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Firm-level performance impact of IS support for product innovation

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Abstract

Purpose – This paper seeks to assess the bottom-line (profitability) impact of information systems support for product innovation at the firm level, based on the current resource-based view of the competitive role of information systems (IS). The paper also explores the role of firm-specific information and knowledge that complement IS support for product innovation in moderating the performance impact of the IS support.

Design/methodology/approach – Both survey and archival data were used to assess the profitability impact of IS support for product innovation. Data tapping IS support for product innovation and firm-specific, complementary information and knowledge were collected from a survey of senior IS executives from 760 large companies operating in different industries in the United States. The profitability data were obtained from the Research Insight database. Hierarchical regression analyses were employed to test the research hypotheses.

Findings – Providing IS support for product innovation alone did not improve profitability as measured by return on sales and return on assets. Only when complemented by firm-specific information and knowledge would IS support for product innovation lead to profitability gains. Research limitations/implications – the use of cross-sectional data collected from single informants and the coarse scales to measure the key variables may limit the usefulness of the research findings.

Practical implications – It is not sufficient for a firm to simply focus on selecting or designing IS that improve the efficiency and effectiveness of its product development process. Rather, the firm and its managers need to pay equal attention to the deployment of firm-specific information and knowledge resources which would not only facilitate the use and implementation of IS for production innovation, but also make such IS less susceptible to imitation by competitors.

Originality/value – This article provides further evidence for the positive influence of IS-based product innovation on the bottom-line performance of firms and uses the resource-based view of the strategic impact of IS to identify one condition under which such influence may occur. Unlike prior research that gauges the performance effects of IS support for product innovation at the project or department level, this research generates evidence for profitability gains accruing from IS support at the firm level.

Keywords Company performance, Competitive advantage, Information systems, Product innovation

Paper type Research paper

Introduction

With the widespread recognition of product innovation as a dynamic organizational capability that enables a firm to achieve and maintain competitive advantage (Brumagim, 1994; McGrath *et al.*, 1996; Teece *et al.*, 1997; Eisenhardt and Martin, 2000), researchers of innovation management and information systems (IS) have devoted lots of attention to the roles of IS in product development and innovation (Davenport, 1993; Alter, 1996; Nambisan, 2003; Pavlou and El Sawy, 2006; Alonso *et al.*, 2010) during the past two decades. While a great deal has been written about how IS can be used to help firms develop new products for competitive success, much fewer research efforts have

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been made to address a critical issue of whether providing IS support for product innovation can actually lead to competitive advantage and superior firm performance. Moreover, prior empirical studies assessing the performance impact of IS support for product innovation tended to focus on evaluating the operational benefits (e.g. reduction in the cycle time and costs of new product development) of the IS support at the project or department level (Laurindo and Carvalho, 2005; Durmusoglu *et al.* 2006; Pavlou and El Sawy, 2006). It then begs the question of whether the operational benefits accrued from the IS support would eventually turn into competitive advantage at the firm level. Indeed, as computer hardware and software become inexpensive, accessible and easy to imitate these days, IS have been increasingly viewed as a "strategic necessity" which is unlikely to create and sustain competitive advantage (Mata *et al.*, 1995; Carr, 2003). The extant literature on the performance impact of IS is replete with studies that showed either null effect or negative effect of IS (Brynjolfsson and Hitt, 1996; Martinsons and Martinsons, 2002). Without empirical work ascertaining the relationship between IS support for product innovation and the bottom-line performance (e.g. profitability) of firms at the firm level, firms and their managers do not have sufficient evidence to base their decisions as to whether they should increase their investment in and deployment of IS resources for new product development. One study in the literature made an attempt to link the interaction between information technology (IT) capital and innovation capital to firm-level profitability (Huang and Liu, 2005). Unfortunately, while finding a synergistic effect between IT capital and innovation capital, the study did not measure specific support the IT capital provided to product innovation. It then remains unclear whether and how the IT capital facilitated product innovation for profitability gains.

