PERFORMANCE EFFECTS OF INFORMATION TECHNOLOGY SYNERGIES IN MULTIBUSINESS FIRMS

By: Hüseyin Tanriverdi
Department of Management Science and Information Systems
Red McCombs School of Business
University of Texas at Austin
CBA 5.202 B6500
Austin, TX 78712
U.S.A.
Huseyin.Tanriverdi@mccombs.utexas.edu

Abstract

Unlike technologies that are applicable in a few specific industries, information technologies have a wide range of applicability across almost all industries. The fundamental principles of good IT management are also applicable in many industries. Thus, firms whose business units operate in different industries have an opportunity to exploit cross-unit IT synergies by applying their IT resources and management processes across multiple units. This study examines sources of cross-unit IT synergy and the conditions under which cross-unit IT synergies improve the performance of multibusiness firms. Building on the resource-based view of diversification and the economic theory of complementarities, the study identifies the relatedness and complementarity of IT resources as two major sources of cross-unit IT synergy. It argues that IT relatedness—the use of common IT infrastructure technologies and common IT management processes across business units—creates sub-additive cost synergies, whereas complementarities among IT infrastructure technologies and IT management processes create super-additive value synergies. In a sample of 356 multibusiness Fortune 1000 firms, the study finds that sub-additive cost synergies arising from the use of related IT resources or management processes do not have any effects on corporate performance, whereas the super-additive value synergies arising from the use of a complementary set of IT resources and management processes have significant effects on corporate performance. The diversification level of the firm moderates the relationship between IT synergies and corporate performance. As the diversification level increases, the performance effects of IT synergies remain positive, but they become weaker. The IT governance mode of the firm (centralized, decentralized, hybrid) does not make a difference in the performance effects of IT synergies.

Keywords: Corporate performance, multibusiness firm, synergy, relatedness, complementarity, diversification, IT governance, coordination, survey, second-order construct

Introduction

This study conceptualizes sources of information technology synergy and the conditions under which IT synergies improve the corporate performance of multibusiness firms. IT is a strategic organizational resource (Wade and Hulland 2004). U.S. corporations allocate more than 50 percent of their capital investments and 4.2 percent of their annual revenues to IT (Weill and Ross 2004). Managers are under constant pressure to reduce costs and increase the value of their firm’s IT resources.

The challenge is particularly salient in firms with business units operating in different industry segments. Since different industries have different competitive imperatives, business units usually seek autonomy from the center when developing their IT strategies, IT
infrastructures, IT vendor relations, and IT human resources. The lack of coordination among these activities creates significant duplication across the firm. Most duplication is preventable since IT infrastructure technologies (e.g., hardware, software, and communications) and fundamental principles of good IT management (e.g., alignment of business and IT strategies, management of IT vendors, management of IT talent) are applicable across many industries. Multibusiness firms have an opportunity to exploit cross-unit IT synergy by using common IT resources and management processes across their business units.

The exploitation of cross-unit synergy is a major determinant of corporate performance in multibusiness firms (Tanriverdi and Venkatraman 2005). Research to date has focused almost exclusively on the performance effects of cross-unit business synergies. Despite the strategic importance of IT (Wade and Hulland 2004), and the applicability of IT resources across a wide range of businesses, researchers have not yet examined whether IT is a significant source of cross-unit synergy, and whether and under what conditions cross-unit IT synergies improve the corporate performance of multibusiness firms.

While some information systems studies recognize IT resources as a source of cross-unit synergy (Brown and Magill 1998; Sambamurthy and Zmud 1999), they do not theorize about cross-unit IT synergies or their performance effects. The IS literature also focuses mainly on cross-unit business synergies. Some IS studies view cross-unit business synergy as a critical contingency in designing IT governance modes of multibusiness firms (Brown and Magill 1998; Weill and Ross 2004). They reason that related business units, which have a potential to exploit business synergies, may benefit from a centralized IT governance mode, whereas unrelated business units that do not have a potential to exploit business synergies may be better off with a decentralized IT governance mode (Brown and Magill 1994). However, studies building on the theory of multiple contingencies uncovered that business synergy is not a dominant contingency for IT governance mode or IT synergies of multibusiness firms (Brown and Magill 1998; Sambamurthy and Zmud 1999).

This paper distinguishes between cross-unit business synergies and IT synergies in a multibusiness firm. Given that (1) IT is the largest capital investment item in many U.S. corporations, (2) IT resources and good IT management practices are applicable across a wide range of businesses, and (3) multibusiness firms have large-scale IT operations, this paper reasons that multibusiness firms have an opportunity to exploit significant cross-unit IT synergies even if they may have limited opportunity to exploit cross-unit business synergies.

The paper starts by explaining why IT resources and IT management practices are distinctive sources of cross-unit synergy in multibusiness firms. It then develops the theoretical foundations of the concept of synergy, identifies the sources of cross-unit synergy, and explains why cross-unit synergy is important for improving corporate performance of multibusiness firms. Synthesizing the resource-based view (RBV) of diversification and the economic theory of complementarities, the paper identifies the relatedness and complementarity of IT resources as two distinct sources of cross-unit synergy. Building on these theoretical foundations, the paper develops the IT relatedness construct and specifies hypotheses examining whether the individual dimensions of IT relatedness have independent effects on corporate performance or whether their complementarity is also required to achieve superior corporate performance. Further, the paper hypothesizes that diversification level and the IT governance mode of the firm moderate the relationship between IT synergy and firm performance. After presenting an empirical study designed to validate the IT relatedness construct and its nomological link to corporate performance, the paper discusses its findings, implications of the findings for research and practice, limitations of the study, and potential avenues for future research.

Theoretical Foundations

IT Resources and Management Practices as a Source of Cross-Unit Synergy

The cross-unit synergy creation potential of a resource depends on its “range of applicability” across multiple industries (Montgomery and Wernerfelt 1988). IT infrastructure technologies and IT management processes exhibit a high degree of applicability across almost all industries.

