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PERFORMANCE EFFECTS OF THE COMPLEMENTARITIES BETWEEN INFORMATION TECHNOLOGY CAPABILITIES AND FIRM COMPETENCIES: AN EMPIRICAL STUDY

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Abstract

This paper has developed a research model that examines the performance effects of the complementarities between information systems capabilities and firm competencies. Drawing from the resources-based theory, we posit that a firm's ability to create competitive advantage using information technology (IT) is a function of its ability to use IT to develop and enhance its core competencies. Other things being equal, organizations that target their IT resources towards their core competencies are likely to realize greater value from their information technology resources than those that are less focused in their IT deployment. Such targeted IT deployment is likely to create unique complementarities and inimitable capabilities that could be rent yielding. The model is empirically tested using data collected from 129 firms in the U.S. The results provide strong support for the research model. The results are interpreted and the implications of this study for IS research and practice are discussed.

Keywords: Information technology and strategy; competitive advantage; resource-based theory; core competencies

Introduction

The potential of Information Technology (IT) to provide firms competitive advantage has been a topic of interests to practitioners and academicians. This interest is reflected in the large number of studies that have examined the strategic value of IT and its impact on firm performance (e.g., Porter and Millar 1985; Bakos and Treacy 1986; Clemons and Row 1988; Kettinger, Grover, Guha, and Segars 1994; Bharadwaj 2000). In part, this attention to IT value stems from the significant investments organizations have made in information systems and the increasing role information technology plays in the strategic thinking of most organizations.

Despite significant work in this area, the need to examine the IT-firm performance relationship exists for two reasons. First, while studies have found that IT does impact firm performance, the underlying mechanisms by which IT relates to firm performance have not been systematically examined (Powell and Dent-Micallef 1997; Bharadwaj 2000). Past studies have investigated the IT-firm performance relationship at an aggregate level (e.g., Floyd and Wooldridge 1990; Brown, et al. 1995; Hitt and Brynjolfsson 1996; Bakos 1997; Mukhopadhyay, et al. 1995) and have attempted to quantify the marginal effects of IT investments on firm productivity, profitability and consumer surplus. Although, recent studies have provided evidence that IT contributes to firm performance (e.g., Hitt and Brynjolfsson 1996; Bakos 1997), the cumulative results have been mixed. Without systematic research on how and why IT leads to firm performance, it is difficult to reconcile the widely differing results presented in the literature.

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Second, the underlying theories used to explain why and how IT innovation contributes to firm performance have undergone a paradigm change creating a need for more current examination (Sambamurthy and Zmud 1997). Previously, the Structure-Conduct-Performance model of Industrial Organizations Economics (I/O) (Porter 1980, 1985) was the most dominant theory influencing the thinking of IS researchers on the strategic use of IT. Based on the I/O paradigm, several strategic frameworks to identify IT deployment opportunities have been proposed (e.g., Porter 1980, 1985; Benjamin et al. 1984; Ives and Learmonth 1984; McFarlan 1984; Porter and Millar 1985; Rockoff et al. 1985; Bakos and Treacy 1986). Although these frameworks are valuable in strategic opportunity analysis, they are deficient in explaining how a firm could use IT to create and sustain competitive advantage and generate above normal rents in the market place (Clemons and Row 1991; Kettinger et al. 1995; Mata et al. 1995). Since the I/O paradigm is based on an assumption that all firms in an industry are homogeneously endowed with resources and capabilities, they are not useful in understanding how IS capabilities could differentiate better performing firms from others in an industry (Clemons and Row 1991; Mata et al. 1995). Recently, IS researchers have used the resource-based theory (Barney 1991; Wernerfelt 1984) to reexamine the sources of IT-based competitive advantage. This stream of research has argued that IT-based competitive advantage stems from IS resources and capabilities and from how these resources are deployed (e.g., Ross, et al. 1997; Feeny and Willcocks 1998; Sambamurthy and Zmud 1997; Powell and Dent-Micallef 1997; Bharadwaj 2000). While a few studies have examined the strategic role of IS resources and capabilities, a clear understanding on these concepts and theoretical explanations about how these resources and capabilities enable business performance are underdeveloped. This paper draws from the resources-based theory and develops a research model that interrelates IT support for core competencies and firm performance. The model is empirically tested using data collected from 127 large firms in the U.S.