Another issue not addressed in the previous assessments of the performance impact of IS support for production innovation is under what conditions such IS support may confer competitive advantage and superior firm performance. Current research on the competitive impact of IS from the resource-based perspective (Barney, 1991) suggests that one condition may be the relationship between the IS support and other organizational resources. For the past decade, IS researchers have increasingly entertained the view that firms complementing their IS with other firm-specific and hard-to-copy organizational resources are in a better position to defend their IS-derived competitive advantage than those that lack such resources (Clemons and Row, 1991; Powell and Dent-Micaleff, 1997; Bharadwaj, 2000). According to this line of reasoning, although the necessary software and hardware used by a firm's IS can be easily imitated, it is more difficult for the competition to copy the unique and intangible resources the firm uses in implementing and exploiting its IS. Moreover, blending IS with other organizational resources may create a complex set of complementary resources that are not easily matched by competitors, thus sustaining IS-based advantage (Bharadwaj, 2000). Hence, investigating the potential performance impact of the complementarity between certain organizational resources and IS support for product innovation may increase our understanding of the conditions under which the firm is more likely to reap the competitive benefits from providing IS support for product innovation.

The purposes of this study were two fold. First, it sought to assess the relationship between IS support for product innovation and the bottom-line performance of firms at the firm level. Unlike other empirical studies which mainly gauged the operational

benefits of IS support for product innovation, this research assessed the bottom-line (profitability) impact of the IS support. Furthermore, the study employed the resource-based theory of competitive advantage (Barney, 1991) to identify two organizational resources (firm-specific information and knowledge) complementing IS used for product innovation and examine their roles in moderating the relationship between IS support for product innovation and firm profitability. The rest of the paper is structured as follows. It starts with a discussion of product innovation as a dynamic organizational capability based on the resource-based theory of competitive advantage in the strategic management literature. This is followed by a review of the current resource-based view of the competitive impact of IS and the extant research that deals with IS support for product innovation and its effects on firm performance. The potential moderating role of firm-specific information and knowledge that complement IS support for product innovation is then examined. The methodology section describes the research method, including sample and data collection, measures and statistical analyses. The last section presents the research findings and discusses their implications for future research and practice, as well as the limitations of the study.

Product innovation as a dynamic organizational capability

As a popular theoretical perspective in the strategic management literature, the resource-based theory of competitive advantage suggests that firms with unique and difficult to imitate or substitute resources and capabilities can gain sustainable competitive advantage and superior performance (Barney, 1991). In recent years, resource-based scholars have placed increasing emphasis on dynamic organizational capabilities as key sources of sustainable competitive advantage. As more and more industries and markets are facing rapid and unpredictable changes nowadays, there is growing recognition in the resource-based research that the mere possession of an appreciate bundle of specific resources and capabilities is insufficient for a firm to sustain competitive advantage in such an environment. Rather, the firm must constantly develop new resources and capabilities for dealing with the new market demands in order to survive and prosper (Teece *et al.*, 1997; Eisenhardt and Martin, 2000; Rindova and Kotha, 2001). The development of new resources and capabilities in turn requires dynamic organizational capabilities which enable the firm to "integrate, build, and reconfigure internal and external competencies" (Teece *et al.*, 1997). Over the past decade, resource-based researchers have identified a number of value-creating dynamic capabilities, among which is product innovation (Eisenhardt and Martin, 2000; Adner and Helfat, 2003). Product innovation is viewed as a dynamic organizational capability because it is one of the organizational routines through which firms combine, recombine or renew different skills, assets and processes to create revenue-producing products or services (Kogut and Zander, 1992; Eisenhardt and Martin, 2000; Danneels, 2002). The strategic value of product innovation also lies in its idiosyncrasy, that is, product innovation often involves the use of firm-specific resources and processes and is path-dependent (Teece *et al.*, 1997; Eisenhardt and Martin, 2000).