Modular, plug and play hardware, software, and communications technologies make it easy to configure and reconfigure IT infrastructures to meet the specific needs of different industries. Due to the digital nature of their inputs and outputs, IT infrastructures provide remote access and dynamic resource allocation capabilities. Geographically dispersed business units can remotely access and use a common IT infrastructure through electronic communications links. A firm can dynamically allocate the excess capacity of a business unit’s IT infrastructure to other business units. Such remote access and dynamic resource allocation capabilities are not available in infrastructures with physical inputs and outputs. For example, to use the excess capacity of a geographically distant manufacturing plant, a business unit has to physically transport its raw materials to the plant and physically pick up the outputs from the plant. It is also relatively easy to expand the storage, processing, and communication capacities of an IT infrastructure compared to expanding the capacity of a manufacturing plant, a transportation system, or a physical distribution channel. Thus, a multibusiness firm such as General Electric (GE), whose business units operate in aircraft engines, medical systems, power systems, appliances, financial services, adhesives and silicones industries, can potentially use a common IT infrastructure to exploit cross-unit IT synergies. In contrast, it would be highly difficult and costly for GE’s business units to use a common manufacturing plant for producing aircraft engines, medical systems, power turbines, appliances, financial products, adhesives, and silicones.
The fundamental principles of good IT management are also applicable across a wide range of industries. An example of good IT management is the alignment of a firm’s business and IT strategies (Sabherwal and Chan 2001). While the specific contents of the business and IT strategies of an aircraft engine business and a medical system business may be different, the IT management principle of aligning business and IT strategies is applicable to both. Similarly, the principles used in formulating IT strategy, making IT investments, or managing business unit IT relations are applicable across business units even though the specifics of the IT strategies, investments, and relationships may be unique to each business unit. Principles used in managing IT human resources (Agarwal and Ferratt 2002) and IT vendor relations (Feeny and Willcocks 1998) are not specific to any particular industry either. IT is a “boundaryless” profession. IT professionals easily move across firms within the IT occupation, across occupations, or across industries (Boh et al. 2001). The multifaceted mobility of IT professionals indicates that IT skills and knowledge are applicable across many different functions and industries.

The Concept of Synergy

The strategy and economics literatures define the concept of synergy in terms of super-additive value or sub-additive cost (Tanriverdi and Venkatraman 2005). Two business units (a) and (b) enjoy super-additive value synergies if their joint value is greater than the sum of their individual values: Value (a, b) > Value (a) + Value (b). They enjoy sub-additive cost synergies (or economies of scope) if the use of common factors of production reduces joint production costs of the business units: Cost (a, b) < Cost (a) + Cost (b).

Resource relatedness and resource complementarity are two major sources of cross-unit synergy in multibusiness firms (Tanriverdi 2005; Tanriverdi and Venkatraman 2005). Resource relatedness refers to the use of common resources (i.e., common factors of production) across business units. According to the RBV of diversification, the use of common factors of production across multiple business units creates sub-additive production cost synergies (Farjoun 1998; Robins and Wiersema 1995). Resource complementarity is also a major source of cross-unit synergy (Tanriverdi and Venkatraman 2005). According to the economic theory of complementarities (Milgrom and Roberts 1990, 1995), a set of resources is complementary when the returns to a resource vary in the levels of returns to the other resources. While resources are distinct, they are also interdependent. They mutually support and reinforce each other. The joint value of complementary resources is greater than the sum of their individual values (Barua and Whinston 1998). Thus, resource complementarity creates super-additive value synergy.

Relatedness of IT Resources and Management Processes as a Source of Cross-Unit Synergy

Building on the RBV of diversification, this study defines IT relatedness as the extent to which a multibusiness firm uses common IT resources and common IT management processes across its business units. IT relatedness can have as many dimensions as the number of distinct IT resources and management processes. However, to develop a parsimonious set of dimensions for the IT relatedness construct, it is important to focus on IT resources and management processes that are likely to create significant cross-unit synergy in a multibusiness firm. Strategy research identifies that cross-unit synergies arise from (1) shared tangible resources, (2) coordinated strategies, (3) pooled negotiating power, (4) shared know-how, (5) vertical integration, and (6) combined new business creation (Campbell and Goold 1998). In the context of IT, shared tangible resources correspond to the use of common IT infrastructure technologies (e.g., hardware, software, and communications) across business units. Coordinated strategies refer to the coordination of the IT strategies of business units. Pooled negotiating power is obtained when the IT vendor relations of the business units are coordinated. Shared know-how refers to the use of common IT skills and knowledge across business units. The vertical integration and combined new business categories capture business synergies arising from the addition of a new business unit to the firm’s business portfolio. Since this study focuses on IT synergies only, the vertical integration and combined new business categories are beyond the scope of this study.

The four dimensions derived from the strategy research are also consistent with prior IS studies. Brown and Magill (1998) argue that both tangible IT resources and intangible IT management expertise and know-how could be sources of cross-unit synergy. Similarly, Sambamurthy and Zmud (1999, p. 267) argue that multibusiness firms can exploit IT synergies either through consolidation of firmwide IT resources (tangible IT resources) or through partnerships among business units (intangible IT management expertise and know-how). The first dimension of IT relatedness—the use of common IT infrastructure technologies—captures IT synergies arising from tangible IT resources. The second, third, and fourth dimensions—coordinated IT strategies, pooled negotiation power, and shared know-how—capture IT synergies arising from intangible IT management expertise and know-how, as explained in more detail below.

Common IT Infrastructures as a Source of Cross-Unit Synergy

When business units use common factors of production, the firm reduces its overall production costs (Campbell and Goold 1998). In the IT function, tangible factors of production are IT infrastructure
components such as hardware, software, and communications technologies. Empirical evidence indicates that the use of a common IT infrastructure can provide more processing power at significantly lower costs (Weill and Broadbent 1998). Yet, multi-business firms find it challenging to create and maintain a common IT infrastructure. Business units tend to invest in IT to accomplish their own goals, and usually respond to technology and business changes in an uncoordinated manner (Weill and Broadbent 1998). When the business units’ IT investments are not coordinated, IT infrastructures can rapidly diverge. Since business units need autonomy for meeting the competitive imperatives of their own industries, it is not appropriate for firms to impose common IT applications on all of them (Brown and Magill 1998). However, it is appropriate to use common hardware, software, and communications technologies, which are applicable across almost all industries. The commonality of such general-purpose technologies is not likely to constrain the autonomy of the business units. To ensure the use of common IT infrastructure technologies across business units, it is important for firms to set common policies and standards for hardware, software, and communications technologies.