Background Literature

The resource-based view prescribes that firm resources are the main drivers of firm performance (Wernerfelt 1984; Dierickx and Cool 1988; Barney 1991; Grant 1991; Hall 1991, 1992). This theory makes a distinction between *resources*, *capabilities*, and *competencies*. *Resources* are stocks of available factors of production owned or controlled by a firm (Amit and Schoemaker 1993); these include fixed firm-specific inputs to the production process (Grant 1991). Resources can be tangible or intangible (Hall 1992). Intangible resources can be viewed as the "information-based resources," such as consumer trust, supplier relationships, management skills, distribution control, and reputation (Hall 1992). *Capabilities*, in contrast, refer to a firm's capacity to deploy resources using organizational processes (Amit and Schoemaker 1993). Capabilities can be viewed as the capacity of a team of resources to perform some task or activity (Grant 1991), and are often developed in functional and sub-functional areas by combining physical, human and technological resources (Amit and Schoemaker 1993). *Competencies* are the higher order capabilities that can be perceived as purposive combinations of firm-specific resources and capabilities that enable firms to accomplish a given organizational goal (Teece et al. 1997; McGrath et al. 1995), preferably in a manner superior to competitors (Hitt and Ireland 1985). Competencies stem from the idiosyncratic combination of resources and capabilities. Over time, firms accumulate unique combinations of resources and capabilities, which allow them to generate rents on the basis of distinctiveness (Selznick 1957). Firms earn above-average returns only when they can differentiate from competitors (Petaraf 1993). Therefore, in order to gain competitive advantage, firms must have some firm-specific competencies that are distinct as compared to its competitors. Distinctiveness does not necessarily mean having unique competencies; rather it could be the extent to which a firm might be better than its competitors in certain aspects.

Adopting the resource-based perspective IS researchers have pursued two general research themes to examine the strategic contributions of IT (e.g., Clemons and Row 1991; Mata et al. 1995; Ross et al. 1996; Feeny and Willcocks 1998; Sambamurthy and Zmud 1997; Bharadwaj 2000) (Table 1). First, some IS researchers have argued that IT alone may not be sufficient to create sustainable competitive advantage and that firms might gain and sustain IT-based competitive advantage by embedding IT in organizations in such a way as to produce inimitable resource complementarities (Clemons and Row 1991; Powell and Dent-Micallef 1997). From this perspective, benefits resulting from strategic IT applications can be readily defended if the applications exploit complementary resources of the firms so that competitors do not fully gain benefits from imitation. Clemons and Row (1991), for example, argued that IT can lead to sustainable competitive advantage when it is used to leverage differences in strategic resources, such as vertical integration, diversification. Powell and Dent-Micallef (1997) empirically tested the effects of complementarities between IT and firm resources such as human, business, and technology resources, on firm performance.

Second, some IS researchers have argued that only the intangible resources such as IS managerial capabilities and IS process quality are likely to be a source of sustainable competitive advantage and physical IS resources such as networks, databases and other hardware and software may not be rent yielding because they can easily be acquired by competitors, (Ross et al. 1996; Feeny and Willcocks 1998; Sambamurthy and Zmud 1997; Bharadwaj 2000). For example, Sambamurthy and Zmud (1997) argued that IT competencies, which are the fundamental capabilities, skills and tacit know-how that organizations develop over time, are key to acquire, deploy, and leverage the IT in pursuit of business strategies. Bharadwaj (2000) examined the relationship between IT

management capability and firm performance and found that firms with a higher capability tend to outperform those with a lower capability.