IS support for product innovation and firm performance

Current resource-based research on the strategic roles of IS reveals that IS may play an indirect (supporting) role in influencing the competitive performance of firms (Wade and Hulland, 2004). It is argued that IS may contribute to competitive advantage to the

extent that they are deployed to support the creation or leveraging of rent-yielding, distinctive organizational capabilities that are hard to imitate or substitute (Lado and Zhang, 1998; Byrd, 2001; Ravichandran and Lertwongsatien, 2005). Moreover, such deployment of IS may create a complex set of complementary resources that are not easily matched by competitors, hence generating sustainable competitive advantage (Bharadwaj, 2000). There is growing empirical evidence for this supporting role of IS in the current literature (Powell and Dent-Micallef, 1997; Bharadwaj, 2000; Tippins and Sohi, 2003; Ravichandran and Lertwongsatien, 2005; Zhang, 2007). For instance, Bharadwaj (2000) compared a group of IT-leading firms (firms that used IT to develop certain intangible resources, customer orientation, knowledge assets and synergy) to a matched control sample of firms with regards to several key profit and cost ratios, and she found that the IT leaders outperformed the control firms.

With increasing infusion of IT in the organizational innovation process over the past two decades, IS have now become an integral part of a firm's capability to pursue business innovation and growth in general (Alonso *et al.*, 2010) and develop new products in particular (Nambisan, 2003). Prior research on IS applications in product innovation has shown that IS can be developed and deployed to enhance the efficiency and effectiveness of new product development (Sanchez, 1995; Nambisan, 2003; Pavlou and El Sawy, 2006; Alonso *et al.*, 2010) and thereby improve profitability (Henard and Szymanski, 2001; MacCormack *et al.*, 2001). For example, IS designed for concurrent engineering (e.g. CAD, CAM and CAE) have been found as a useful tool for enhancing communication and collaboration among cross-functional product teams, hence reducing time and costs in new product development (Sanchez, 1995; Pavlou and El Sawy, 2006). Besides saving time and costs, IS can be used to create some unique opportunities for product innovation. Alter (1996) noted that a firm could make a product more useful or less costly by building IS into the product or using IS to bundle more information or knowledge with the product. An increasing number of empirical studies have showed that effective IS deployment to support product innovation may not only significantly reduce the costs of product modification and development, but also improve product innovativeness and flexibility (Corso and Paolucci, 2001; Laurindo and Carvalho, 2005; Durmusoglu *et al.*, 2006; Pavlou and El Sawy, 2006; Barczak *et al.*, 2007). For instance, in a recent study of IS use in new product development, Pavlou and El Sawy (2006) found that firms which effectively utilized IS (such as knowledge management systems and cooperative work systems) to enhance their product development capabilities were more efficient in the new product development process and more effective in product innovativeness and improvements. While the prior empirical research gauged the impact of IS support for product innovation mainly in terms of operational benefits, one study by Huang and Liu (2005) found that IT capital (as measured by IT intensity) interacted with innovation capital (as measured by R&D intensity) in influencing returns on assets (ROA) and returns on sales (ROS). Although the researchers did not specify what types of support were provided by the IT in their study, their finding implied that higher levels of profitability might accrue from IS related to investment in innovation. In view of the normative and empirical literatures reviewed above, IS support for product innovation was expected to positively influence a firm's profitability.

H1. IS support for product innovation is positively related to firm-level profitability.

The moderating role of firm-specific, complementary information and knowledge

While a firm may improve its competitive performance through deploying IS to support product innovation, one may argue such IS deployment is subject to easy imitation because many IS lack characteristics that are unique or difficult to copy (Mata *et al.*, 1995; Carr, 2003). However, drawing on the notion of complementary assets (resources whose presence enhances the values of other resources) from the resource-based literature (Teece, 1986), IS researchers have argued that firms with certain firm-specific and hard-to-copy resources that complement their IS are in a better position to defend their IS-derived advantage than those that lack such resources (Clemons and Row, 1991; Wade and Hulland, 2004). This argument has received some empirical support from several studies that found IS complemented by other intangible organizational resources yielded competitive advantage (Powell and Dent-Micallef, 1997; Bharadwaj, 2000; Zhang, 2007). In a study of the competitive impact of IT in the US retail industry, Powell and Dent-Micallef (1997) found some retailers gained performance advantages from complementing intangible human resources with IT resources. The resource complementarity argument thus suggests that the presence of certain organizational resources that complement IS used for product innovation may influence the extent to which firms derive profitability improvements from IS-based product innovation. In other words, complementary organizational resources may provide the context in which the profitability impact of IS support for product innovation may exist. Among the organizational resources that might differentiate firms' ability to develop and deploy IS for product innovation successfully are their information and knowledge resources (Feeny and Ives, 1990; Lei *et al.* (1996). The influence of these resources on the relationship between IS support for product innovation and profitability is discussed below.