Common IT Strategy-Making Processes as a Source of Cross-Unit Synergy

Coordinated business strategies create synergy because they enable a firm to take joint actions and minimize competition among its business units (Campbell and Goold 1998). Since the alignment of business and IT strategies is important for firm performance (Henderson and Venkatraman 1993; Sabherwal and Chan 2001), coordinated business strategies imply coordinated IT strategies. However, it is challenging to coordinate IT strategies due to the conflicting objectives of the corporate center and the business units (Brown 1999; Brown and Magill 1998; Sambamurthy and Zmud 1999). While the center seeks to maximize corporate performance, business units seek to maximize their own performances. Using a common IT strategy is not appropriate because it can inhibit autonomy and reduce the performance of individual business units (Sawhney 2001). Using a unique IT strategy in each business unit is not appropriate either because it fosters independent actions and minimizes the firm’s chances of creating cross-unit IT synergy.

Milgrom and Roberts (1995) argue that firms can substantially ease such cross-unit coordination problems by providing a general strategic direction to the business units rather than trying to coordinate the contents of their strategic decisions. The use of a common IT strategy-making process can provide the general strategic direction needed for coordinating IT strategies of business units. A common IT strategy-making process embeds guidelines reflecting the firm’s prior experiences, learning, deep-rooted beliefs, attitudes, and preferences about strategic IT issues such as the formulation of IT strategy (Segars and Grover 1998), alignment of IT and business strategies (Henderson and Venkatraman 1993), management of business unit and IT relations (Henderson 1990), and IT investments (Weill and Broadbent 1998). Consider two business units that pursue different business maxims. In developing their IT strategies, the two businesses use two distinct instantiations of a common IT strategy-making process. The process asks each business unit to select a strategic rationale for investing in IT: for example, cost reduction, differentiation, or strategic flexibility. It explains under what business maxims each rationale makes sense. The process offers methods for assessing and justifying different types of IT investments. It also provides guidelines for aligning the business and IT strategies of the business units. Although the two businesses are using instantiations of a common process, the inputs they provide to the process (e.g., business maxims), and the decisions they make during the process are different. Hence, the common process produces two unique IT strategies that respectively meet the specific needs of the two business units. At the same time, the guidelines provided by the common process increase the business units’ adherence to corporate objectives and facilitate the coordination of IT strategies.

Common IT Vendor Management Processes as a Source of Cross-Unit Synergy

The multibusiness firm also has an opportunity to increase cross-unit synergies by exploiting the pooled negotiating power of its business units (Campbell and Goold 1998). Business units often develop relationships with multiple IT vendors for meeting their technology and service needs. They spend substantial time and effort in determining strategic goals for these relationships, negotiating terms of the contracts, making deals, and managing the relationships (Useem and Harder 2000). However, units usually lack systematic coordination of these relationships. In the absence of coordination, business units independently develop contracts with the same IT vendors or buy similar products from different ones, each unaware of what the other is doing. The lack of coordination leads to redundancies and overspending on IT resources. It also hinders the firm’s ability to negotiate lower costs and higher quality.

Increasingly, the IT function assumes responsibility for developing and managing IT vendor relationships (Brown and Ross 2003), creating an opportunity to use common goal setting, negotiation, deal making, and relation management processes across the firm. Commonality of the IT vendor management processes facilitates the sharing of purchasing information and best practices across business units. It also fosters informed buying, contract preparation, and contract monitoring practices (Feeny and Willcocks 1998). The use of common IT vendor management processes creates cross-unit IT synergies by increasing the firm’s ability to negotiate for lower cost and higher quality IT products and services.

Common IT Human Resource Management Processes as a Source of Cross-Unit Synergy

Multibusiness firms also exploit cross-unit synergies by using the skills and know-how of their employees across multiple business
units (Campbell and Goold 1998; Farjoun 1998). Unlike other occupations, whose skills and know-how are often applicable in certain functional areas such as marketing, finance, engineering, and so forth, IT skills and know-how are applicable across a broad range of functional areas and industries (Boh et al. 2001).

The skills and know-how of IT talent are particularly valuable when they are transformed into firm-specific skills and know-how and aligned with corporate goals (Segars and Hendrickson 2000). Recruitment, training, motivation, and retention processes are critical for attracting IT talent into the firm, equipping them with firm-specific skills and know-how, aligning their interests with those of the corporation, and retaining them (Agarwal and Ferratt 2002). However, the general human resource management processes of the firm may not meet the challenges of recruiting, training, motivating, and retaining IT talent on a continual basis due to the rapidly evolving nature of IT skills and knowledge. While developing and running IT-HR processes are costly (Agarwal and Ferratt 2002), a multibusiness firm has the scale to reduce IT-HR costs. When some business units excel in recruiting, training, motivating, and retaining high quality IT talent, the firm can capture and codify their learning into common IT-HR processes that can benefit other business units of the firm as well.

For example, a common IT recruitment process can reduce the overall costs of IT recruitment across business units. It also improves prospective employees’ understanding of the firm’s expectations. Although different business units may be looking for different IT skills and know-how, by using instantiations of a common IT recruitment process, they can send coordinated messages to the IT talent about the needs and expectations of the corporation. The improved communication of the firm’s needs and expectations increases the rate of success in matching prospective IT talent to the corporation (Baron and Kreps 1999). Once recruited, IT employees need to continuously update their skills and know-how in order to stay current and responsive to emerging technology and business needs (Agarwal and Ferratt 2002). The ongoing training of IT talent is also very costly (Segars and Hendrickson 2000). The use of common IT training programs can reduce the overall IT training costs of the firm and instill common goals, principles, values, and language among the IT talent. Other prominent IT-HR challenges include aligning interests of the IT talent with those of the corporation and retaining them, especially if the firm makes substantial investments in their training (Segars and Hendrickson 2000). The use of common incentive alignment and retention processes can enable business units to coordinate incentive and compensation schemes for IT talent across the firm (Baron and Kreps 1999). The use of common IT-HR management processes also builds predispositions toward cross-unit partnerships (Brown 1999). When IT employees understand the overall needs and expectations of the corporation and share common values, goals, and incentives, they are more likely to contribute to the exploitation of other cross-unit IT synergies across the firm.