Table 1. Research Themes of Resource-Based View of Information Technology

Research Themes	Premises	Key References
Resource complementarities	Embedding IT in organizations in such a way as to produce valuable resource complementarities making it difficult to be imitated by rivals.	Clemons and Row (1991); Clemons (1991); Powell and Dent-Micallef (1997).
Strategic intangible resources	Intangible aspects of IT provide competitive advantages that are difficult to imitate.	Mata et al. (1995), Duncan (1995), Ross et al. (1996), Sambamurthy and Zmud (1996), Feeny and Willcocks (1998), Bharadwaj (2000)

Theory and Hypotheses

Drawing from the notion of resources complementarities we posit that a firm's ability to create competitive advantage using information technology (IT) is a function of its ability to use IT to develop and enhance its core competencies. Other things being equal, organizations that target their IT resources towards their core competencies are likely to realize greater value from their information technology resources than those that are less focused in their IT deployment. Such targeted IT deployment is likely to create unique complementarities and inimitable capabilities that could be rent yielding.

Firm Performance

In the IT-firm performance literature, several approaches have been proposed to measure the financial impacts of IT (e.g., Banker and Kauffman 1988; Clemons 1991; Kauffman et al. 1989). These studies have attempted to identify changes in financial indicators such as return on investment (ROI), return on assets (ROA), and sales growth that result from specific or a group of IT investment. These studies have showed promising results in linking IT and firm performance. In addition, many researchers also have emphasized the strategic impacts of IT on market share (e.g., Clemons 1986; Lieberman and Montgomery 1988; Kettinger et al. 1994). For example, Weill and Broadbent (1990) pointed out two strategic impacts of IT: gain a competitive advantage and gain market share via sales growth. Clemons (1986) stated that strategic systems have two sources of benefits to firms: increase profit margins and increased market share.

Drawing from the past research, this study defines firm performance in terms of two dimensions: operating performance and market-based performance. *Operating performance* refers to the fulfillment of economic goals of the firm, measured by a firm's financial performance (i.e., profitability). *Market-based performance* refers to the capability of firms to respond to competition, measured by market responsiveness (i.e., entering new market, market share). Both measures have been used extensively in the strategy and information systems literature to assess firm performance (e.g., Kettinger et al. 1994; Powell and Dent-Micallef 1997).

IT Support for Core Competencies

Core competencies are a basis for firms to compete in the market. In the dynamic business environment, successful companies have learned to identify, develop, and nurture a firm's core competencies. Drawing from Hamel (1994), we categorize core competencies into three groups: market-access, integrity-related, and functionality-related competencies. *Market-access competencies* include all those competencies that allow a firm to be in close proximity to its customers. Market-access competencies enable a firm to be able to segment and target markets precisely and tailor offerings to match exactly the demands of customers in a manner that is difficult for competitors to contest with. *Integrity-related competencies* include those competencies that allow a firm to offer reliable products and services at competitive prices and deliver them with minimal inconvenience. Finally, *functionality-related competencies* are those competencies that enable a firm to offer unique products and services to customers with distinctive customer benefits (i.e., new product development).

IT support for core competencies refers to the extent to which the firms use IT in business value chain activities to support and enhance the development and deployment a firm's core competencies. The IS literature suggests that IT is key to support the three

types of competencies discussed above. IT facilitates market-access competencies by improving customer services and marketing related activities. In addition, IT also eliminates the geographical barriers to new markets (Neumann 1994), and helps a firm identify the market trend (Mahmood and Soon 1991). Clemons and Weber (1994) illustrated the benefits that companies would gain through IT enabled market segmentation. These benefits include segmentation of customers, differentiation of service offerings (e.g. range of offered products and services to meet customer needs), and flexible pricing (e.g., charging different customers different prices). For example, as the dominant long distance provider to households, AT&T can offer highly tailored programs based on customers' usage.

IT can enhance a firm's integrity-related competencies by improving key business value chain activities by reengineering business processes, integrating supply chain, and enhancing business flexibility. Several authors have suggested a number of ways in which firms can utilize IT to support integrity-related competencies. For example, Davenport (1993) suggested nine ways use IT to redesign business processes, including eliminating human labor, capturing business process information, enabling parallelism, monitoring business process status, improving analysis of information and decision-making, coordinating business processes across distances, coordinating tasks between business processes, capturing and distributing intellectual assets, and eliminating intermediaries from business processes. Many organizations used IT to develop integrity-related competencies and leverage them to create and sustain competitive advantage. For example, Merrill Lynch succeeded with its Cash Management Account (CMA) because it could effectively manage its interdependent business processes to pool information from different financial products into an "integrated" product in response to strong market demands (Clemons and Row 1991; Venkatraman 1994).