It is well recognized in the product innovation literature that information and knowledge about the firm's customers, suppliers and internal processes and capabilities play a pivotal role in new product development (Kotha, 1995; Sanchez, 1995; Hong *et al.*, 2004). Hong *et al.* (2004) argued that the essence of new product development is about matching customer needs with the engineering and manufacturing capabilities of a firm and its suppliers. Therefore, information and knowledge about what customers require, what a firm is capable of designing and producing, and what capacities the firm's suppliers have are critical to the effectiveness and efficiency of the new product development process. Furthermore, the idiosyncrasy of a firm's information and knowledge about its customers, suppliers and internal capabilities may make the firm's IS support for product innovation more valuable. Although many firms may potentially develop and use similar IS to pursue product innovation, only firms with unique market information and knowledge (e.g. proprietary databases of customers and markets) are in a better position to gain and maintain competitive advantage from IS-based product innovation. In other words, the presence of proprietary information and knowledge confers additional value to a firm by making it difficult for its competitors to reap the same benefits the firm accrues from the IS support (Feeny and Ives, 1990).

Firm-specific knowledge not only affects the new product development process, but also influences the deployment of IS for product innovation. Lei *et al.* (1996) noted that the long-term implementation success of IS hinges on the richness of a firm's tacit

knowledge (the insights, heuristics and experiences of the firm's employees) applied in the procedures and workflows involved in the use of IS. Moreover, firms that are successful in mobilizing their unique employee knowledge and skills to implement IS for product innovation are more likely to deter imitation of their IS because those complementary knowledge and skills tend to be contingent on firm-specific organizational routines developed over an extended period of time. In their analysis of the imitability of IS management skills, Mata *et al.* (1995) argued that a firm's skills in implementing and managing IS often require long periods of practice and learning and involve complex social relations. Kotha (1995) studied the successful experience of product development in a Japanese bicycle manufacturer (National Bicycle Industrial Company (NBIC)) and observed that the main rivals of NBIC had a hard time trying to imitate the company's IS supporting its product development capabilities because NBIC's IS were bundled with in-house engineering and manufacturing expertise accumulated over many years. In light of the above reasoning, firm-specific information and knowledge that complement IS used for product innovation were expected to enhance the profitability influence of IS support for product innovation.

H2. Firm-specific, complementary information and knowledge strengthen the relationship between IS support for product innovation and firm-level profitability

Methodology

Sample and data collection

This study used both survey and archival data to test its hypotheses. The data tapping the independent and moderating variables were collected from a mail survey, while the data about the dependent and control variables were obtained from the Research Insight Database. The target respondents of the survey were senior IS executives in large (*Fortune*) companies in the USA. Before being mailed out, the survey instrument was pre-tested and refined with senior IS executives from several companies headquartered in a mid-western state. Out of the 760 companies that received the questionnaires, 150 usable responses were received, resulting in an effective response rate of 20 percent. Of the responding firms, 71 (47 percent) were manufacturers; 43 (29 percent) were service companies; 19 (13 percent) were in wholesale or retail trade; and 17 (11 percent) were in the transportation or public utilities segments.

To test for potential nonresponse bias in the sample, the respondent firms were compared to their non-respondent counterparts with respect to sales and number of employees. *T*-test results showed no significant differences between the two groups in those two characteristics. In keeping with Armstrong and Overton (1977), another nonresponse bias check was conducted by comparing early with late respondents. *T*-tests of the mean differences for the two explanatory variables failed to reveal any significant differences. Together, these checks provided some evidence for the absence of non-response bias in the data set.

Measures

In this study, IS support for product innovation was defined as the extent to which IS was used to reduce product development costs and increase product innovativeness. This construct was measured with six items on a five-point, Likert-type scale developed based on the ideas of Sanchez (1995), Alter (1996), Nambisan (2003), and

Pavlou and El Sawy (2006). For each item, the respondents were asked to indicate the extent to which their IS had provided a particular type of support for product innovation. A principal components factor analysis (with varimax rotation) of the six items revealed a single factor explaining about 60 percent of the total variance and thus supported the unidimensionality of the scale ($a = 0.87$). The items and their factor analysis are presented in Table I.