Complementary IT Resources and Management Processes as a Source of Cross-Unit Synergy

While the four dimensions of IT relatedness are distinct, they are also interdependent. IT infrastructures, IT human resources, IT vendor relations, and IT strategies are complementary (Ross et al. 1996). They mutually support and reinforce each other. According to the economic theory of complementarities (Milgrom and Roberts 1995), a complementary set of resources creates super-additive value synergies (Barua and Whinston 1998). The returns to one resource vary in the levels of returns to the other resources (Milgrom and Roberts 1995). When the firm achieves commonality in one dimension of IT relatedness, it becomes more valuable for the firm to achieve commonality in the other dimensions as well. For example, if business units use a common IT strategy-making process, they realize more value from the use of common IT-HR management processes. Common IT-HR processes enable the firm to communicate its corporate strategies, objectives, values, and principles to its IT talent. They create a common understanding among the IT talent and help the firm to implement IT strategies that balance the objectives of the business units with those of the corporation as a whole. The use of a common IT strategy-making process also increases the value of using common IT vendor management processes. The coordination of IT vendor relationships across business units increases negotiation power of the firm, and enables the firm to acquire higher quality IT products and services at lower cost. The use of common IT strategy-making processes, common IT-HR management processes, and common IT vendor management processes also makes it attractive for the firm to use a common IT infrastructure across its business units. A common IT infrastructure enables the firm to use the skills and know-how of IT talent anywhere in the firm. The scale of the common IT infrastructure also increases the firm’s negotiating power in purchasing hardware, software, and communications technologies and services.

On the other hand, when one dimension of IT relatedness is weak or absent, values of the other dimensions also diminish. For example, if business units do not use common IT infrastructure technologies, it becomes less valuable for them to use common IT vendor management processes. Using common IT vendor management processes still enables business units to exchange purchasing information and best practices, and thus improves the effectiveness of their IT vendor relations. However, since they use different IT infrastructure technologies, they will tend to buy equipment from different IT vendors, hence forgoing the benefits of pooled negotiation power.

Performance Effects of Cross-Unit IT Synergies

According to the RBV of diversification, if a resource is not strategic, its relatedness cannot create strategic cross-unit synergies. Hence, the RBV of diversification posits that the relatedness of a
nonstrategic resource does not improve firm performance (Farjoun 1994; Robins and Wiersema 1995). Taken in isolation, individual dimensions of IT relatedness may not satisfy the value, rareness, imitability, and nonsubstitutability criteria of RBV. For example, IT infrastructure technologies are available to all firms in competitive markets. Hence, competitors can imitate sub-additive cost synergies arising from the relatedness of IT infrastructure technologies. There are also well-functioning markets for IT human resources and IT vendors. Hence, sub-additive cost synergies arising from the relatedness of IT human resources or the relatedness of IT vendors can be imitated. Indeed, Farjoun (1998) shows that the relatedness of human resources does not have a significant effect on firm performance. Similarly, a competitor may be able to observe and imitate sub-additive cost synergies arising from coordinated IT strategies across business units of a multibusiness firm. However, as a system of complements, the four dimensions of IT relatedness become much more valuable, rare, and difficult to imitate and substitute.

A complementary set of resources provides unique value to the firm. Compared to synergies arising from the relatedness of resources, synergies arising from the complementarity of resources are much more difficult to observe and imitate (Tanriverdi and Venkatraman 2005). Competitors usually lack the strategic foresight to recognize complementarities (Milgrom and Roberts 1995). Even if they successfully recognize the complementarities, to imitate them successfully, competitors have to make systemic changes in IT infrastructures, IT strategy-making processes, IT-HR management processes, and IT vendor management processes of their business units simultaneously. Due to the complementarities, implementation failure in one dimension will negatively affect the implementation of other dimensions, leading to the failure of the entire imitation effort (Milgrom and Roberts 1995). Thus, the performance effects of IT relatedness are likely to be contingent on the complementarity of the four dimensions.

H1a. Super-additive value synergies arising from the complementarity of the four dimensions of IT relatedness have a positive effect on corporate performance of a multibusiness firm.

Although the RBV of diversification does not predict independent performance effects for individual dimensions of IT relatedness, in establishing performance effects of a system of complements, it is imperative to assess whether individual system elements have performance effects on their own (Tanriverdi and Venkatraman 2005). Thus

H1b. Sub-additive cost synergies arising from the individual dimensions of IT relatedness have independent positive effects on corporate performance of a multibusiness firm.

Moderating Role of Diversification Level

Diversification level refers to the extent to which a firm operates in distinct business segments (industries) simultaneously (Palepu 1985). Increasing diversification level increases the number of business segments in which the firm operates, and limits the firm’s ability to coordinate IT resources and management processes across those businesses. Firms that grow by acquiring other businesses often experience problems in integrating the disparate IT infrastructures of the acquired businesses with their own IT infrastructures (Weill and Broadbent 1998). Unique histories and cultures of interactions among the IS and business managers of the acquired businesses and different levels of reliance on IT in business strategies further inhibit the integration efforts (Sambamurthy and Zmud 1999). Hence, at increasing levels of diversification, it becomes more difficult for a firm to convert cross-unit IT synergies into performance outcomes.

H2. Diversification level of a firm moderates the relationship between cross-unit IT synergy and firm performance: Performance effects weaken at increasing levels of diversification.