IT facilitates functionality-related competencies by enhancing a firm's ability to provide innovative products and services and provide a firm an opportunity to expand its business scope. Many case studies have illustrated the ways in which IT is used to redefine and expand business scope. For example, Baxter Healthcare leveraged its Valuelink program to become a materials management consultant to hospitals (Venkatraman 1994). Otis Elevator leveraged IT-enabled features like remote elevator monitoring (REM) to expand its market share in the highly profitable elevator services business (Venkatraman 1994). More recently, IT is a fundamental element to support and implement business process innovations in many "dotcom" companies, such as E-bay, Priceline.com, and Expedia.com.

In sum, IT obviously is a strategic weapon for firms to create competitive advantage. However, the ways in which firms can protect IT-based competitive advantage is to use IT in such a way that it is embedded in an organization making it difficult to be imitated by competitors. Core competencies are a basis for firms to compete in the markets. Hence, the roles of IT in contributing to firm performance should aim to support the development and an enhancement of a firm's core competencies. Thus, the following hypotheses are proposed:

Hypothesis 1: *There is a positive relationship between IT support for core competencies and the operating performance of a firm.*

Hypothesis 2: *There is a positive relationship between IT support for core competencies and the market-based performance of a firm.*

Methodology

Data Collection

Data for testing the research model was collected though a survey. The mailing list for the survey was constructed to include *Fortune 1000* firms and large organizations in the northeast region of the US. The names, titles, addresses, and phone numbers of top computer executives for the firms in our mailing list were obtained from the *Directory of Top Computer Executives* (1999). Totally, seven hundred and ten questionnaires were effectively mailed out. 129 responses were received resulting in a response rate of 18.2 %. Fifty percent of the respondents were either chief information officers or vice presidents of information systems, and 89.9% of respondents were within two levels from the highest position in their organization. The firms that responded represented a wide cross section of industries. 51.2% of the firms had 5000 or less employees, 12.4% had between 5001 and 10000 employees, 15.5% had between 10001 and 25000 employees, and 15.5% had grater than 25001 employees.

Measures

Firm performance was measured by the respondent's assessment of the firm's performance position (1-strongly disagree, 4-neutral, 7-strongly agree) over the past 3 years on two dimensions: (1) operating performance, and (2) market-based performance. Operating performance was measured by using three items. Two items pertain to a firm's financial performance; one item pertains to profitability. Market-based performance was measured by using three items. Two items measure a firm's ability to introduce new products and services to the market, and one item measures a firm's ability to enter new markets. We validated our firm performance measure by examining their correlation with the change in objective performance measures such as return on sales and sales growth during a 3-year period (1997- 1999). The results indicated that operating performance was significantly correlated with ROS (0.401; $p < 0.01$) and market-based performance was significantly correlated with the sale growth (0.282; $p < 0.05$). The results suggest that our firm performance measures have acceptable validity.

IT support for core competencies was measured by the extent to which a firm is capable of using IT in business value chain activities to support and enhance the development and deployment of a firm's core competencies. Drawing from prior studies (e.g., Sethi and King 1994; Mahmood and Soon 1991; Venkatraman 1991), an 18-item scale was developed to tap the extent of the strategic use of IT in supporting three main categories of core competencies. The respondents were asked to rate (1-not used at all, 7-extensively used) the extent to which a firm uses information technology to support the three categories of core competencies: *IT support for market-access competencies, IT support for integrity-related competencies*, and *IT support for functionality-related competencies*.

Analysis and Results

The Partial Least Square (PLS) was a statistical approach to testing the research model. There were three constructs in the model: IT support for core competencies, operating performance, and market-based performance. IT support for core competencies were conceptualized as a formative construct with three underlying indicators: IT support for market-access competencies, IT support for integrity-related competencies, and IT support for functionality-related competencies. Operating performance and market-based performance were reflective construct with single indicator. Indicators underlying each construct were derived from the average score of the items used to measure those indicators.