Firm-specific, complementary information and knowledge were measured with two items on a five-point, Likert-type scale ($a = 0.57$). For each item, the respondents were asked to indicate the extent to which the use and implementation of their IS required:

- firm-specific knowledge, skills or experience; or
- proprietary databases.

The profitability of the sample firms was measured in terms of ROS and ROA. Both profitability ratios have been frequently used in previous assessments of the strategic impacts of IS (Kettinger *et al.*, 1994; Brown *et al.*, 1995; Tam, 1998; Li and Ye, 1999). To smooth annual fluctuations and average out short-term effects, a three-year average was used for both measures.

Five control variables were employed to control industry conditions, firm size, and organizational slack. Since the firms participating in the survey came from a variety of industries, it was necessary to control, to some degree, the different industry conditions under which the firms operated. To control the industry effects, SIC codes were first used to classify the firms into four groups:

(1) manufacturing;
(2) transportation and public utilities;
(3) wholesale and retail trade; and
(4) service.

Where a firm operated in more than one industry, the firm's SIC code was determined by identifying the industry from which the firm received the largest percentage of sales and the corresponding SIC code.

Item description	IS support for product innovation
To what extent have your company's IS provided each of the following support?	
1. Reduce the cost of tailoring products/services to market segments	0.761
2. Reduce the cost of modifying or adding features to existing product/services	0.774
3. Reduce the cost of designing new products/services	0.749
4. Provide unique opportunities for product/service innovation	0.812
5. Bundle more information with products/services	0.803
6. Build information systems into existing products/services to enhance their value	0.759
Eigen value	3.62
% of common variance explained	60.32
Cronbach alpha	0.87

Table I.
Factor analysis of IS support for product innovation

Three dummy variables (each with values of 0 or 1) were then created for the second (transportation and public utilities), the third (wholesale and retail trade) and the fourth (service) groups of firms. For each dummy variable, a firm was assigned a value of 1 if it belonged to a group.

Firm size has frequently been used as a control variable in other studies involving firm performance as a dependent variable (Tam, 1998; Li and Ye, 1999). In keeping with convention, firm size was measured as the number of full-time employees. Another control variable was organizational slack which is indicative of a firm's ability to generate cash flow for reinvestment (Chakravarthy, 1986). Organizational slack needs to be controlled due to its potential influence on a firm's financial performance as well as the firm's ability to invest in and develop IS (Kettinger *et al.*, 1994; Li and Ye, 1999). A traditional ratio, the current ratio (current assets to current liabilities), was used to measure organizational slack (Bourgeois, 1981).

Statistical analyses

Since the second research hypothesis proposed IS support for product innovation interacts with firm-specific, complementary information and knowledge in determining profitability, hierarchical multiple regression analysis was employed to test the interactive effect (Arnold, 1982; Sharma *et al.*, 1981). Hierarchical multiple regression analysis can also test the main effect proposed in the first research hypothesis. Two sets of hierarchical multiple regression analyses were performed, using ROS and ROA as the dependent variables. In the first stage of the analyses, the five control variables were entered as a set into the regression models to control their potential effects. In the second stage, the independent variables (IS support for product innovation) and the moderating variable (firm-specific, complementary information and knowledge) were added to the model to separate their potential main effects. In keeping with Aiken and West (1991), both variables were mean-centered before being entered into the models. In the third stage, the two-way interaction term between the independent variable and the moderating variable were added to the equation to detect any potential interactive effect.

Findings and discussion

Table II reports the means, standard deviations and zero-order correlations for all the variables. The correlations indicated that IS support for product innovation was not significantly related to either ROS or ROA. IS support for product innovation was also not significantly associated with firm-specific, complementary information and knowledge.