Moderating Role of IT Governance Mode

Business units that seek to exploit related resources have a marked need for coordination (Brown and Magill 1998), as do business units that seek to exploit complementary resources (Milgrom and Roberts 1990, 1995). Thus, the exploitation of cross-unit IT synergy through related and complementary IT resources requires significant cross-unit coordination. According to Sambamurthy and Zmud (1999, pp. 266-267), “a centralized locus for IT decision making makes it possible to exploit the IT-related commonalities and leverage considerable economies of scope.” For example, Levina and Ross (2003) found that by centralizing IT decision rights, an IT outsourcing vendor was able to exploit a complementary set of IT competences across the IT projects of multiple client firms and gain synergistic benefits such as productivity improvements and cost reductions. Using the same theoretical rationale, the IT function of a multibusiness firm can exploit a complementary set of related IT resources and management processes across business units by centralizing IT decision rights (Sambamurthy and Zmud 1999). A decentralized IT governance mode is less effective in facilitating the coordination and exploitation of cross-unit IT synergies because autonomous business units usually pursue their own objectives rather than the center’s objective to exploit cross-unit synergies (Brown 1999; Brown and Magill 1998; Sambamurthy and Zmud 1999). A hybrid mode of IT governance is the least effective because the centralization of some decision rights and decentralization of others create conflicts between the corporate center and the business units and raise barriers to collaborative efforts.
seeking to exploit cross-unit synergies (Brown 1999; Brown and Magill 1998). Thus,

H3. IT governance mode moderates the relationship between cross-unit IT synergy and firm performance: Performance effects of cross-unit IT synergy will be highest in firms using a centralized mode of IT governance, moderate in firms using a decentralized mode of IT governance, and lowest in firms using a hybrid mode of IT governance.

Methodology

This study uses the survey method to collect primary data from senior IT executives of multibusiness Fortune 1000 firms to measure IT relatedness. It also uses secondary data from the COMPUSTAT and CRSP databases to compute objective measures of firm performance, industry performance, firm size, and diversification and relatedness levels of these firms.

Independent Variable: IT Relatedness

Due to a lack of previously validated instruments (Straub 1989), the study develops a new measurement scheme for IT relatedness. As discussed in the theory section, the use of common tangible resources, coordinated strategies, human skills and know-how, and pooled negotiation and purchasing power across multiple business units can create cross-unit synergies in a multibusiness firm (Campbell and Goold 1998). Accordingly, this study identifies four dimensions for the IT relatedness construct. It builds on the literature stream on IT resources (Wade and Hulland 2004) in developing specific measurement items for each dimension. The IT infrastructure dimension focuses on the use of common hardware, software, and communications technologies across business units (Weill and Broadbent 1998). The IT strategy dimension focuses on the use of common managerial processes that are likely to enhance coordination of IT strategies across business units: for example, common processes for formulating IT strategy (Segars and Grover 1998), aligning business and IT strategies (Sabherwal and Chan 2001), managing relationships between business and IT units (Henderson 1990), and investing in IT (Weill and Broadbent 1998). The IT human resource dimension focuses on the use of common IT-HR processes that are likely to enhance coordination of IT strategies across business units: for example, common processes for formulating IT strategy (Segars and Grover 1998), aligning business and IT strategies (Sabherwal and Chan 2001), managing relationships between business and IT units (Henderson 1990), and investing in IT (Weill and Broadbent 1998). The IT strategy dimension focuses on the use of common managerial processes that are likely to enhance coordination of IT strategies across business units: for example, common processes for formulating IT strategy (Segars and Grover 1998), aligning business and IT strategies (Sabherwal and Chan 2001), managing relationships between business and IT units (Henderson 1990), and investing in IT (Weill and Broadbent 1998). The IT human resource dimension focuses on the use of common IT-HR processes that are likely to enhance coordination of IT strategies across business units: for example, common processes for formulating IT strategy (Segars and Grover 1998), aligning business and IT strategies (Sabherwal and Chan 2001), managing relationships between business and IT units (Henderson 1990), and investing in IT (Weill and Broadbent 1998).

The study used a key informant approach for data collection (Bagozzi, et al. 1991). CIO and Darwin magazines sponsored the surveys, and a direct mailing company customized the surveys and cover letters to individual firms and informants. Four follow-up letters were mailed on the second, fourth, eighth, and twelfth weeks after the initial mailing (Dillman 2000). All mailings informed recipients that a Web-based version of the survey was also available for their convenience, and provided them with unique passwords to the survey Web site.

Response rate. Of the original sample, 32 firms in the original sample merged with other firms, became acquired, or declared bankruptcy during data collection. Another 82 firms declined to participate due to company policy. Usable responses came from 256 firms, yielding a response rate of about 40 percent. Responding firms represented 51 industries: 165 of them (46.35 percent) operate in manufacturing industries, whereas 191 (53.65 percent) operate in service industries. There were no statistically significant differences between responding and non-responding firms on measures of size ($t = -0.63, p > 0.1$), performance (Tobin’s $q$) ($t = 1.39, p > 0.1$), or diversification level ($t = -0.25, p > 0.1$). Early and late respondents did not differ on these measures either.
Assessment of informant competency. In all, 81 percent of informants were at chief information officer or higher levels (i.e., vice president, senior vice president, or executive vice president of information services), 6 percent were chief technology officers (CTO), and 13 percent had other job titles such as chief financial officer, director of information systems, and so forth. Average organizational tenure of the informants was 10.8 years. They had been involved in corporate IT strategy formulation for 5.8 years on average. They were also highly active in formulation of corporate IT strategies for their firms at the time of the study (average = 4.73 on a 5-point scale, 5 representing “very active”). Thus, informants were highly qualified to answer the questions.

Dependent Variable: Firm Performance

Achieving resource relatedness across multiple businesses takes several years (Gupta and Govindarajan 2000). Hence, it may take several years to detect performance effects of cross-unit IT synergies. Forward-looking performance measures such as Tobin’s q are appropriate for capturing future performance potential of IT initiatives (Bharadwaj et al. 1999). Tobin’s q is also appropriate for capturing the super-additive value of business combinations as indicated by its widespread use in the valuation of multibusiness firms (Tanriverdi and Venkatraman 2005). Thus, this study uses Tobin’s q as its main measure of firm performance, and computes it by taking the ratio of the market value of a firm to the replacement cost of its assets (Chung and Pruitt 1994). Since the study measured IT relatedness at the beginning of year 2000, it examinies the impacts on Tobin’s q at the end of years 2000, 2001, and 2002, as well as on the three-year average of the Tobin’s q values. Using multiple years of performance data reduced the chance that an unusually good or bad year might confound the results. To ensure that the results are not idiosyncratic to Tobin’s q, the study also tested robustness of the findings with the Treynor ratio, a risk-adjusted market-based measure of firm performance.

