construct to test the significance of our hypothesis. The population effect size indicates the extent to which the independent variable affects the dependent variable. It is estimated from correlations published in previous studies, which is different from the effect size estimated in regression analysis. As suggested in Cohen (1977), the population effect size (r) > 0.1 is

Relationship	No. of studies	Positive correlation ($r \geq 0.1$)	Low correlation ($0.1 > r > -0.1$)	Negative correlation ($r \leq -0.1$)	Remarks
H1a: TR-FP	15	8	7	0	TR: technological resources
H1b: TR-EP	8	7	1	0	OR: organizational resources
H1c: OR-FP	13	8	5	0	IC: internal capability
H1d: OR-EP	5	4	0	1	EC: external capability
H2a: TR-IC	14	12	2	0	FP: financial performance
H2b: TR-EC	6	6	0	0	EP: efficient performance
H2c: OR-IC	14	9	3	2	
H2d: OR-EC	5	3	2	0	
H3a: IC-FP	8	7	1	0	
H3b: IC-EP	16	14	2	0	
H3c: EC-FP	6	6	0	0	
H3d: EC-EP	9	7	2	0	

Table IV.
Descriptive statistics of the coding result

known as having low effect; $r > 0.3$ is medium effect, and $r > 0.5$ is high effect. The fail-safe N indicates the number of insignificant correlations that would have to be included in the sample to reverse the conclusion that a significant relationship exists. According to Rosenthal's (1991) suggestion, the significant threshold of fail-safe N in 95 percent confidential level is Nfs $> 5*k + 10$, where Nfs is the fail-safe N and k is the total number of studies in each pairwise relationship.

Direct effect of resource on performance

Table V shows the meta-analysis result of the direct-effect model. We find two significant combines Z scores (*H1b* and *H1d*) to show weakly support of the positive impact of technological and organizational resources on efficiency. Their effect sizes are in the low-medium range (>0.3) and only *H1b* holds when we look at the Nfs threshold. The other three relationships do not pass their fail-safe N thresholds. This indicates that the direct effects between organizational resources and firm performance are quite weak if it is not totally non-existent.

Hypothesis test	Relationship *H1a:* TR-FP	*H1b:* TR-EP	*H1c:* OR-FP	*H1d:* OR-EP
No. of studies	15	8	13	5
Total samples size	3,788	2,257	3,879	1,579
Effect size (r)	0.107	0.381	0.144	0.388
Combined Z scores	6.64	17.39	9.035	15.72
Threshold of Nfs in 0.05	85	50	75	35
Nfs ($p = 0.05$)	17.31	52.97	24.53	32.89
Hypothesis supported	No	Weak support	No	Weak support

Note: All combined Z scores are significant at: <0.001 level

Table V.
Correlations between resource and firm performance

Effect of resources on capability

The indirect-effect model includes two sequential relationships that need to be assessed separately: resource to capability and capability to firm performance. The resulting statistics between resources and organizational capabilities are shown in Table VI. Three relationships are supported, except *H2d* (organizational resource on external capabilities) that has a low-effect size and does not pass the fail-safe *N* threshold. *H2a* (technological resources-IC (TR-IC), *H2b* (TR-EC), and *H2c* (organizational resources-IC (OR-IC) have medium effect sizes to show significant impacts of technological resources on internal capabilities, technological resources on external capabilities, and organizational resources on internal capabilities. The combined *Z* scores and the test results on Nfs further strengthen the above findings. Except for *H2d*, all combined *Z* scores are significant at $p < 0.001$, and Nfs are significant at $p < 0.05$.

Therefore, we conclude that organizations with stronger technological resources can significantly enhance their internal and external capabilities but organizational resources can only improve internal capabilities.

Effect of capability on firm performance

The meta-analysis results on the correlations between capability and firm performance is shown in Table VII. *H3b* (IC-EP) is significantly supported (medium effect size and passing the fail-safe *N* threshold), which means internal capabilities have a significant positive effect on the efficiency of the organization. *H3a* and *H3c* are weakly supported, which indicates that both internal and external capabilities can enhance

Hypothesis test	Relationship			
	H2a: TR-IC	*H2b:* TR-EC	*H2c:* OR-IC	*H2d:* OR-EC
No. of studies	14	6	14	5
Total samples size	2,351	903	1,876	996
Effect size (*r*)	0.374	0.441	0.481	0.244
Combined *Z* scores	18.82	13.96	22.25	7.82
Threshold of Nfs in 0.05	80	40	80	35
Nfs ($p = 0.05$)	90.78	46.96	120.94	20.16
Hypothesis supported	Support	Support	Support	No