Table III presents the results from the hierarchical regression analyses. Models 2 and 5 showed that IS support for product innovation was not significantly associated with either ROS or ROA. Hence, *H1* was not supported. On the other hand, the interaction term was significantly related to both ROS ($b = 0.16$, $p < 0.05$) and ROA ($b = 0.20$, $p < 0.05$) in the expected direction (see Models 3 and 6). To probe the patterns of the significant interactive effects, the interactions were plotted using one standard deviation above and below the mean to represent high and low levels of the moderating variable (Cohen and Cohen, 1983). The two plots in Figure 1 indicate the effects of IS support for product innovation on ROS and ROA were both positive when complementarity from firm-specific information and knowledge was high. In contrast,

Table II.
Means, standard deviations and correlation coefficients

Variable	Mean	SD	1	2	3	4	5	6	7	8
1. Return on sales	0.05	0.06								
2. Return on assets	0.04	0.05	0.49							
3. Transportation and public utilities	0.08	0.28	0.01	−0.01						
4. Wholesale and retail trade	0.16	0.37	−0.27	−0.11	−0.14					
5. Service	0.26	0.44	0.43	−0.22	−0.18	−0.26				
6. Number of employees (in thousands)	34.70	63.00	−0.09	0.18	0.10	0.22	−0.27			
7. Current assets to current liabilities	1.89	3.02	0.01	−0.05	−0.09	−.04	0.22	−0.24		
8. IS support for product innovation	3.14	0.85	0.09	−0.04	0.05	−0.01	0.1	−0.06	−0.04	
9. Firm-specific, complementary information and knowledge	3.57	0.92	0.07	0.10	0.12	0.09	−0.01	0.15	0.05	0.08

Notes: $n = 150$; correlations greater than or equal to 0.14 are significant at the 0.10 level; $r \geq 0.16$ are significant at the 0.05 level; $r \geq 0.21$ are significant at the 0.01 level; $r \geq 0.26$ are significant at the 0.001 level; all two-tail tests

Table III. Regression results

Variables	ROS Model 1	Model 2	Model 3	ROA Model 4	Model 5	Model 6
Industry dummy 1	0.06	0.04	0.01	−0.10	−0.11	−0.15*
Industry dummy 2	−0.16**	−0.17**	−0.16**	−0.23***	−0.24***	−0.23***
Industry dummy 3	0.42****	0.41****	0.40****	−0.26***	−0.26***	−0.28***
Firm size	0.03	0.02	0.02	0.18**	0.17*	0.17**
Current ratio	−0.08	−0.09	−0.09	0.04	0.03	0.03
IS support for product innovation		0.03	0.01		−0.02	−0.04
Firm-specific, complementary information and knowledge		0.08	0.07		0.11	0.09
IS support for product innovation × firm-specific, complementary information and knowledge			0.16**			0.20**
R^2	0.22	0.23	0.25	0.11	0.13	0.16
ΔR^2		0.01	0.02		0.02	0.03
Adjusted R^2	0.19	0.19	0.21	0.08	0.08	0.12
F	8.23****	6.04****	5.98****	3.77**	02.97***	3.52****
ΔF		0.65	4.57**		0.96	6.56**

Notes: $n = 150$; standardized regression coefficients are shown; $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$; $^{****}p < 0.001$

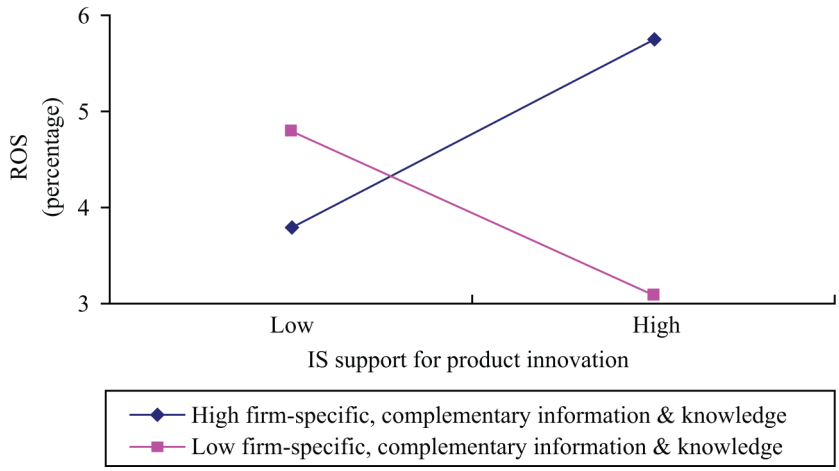

Figure 1.
Moderating effects of firm-specific, complementary information and knowledge

IS support for product innovation was negatively related to both ROS and ROA when complementarity from firm-specific information and knowledge was low. Thus, the regression results and the interaction plots provided support for *H2*.