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\text{Treynor ratio} = \frac{(R_i - R_f)}{\beta_i}
\]

\(R_i\) = monthly stock returns of firm i (over a 12 month period)

\(R_f\) = risk-free rate (monthly treasury bill returns over a 12 month period)

\(\beta_i\) = systematic risk of firm i (derived from the capital asset pricing model)

The study computed the Treynor ratio with stock market returns of the firm in 2001 to assess whether IT synergies in year 2000 had any effect on the market value of the firm in the subsequent year.

Accounting-based measures of firm performance such as return on assets (ROA) and return on sales (ROS) are backward-looking measures that assess past performance of assets. To assess if IT synergies had any effects on the accounting-based performance measures within three years, the study also included three-year averages of ROA and ROS (for years 2000, 2001, and 2002).

Moderating Variables

Diversification level. This study used Palepu’s (1985) entropy measure of total diversification to capture the extent to which business units of a firm were spread across distinct industries.

IT governance mode. Building on Brown (1999), this study measured IT governance mode as a categorical variable assessing whether a multibusiness firm uses a centralized, decentralized, or hybrid locus of IT decision-making authority.

Controls

Industry performance. Industry performance is an important determinant of firm performance (McGahan and Porter 1999). This study used the average ROA values of all firms operating in the firm’s primary industry (at the two-digit SIC code level) to control for industry performance.

Past performance of the firm. Not controlling for past performance of the firm may overstate the performance effects of IT (Santhanam and Hartono 2003). This study used average ROA values of a firm in the three years prior to the measurement of IT synergies (1997 through 1999) to control for past performance.

Firm size. Large size may influence the performance of multi-business firms by offering a higher potential for synergy creation, or it may decrease performance by leading to costs arising from managerial diseconomies. Firm size may also influence the organization and management of IT resources. Smaller firms tend to centralize IT management, whereas larger firms tend to decentralize it (Sambamurthy and Zmud 1999). To account for such relationships, this study controlled for firm size by taking the logarithm (base 10) of the number of firm’s employees.

Relatedness of business units. This study also controls for Palepu’s (1985) related diversification measure, which is a proxy for potential cross-unit business synergies in a multibusiness firm.

Results

Measurement Properties of IT Relatedness

The study used a combination of exploratory and confirmatory factor analytic approaches, as implemented in LISREL 8.5 (Jöreskog and Sörbom 1996), to test for measurement properties of IT relatedness. It obtained full evidence for the measurement efficacy
Table 1. IT Relatedness: Instructions, Measurement Scale, and Purified Measurement Items

Instructions: In answering the questions, please take the perspective of the corporate headquarters of <<CompanyName>>. Please focus on how the corporate headquarters organize IT resources across business units today rather than on its plans for the future. We would like to learn if IT policies and resources of your corporation are unique and specific to each business unit, or common and applicable across multiple business units. For each of the following descriptions, please select a phrase from the box below (measurement scale) that best completes the meaning of the description as it applies to your corporation. Please circle the number of your selection in the 5-point scale next to the description.

Anchor Points of the Measurement Scale
1. Unique in all or almost all of the business units.
2. Unique in a majority of the business units.
3. Unique in about half of the business units; common across the other half.
4. Common across a majority of the business units.
5. Common across all or almost all of the business units.

<table>
<thead>
<tr>
<th>Measurement Items</th>
<th>Coefficient</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relatedness of IT Strategy-Making Processes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STR1. Strategic rationale for investing in IT is ...</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>STR2. Processes used for formulating IT strategy are ...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STR3. Processes used for aligning IT strategy with business strategy are ...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STR4. Processes used for managing relationships between the IT department and the business units are ...</td>
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<tr>
<td><strong>Relatedness of IT Relationship Management Processes</strong></td>
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<tr>
<td>REL1. Strategic goals for entering into IT outsourcing relationships are ...</td>
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</tr>
<tr>
<td>REL2. Processes used for negotiating and making deals with IT vendors and service providers are ...</td>
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<td></td>
</tr>
<tr>
<td>REL3. Processes used for managing relationships with IT vendors are ...</td>
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<td></td>
</tr>
<tr>
<td>REL4. Processes used for managing relationships with IT outsourcing relationships are ...</td>
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<tr>
<td><strong>Relatedness of IT Human Resource Management Processes</strong></td>
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</tr>
<tr>
<td>HR1. Processes used for identifying and recruiting IT talent are ...</td>
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<tr>
<td>HR2. Training programs and opportunities provided to IT talent are ...</td>
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<tr>
<td>HR3. Incentives used for aligning interests of IT talent with business goals are ...</td>
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<tr>
<td>HR4. Strategies used for retaining IT talent are ...</td>
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<tr>
<td><strong>Relatedness of IT Infrastructure</strong></td>
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<td>INFR1. Policies used for managing IT infrastructure are ...</td>
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</tr>
<tr>
<td>INFR2. IT software standards are ...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INFR3. IT hardware standards are ...</td>
<td></td>
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</tr>
<tr>
<td>INFR4. IT communications standards are ...</td>
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Table 2. IT Relatedness: Reliability Measures and Goodness of Fit Statistics

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<tr>
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<th>Items</th>
<th>Coefficient Alpha</th>
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<th>NFI</th>
<th>CFI</th>
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<td>0.90</td>
<td>0.95</td>
<td>0.95</td>
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<td>IT HR Management (HR)</td>
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<td>0.87</td>
<td>0.93</td>
<td>0.97</td>
<td>0.97</td>
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<td>IT Infrastructure (INFR)</td>
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<td>0.81</td>
<td>0.97</td>
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<td></td>
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<td>SD</td>
<td>STR1</td>
<td>STR2</td>
<td>STR3</td>
<td>STR4</td>
</tr>
<tr>
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<tr>
<td>STR1</td>
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<td>1.00</td>
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<tr>
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<td>0.76</td>
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<tr>
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<tr>
<td>INFR4</td>
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<td>0.39</td>
<td>0.44</td>
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<td>0.43</td>
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</table>
of IT relatedness by identifying items that parsimoniously capture the variance in the data, assessing measurement properties of the first-order factors, comparing relative fit among alternative first-order measurement models, and testing for the presence of a second-order factor (Segars and Grover 1998).

Table 2 presents reliability measures and goodness of fit indices for the first-order dimensions of IT relatedness. Coefficient Alpha values range from 0.88 to 0.95, providing evidence of measure reliability (Nunnally 1978). Composite measure reliability ($p_c$) scores are all above 0.77, demonstrating internal consistency of the measures. Goodness of fit index (GFI), normed fit index (NFI), and comparative fit index (CFI) are all above the suggested threshold of 0.90.