Note: All combined *Z* scores are significant at: <0.001 level

Table VI.
Correlations between resources and capability

Hypothesis test	Relationship			
	H3a: IC-FP	*H3b:* IC-EP	*H3c:* EC-FP	*H3d:* EC-EP
No. of studies	8	16	6	9
Total samples size	877	2,430	1,593	1,486
Effect size (*r*)	0.343	0.423	0.347	0.243
Combined *Z* scores	10.47	19.08	14.30	9.52
Threshold of Nfs in 0.05	50	90	40	55
Nfs ($p = 0.05$)	46.95	106.38	35.69	34.83
Hypothesis supported	Weak support	Support	Weak support	No

Note: All combined *Z* scores are significant at: <0.001 level

Table VII.
Correlations between capability and performance

financial performance of a firm but the result may not be very conclusive. The weakly support is due to the fact that these relationships are supported by the significance of combined *Z* scores but do not pass the Nfs thresholds. *H3d* is not supported because it fails both hurdles.

Discussion and conclusion

In this study, we have reviewed 50 published studies on using RBV to investigate whether IT can enhance firm performance between 1990 and 2009 and found the following. First, the use of the resource-based model to investigate the relationship between IT and firm performance in ISs research has been inconclusive when the research model does not include organizational capabilities. The indirect-effect model that includes organizational capabilities as mediators between organization resources and firm performance can better explain the value of IT than the direct-effect RBV model without organizational capabilities.

Second, we have found that technological resources can significantly improve organizational capabilities. Its impact on both internal and external capabilities is significant, but organizational resources can only improve internal capabilities. This may be due to the nature of IT that cannot directly generate revenues without complementing with other business functions such as marketing and SCM. Another possible explanation is that there are so many different factors that could affect the financial performance of an organization. The effect of IT may be overshadowed by other factors and hence does not show its effect up to the statistically significant level. Other potential reason is that the effect of IT investment may have time lag as argued in Kohli and Devaraj's (2003). Unfortunately, we do not have adequate data to examine the effect due to time lag.

Managerial implications

This study has several important implications for management. First, our study confirmed that IT can enhance organizational capabilities. The results showed that technological resources, that include IT infrastructure, assets, software applications, and IT investment, positively influence internal and external capabilities. Managers should cultivate IT resources in their firms and carefully implement those of critical importance to building their core competence.

Second, IC can improve organizational performance. Our empirical results highlight the importance of IC (measured by managing internal relationships, IS planning, and change management) are beneficial to organizational efficiency. Prior studies also found that IC will increase the collaboration within employees (Nosek and McManus, 2008; Lee and Choi, 2003). Therefore, managers should utilize IT to create a cooperative environment in which employee interactions can be enhanced to increase working efficiency. A recent development of web 2.0 provides a vast amount of useful tools for such a purpose.

Third, IT managers should focus on how IT resources can be converted into organizational capabilities when they evaluate IT investment projects. We have shown that the direct effect of IT does not affect firm performance, but this does not mean that companies should not invest in IT because IT can enhance organizational capabilities and then improve firm performance. Therefore, managers who intend to take advantage of IT should focus on how to transfer IT resources into useful capabilities. As Bharadwaj (2000) concluded, firms should identify ways to create capabilities rather

than merely invest in IT. In addition to making new investments in hardware and software systems, companies need to consider resource complementarity and focus on the integration among resources in order to benefit from IT investments.

Limitations and future work

The research has several limitations. First, meta-analysis has some inherent limitations. We are comparing data collected from different sources and at different time. These data may have very different attributes such as different industries (Byrd and Davidson, 2003; Straub *et al.*, 2004), national conditions (Zhu *et al.*, 2004; Tanriverdi, 2005; Wang *et al.*, 2006), or economic environments. All these factors could cause biased observations. Nonetheless, the aggregated results from our meta-analysis provide more robust conclusions as they were derived from large sample sizes combined from multiple studies to even out possible errors due to data collection in individual studies.

The second limitation is that different coding may lead to different results. This exists in all research that involves human coding. We believe that we have done our best to ensure a consistent and proper coding process. Our findings also imply that more studies may be needed in the future to investigate why certain relationships are insignificant and whether there are better measures that can reveal more insights into the role of IT in enhancing firm performance.

Conclusion

The paper contributes to increasing our theoretical and empirical understanding of how IT resources affect firm performance. We have presented a framework to exploring the relationship among resource, capability, and performance. A meta-analysis on 50 published studies was conducted to test the direct model and the mediated model that includes organizational capabilities as mediators between organization resources and firm performance. The results have shown that the mediated model can better explain the value of IT than the direct-effect model without organizational capabilities.

We have found that technology resources raise internal and external capabilities, which in turn affect firm performance. Organization resources positively affect organizational efficiency through its impact on internal capabilities. The results of this study provide direction for investing and managing organizational IT resources to enhance their performance. Managers can contribute to enhancing firm performance through transferring IT resources to firm's capabilities. Our study points to a better use of RBV model in future research on IT and firm performance.

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