The findings from this study were consistent with those found in recent studies of the performance impact of IS used in product innovation (Corso and Paolucci, 2001; Pavlou and El Sawy, 2006; Barczak *et al.*, 2007) and provided further evidence for the positive influence of IS-based product innovation. Unlike the prior research that mainly gauged the performance effects of IS support for product innovation at the project or department level, this research generated evidence for profitability gains accruing from the IS support at the firm level. With more empirical support for the bottom-line benefits from providing IS support for product innovation, firms and managers have a stronger rationale for investing in the development and deployment of IS for product innovation. While upholding the value of IS support for product innovation, the study findings should not be interpreted as calling for making one-time investment in IS support for product innovation. As shown in a recent study by Stratopoulos and Lim (2010), a firm is more likely to achieve sustainable competitive advantage and superior performance through continuous development and deployment of IS to innovate over a long period of time.

Another contribution from the study is that it highlighted the roles of certain complementary organizational resources (firm-specific information and knowledge) in moderating the relationship between IS support for product innovation and the bottom-line performance of firms. Without the support of these complementary resources, IS support for product innovation may not improve the profitability of a firm. Consequently, future studies need to incorporate firm-specific organizational resources that complement IS used for product innovation in assessing the performance impact of IS support for product innovation. So far, the moderating roles of these complementary resources have not received much research attention in the extant literature. Besides firm-specific information and knowledge, other possible types of organizational resources that may affect the effective use and implementation of IS for product innovation include organizational culture and structure, trust and

absorptive capacity (Powell and Dent-Micallef, 1997). Since these resources tend to be firm-specific and hard to imitate, they might help a firm defend its advantage from providing IS support for product innovation and thus warrant investigation in future research.

In a larger sense, this paper contributes to the on-going debate about the strategic role of IS. On one hand, as computer hardware and software become inexpensive, accessible and easy to imitate these days, some researchers view of IS as a "strategic necessity" which is unlikely to create and sustain IS-based competitive advantage (Mata *et al.*, 1995; Carr, 2003). On the other hand, scholars rooted in the resource-based view of competitive advantage argue that IS may still play an important strategic role. That is, IS can be a source of competitive advantage and superior economic performance if they provide support to the development and deployment of certain distinctive organizational capabilities tied to sustainable competitive advantage (Lado and Zhang, 1998; Byrd, 2001; Ravichandran and Lertwongsatien, 2005). By finding some positive performance effects of IS support for product innovation, this study lends additional empirical support to the latter view. Moreover, the study increases our understanding of the conditions under which IS support for product innovation may improve a firm's bottom-line performance.

The main managerial implication from this study is that firms should continue to invest in and deploy IS that support product innovation. Furthermore, since the presence of firm-specific, complementary information and knowledge was found as important as IS support for product innovation in gaining competitive advantage, it is not sufficient for a firm to simply focus on selecting or designing IS that improve the efficiency and effectiveness of its product development process. Rather, the firm and its managers need to pay equal attention to the deployment of firm-specific information and knowledge resources which would not only facilitate the use and implementation of IS for production innovation, but also make such IS less susceptible to imitation by competitors.

The findings from this study need to be interpreted within its limitations. First, derived from cross-sectional data, the significant results found herein proved only association, not causality. Second, the study relied on perceptual data collected from single informants in measuring the independent and moderating variables. Data collected in such a manner may be subject to the respondents' cognitive biases and distortions. On the other hand, by employing objective measures of the performance and control variables, the study reduced similar biases and inaccuracies in collecting the data for those variables and avoided the problem of "common method variance." Another limitation of the study lies in the coarse measures of the key variables. Future studies need to develop and use more fine-grained scales to measure IS support for product innovation as well as the complementary organizational resources.

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