**Dimensionality and Convergent and Discriminant Validity**

Table 3 presents correlations among items of IT relatedness. The study compared three alternative first-order factor models tests for dimensionality and convergent and discriminant validity of the IT relatedness construct. Model 1 hypothesizes that a unidimensional first-order factor accounts for the variance among all 16 measurement items. Model 2 hypothesizes that the 16 items form into four uncorrelated first-order factors: relatedness of IT strategy, relatedness of IT resource management, relatedness of IT human resource management, and relatedness of IT infrastructure. Model 3 hypothesizes that the 16 items form into four freely correlated first-order factors. Finally, Model 4 hypothesizes a second-order factor that accounts for the relationships among the four first-order factors.

Comparison of Model 1 ($\chi^2 = 1925.54, \text{d.f.} = 104, \text{NFI} = 0.69, \text{NNFI} = 0.66, \text{CFI} = 0.71, \text{GFI} = 0.60, \text{RMSEA} = 0.22$) and Model 2 ($\chi^2 = 466.01, \text{d.f.} = 104, \text{NFI} = 0.91, \text{NNFI} = 0.92, \text{CFI} = 0.93, \text{GFI} = 0.85, \text{RMSEA} = 0.099$) shows that Model 2 is a better-fitting model (lower chi-square for the same degrees of freedom and better fit indices), indicating that a multidimensional model comprising of four uncorrelated first-order factors is superior to a unidimensional first-order factor model. Hence, support is obtained for multi-dimensionality of IT relatedness.

Further comparison of Model 2 ($\chi^2 = 466.01, \text{d.f.} = 104, \text{NFI} = 0.91, \text{NNFI} = 0.92, \text{CFI} = 0.93, \text{GFI} = 0.85, \text{RMSEA} = 0.099$) with Model 3 ($\chi^2 = 418.70, \text{d.f.} = 98, \text{NFI} = 0.92, \text{NNFI} = 0.93, \text{CFI} = 0.94, \text{GFI} = 0.87, \text{RMSEA} = 0.096$), which are nested models, indicates that Model 3, four freely correlated first-order factors (unconstrained model), is superior to Model 2 (constrained model), four uncorrelated first-order factors ($\Delta \chi^2 = 42.31, \Delta \text{d.f.} = 6; p < 0.0001$). In Model 3, standardized factor loadings of measurement items on their respective factors are all highly significant ($p < 0.001$), providing support for convergent validity.

Superiority of Model 3 (unconstrained model) over Model 2 (constrained model) indicates that pairs of correlations among the first-order factors are significantly different from zero. They are also below the cut-off value of 0.90 (Bagozzi et al. 1991), demonstrating distinctiveness of theoretical content captured by the individual first-order factors. Since measurement items converge on their respective factors and the factors are distinct from each other, support is obtained for discriminant validity (Bagozzi et al. 1991).

**First-Order Versus Second-Order Factor Models**

Finally, the study tested whether a second-order factor accounts for the relationships among the first-order factors. Previous literature used four criteria for comparing first-order and second-order factor models: (1) goodness of fit statistics for the two models (Grover et al. 2002; Tippins and Sohi 2003; Venkatraman 1990); (2) significance of the second-order factor loadings (Tippins and Sohi 2003; Venkatraman 1990); (3) target coefficient (T) statistics (Marsh and Hocevar 1985); and (4) significance of the structural links that link measurement models to a criterion variable of interest such as firm performance (Venkatraman 1990).

Model statistics of the first-order factor model ($\chi^2 = 418.70, \text{d.f.} = 98, \text{NFI} = 0.92, \text{NNFI} = 0.93, \text{CFI} = 0.94, \text{GFI} = 0.87, \text{RMSEA} = 0.096$), and the second-order factor model ($\chi^2 = 424.76, \text{d.f.} = 100, \text{NFI} = 0.92, \text{NNFI} = 0.93, \text{CFI} = 0.94, \text{GFI} = 0.87, \text{RMSEA} = 0.096$) are almost identical. The second-order factor model should be accepted because it is a more parsimonious model with fewer parameters to be estimated and more degrees of freedom (Grover et al. 2002; Venkatraman 1990). All second-order factor loadings ($\gamma_{i1}$ to $\gamma_{41}$) are highly significant ($p < 0.001$), also providing justification for the acceptance of the second-order factor model (Tippins and Sohi 2003; Venkatraman 1990). The target coefficient value, $T = 0.99$, is very close to the theoretical upper limit of 1, indicating that the second-order factor accounts for 99 percent of the relations among the first-order factors. Hence, it also suggests the acceptance of the second-order factor model (Marsh and Hocevar 1985). Finally, as shown in Figures 1 and 2, only the second-order measurement model has a significant impact on firm performance. Collectively, these results confirm IT relatedness as a second-order construct.

**Descriptive Statistics and Correlations**

Table 4 provides the descriptive statistics and correlations among the constructs of the study. The second-order IT relatedness construct has significant correlations with market-based measures of firm performance: Tobin’s q ($r = 0.18, p < 0.01$) and Treynor ratio ($r = 0.14, p < 0.05$). However, it does not have significant correlations with accounting-based measures of firm performance: ROA ($r = 0.10, p > 0.1$) and ROS ($r = 0.03, p > 0.1$). Thus, the rest of the analysis uses the market-based measures of firm performance.
Sub-additive cost synergies arising from individual dimensions of IT relatedness