In assessing the measurement model for the formative constructs, only the weights, which have a regression-like relationship between indicators and the latent construct need to be considered (Chin 1998). Prior studies adopted PLS approach suggested that the statistical significance of the weights can be used to determine the relative importance of the indicators in forming a latent construct (Ravichandran and Rai 2000). Table 2 shows the results of statistical significant of weights for the research model. All except one indicator, IT support for integrity-related competencies (-0.19; t=1.58), were statistical significant. This indicator was dropped for further analysis. Table 2 shows the statistical significance of the loadings and weights of the formative indicators in the revised model.

Table 2. Weights and Loadings for the Initial Model & Revised Model

Model	Constructs	Indicators	Weights	Loadings
Initial Model	IT Support for Core Competencies	IT support for market-access competencies	0.23*	0.80**
		IT support for integrity-related competencies	-0.19	0.57**
		IT support for functionality-related competencies	0.94**	0.98**
Revised Model	IT Support for Core Competencies	IT support for market-access competencies	0.21*	0.81**
		IT support for functionality-related competencies	0.83**	0.99**

*$p \leq 0.05$, **$p \leq 0.01$

Figure 1 shows the path coefficients and R^2 values of the model. The results indicate that the full model explained 16% of the variance in operating performance and 22% of the variance in market-based performance. Furthermore, all path coefficients were significant. Specifically, IT support for core competencies positively and significantly impacts operating performance and market-based performance with the path coefficients values of 0.40 and 0.47 respectively. These empirical results provide strong support for the two stated hypotheses.

Discussion

The results from our empirical analysis show that IT support for core competencies significantly effect firm performance, particularly operating performance and market-based performance. Interestingly, we found that IT support for core competencies has a greater effect on market based performance than operating performance. The results from our empirical study strongly support the theoretical arguments that firms that target IS resources and capabilities towards enhancing their core competencies are likely to be more successful (Ravichandran and Lertwongsatien 2000). Moreover, the results reported here help explain why IT investment does not produce direct superior financial performance in some cases. Our findings suggest that IT would provide firms performance advantage when they are used to foster firm-specific core competencies. This observation is similar to those proposed by several IS researchers (e.g., Weill 1992; Clemons and Row 1991; Powell and Dent-Micallef 1997). From this view, firms gain IT-related advantage by embedding IT with a firm's complementary resources, providing competitive advantages that are difficult to be imitated.

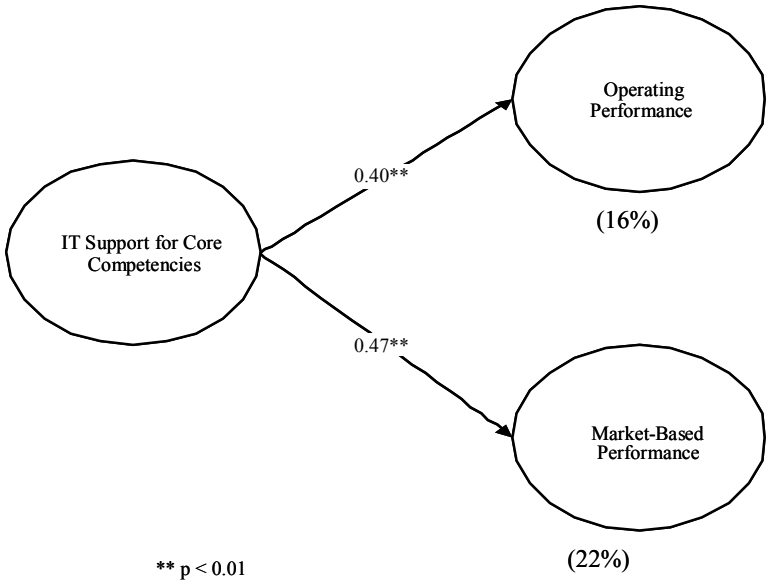

Figure 1. Path Coefficients and Significant Paths of the Research Model

This study provides a theoretical framework to explain how firms attain superior performance through IT. This study has also developed and validated an instrument that can be used to measure key indicators of IT support for core competencies. From a practical viewpoint, it provides guideline on key business strategies for firms to use IT for developing and sustaining competitive advantage. In general, this study makes a significant contribution in advancing our understanding of how firms gain and sustain competitive advantage through information technology.

References

Available upon request.