Super-additive value synergies arising from the complementarity of the four dimensions of IT relatedness

\[ \eta_1 = \text{Performance} \]

\[ \eta_2 = \text{IT Strategy Making} \]

\[ \eta_3 = \text{IT Vendor Management} \]

\[ \eta_4 = \text{Human Resource Management} \]

\[ \eta_5 = \text{IT Infrastructure} \]

\[ \beta_{21} = 0.82^{***} \]

\[ \beta_{31} = 0.30^{**} \]

\[ \beta_{41} = 0.84^{**} \]

\[ \beta_{51} = 0.76^{***} \]

\[ \gamma_{11} = 0.17 \ (t=1.87) \]

\[ \gamma_{12} = -0.25 \ (t=-2.29)^* \]

\[ \gamma_{13} = 0.13 \ (t=1.38) \]

\[ \gamma_{14} = 0.12 \ (t=1.42) \]

\[ \varphi_{24} = 0.48^{***} \]

\[ \varphi_{12} = 0.50^{***} \]

\[ \varphi_{13} = 0.48^{***} \]

\[ \varphi_{14} = 0.48^{***} \]

\[ \varphi_{21} = 0.55^{***} \]

\[ \varphi_{23} = 0.38^{***} \]

\[ \varphi_{31} = 0.41^{***} \]

\[ \varphi_{32} = 0.35^{**} \]

\[ \varphi_{34} = 0.48^{***} \]

\[ \varphi_{41} = 0.55^{***} \]

\[ \varphi_{43} = 0.48^{***} \]

\[ \xi_1 = \text{IT Strategy Making} \]

\[ \xi_2 = \text{IT Vendor Management} \]

\[ \xi_3 = \text{Human Resource Management} \]

\[ \xi_4 = \text{IT Infrastructure} \]

\[ \gamma_{11} = 0.17 \ (t=1.87) \]

\[ \gamma_{12} = -0.25 \ (t=-2.29)^* \]

\[ \gamma_{13} = 0.13 \ (t=1.38) \]

\[ \gamma_{14} = 0.12 \ (t=1.42) \]

\[ \gamma_{21} = 0.50^{***} \]

\[ \gamma_{23} = 0.38^{***} \]

\[ \gamma_{31} = 0.41^{***} \]

\[ \gamma_{32} = 0.35^{**} \]

\[ \gamma_{34} = 0.48^{***} \]

\[ \gamma_{41} = 0.55^{***} \]

\[ \gamma_{43} = 0.48^{***} \]

\[ \varphi_{24} = 0.48^{***} \]

\[ \varphi_{12} = 0.50^{***} \]

\[ \varphi_{13} = 0.48^{***} \]

\[ \varphi_{14} = 0.48^{***} \]

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\[ \varphi_{32} = 0.35^{**} \]

\[ \varphi_{34} = 0.48^{***} \]

\[ \varphi_{41} = 0.55^{***} \]

\[ \varphi_{43} = 0.48^{***} \]

\[ \xi_5 = \text{Industry Performance} \]

\[ \xi_6 = \text{Past Performance} \]

\[ \xi_7 = \text{Size} \]

\[ \xi_8 = \text{DR} \]

\[ \chi^2 = 562.31; \text{d.f.} = 185; \text{NNFI} = 0.92; \text{CFI} = 0.93; \text{IFI} = 0.93; \text{GFI} = 0.87; \text{RMSEA} = 0.076 \]

\[ \chi^2 = 514.55; \text{d.f.} = 158; \text{NNFI} = 0.91; \text{CFI} = 0.93; \text{IFI} = 0.93; \text{GFI} = 0.88; \text{RMSEA} = 0.080 \]
<table>
<thead>
<tr>
<th>Table 4. Descriptive Statistics and Correlations</th>
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<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1. Tobin’s qa</td>
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<tr>
<td>2. Treynor ratio</td>
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<tr>
<td>3. Return on Sales (ROS)</td>
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<td>4. Return on Assets (ROA)</td>
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<td>5. Past firm performance</td>
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<td>8. IT infrastructure</td>
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<td>9. IT strategy making processes</td>
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<td>10. IT human resource management processes</td>
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<tr>
<td>11. IT vendor management processes</td>
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<tr>
<td>12. IT governance mode</td>
</tr>
<tr>
<td>13. Relatedness of firm’s businesses</td>
</tr>
<tr>
<td>14. Total diversification level of the firm</td>
</tr>
<tr>
<td>15. Firm size</td>
</tr>
</tbody>
</table>

*bComputed using monthly stock returns of the firm and risk-free rate (monthly treasury bill returns) over a 12 month period in year 2001 and beta values from CAPM.
*cThree year average of ROA values for the firm in 1997, 1998, and 1999 prior to the measurement of IT relatedness in the beginning of year 2000.
*dMeasured in year 2000.
*eCategorical variable (decentral = 1, hybrid = 2, central = 3); entries for this variable represent Kendall's Tau-b. All other entries are Pearson correlations.

*p < 0.1,  **p < 0.05,  ***p < 0.01,  ****p < 0.001
Hypotheses Testing

Test of Direct Effects

The study used the structural equation models in Figures 1 and 2 to test H1a and H1b. Figure 1 models IT relatedness as a second-order construct. The first-order factors capture sub-additive cost synergies arising from the use of a common IT resource or a common IT management process across business units. The second-order factor captures super-additive value synergies arising from the complementarity of the four first-order factors. H1a states that corporate level performance effects are contingent on the complementarity of the four factors. H1b specifies direct links from the four factors to firm performance. It states that individual dimensions of IT relatedness can have independent effects on corporate performance.

In both structural models, firm performance is a 3-year average of a firm’s Tobin’s q values (over years 2000, 2001, and 2002) following the measurement of IT relatedness in early 2000. In Figure 1, the structural link (SL) from the second-order IT relatedness to Tobin’s q is positive and significant (SL = 0.12, p < 0.05). Model statistics indicate good fit ($\chi^2 = 562.31; df = 185; $NNFI = 0.92; $CFI = 0.93; $IFI = 0.93; $GFI = 0.87; $RMSEA: 0.076$). These results hold and become slightly better with the Treynor ratio. The structural link (SL) from the second-order IT relatedness to Treynor ratio is positive and significant (SL = 0.15, p < 0.05). Model statistics are also satisfactory ($\chi^2 = 557.13; df = 185; $NNFI = 0.92; $CFI = 0.93; $IFI = 0.93; $GFI = 0.87; $RMSEA: 0.075$). These findings support H1a: a second-order factor capturing super-additive value synergies arising from the complementarity of the four dimensions of IT relatedness has a positive effect on firm performance. However, the test of complementarity is not complete without an examination of the independent performance effects of the individual dimensions of IT relatedness. Evidence of independent performance effects would be obtained if the structural links in Figure 2 that link dimensions of IT relatedness to firm performance were all positive and significant. Although the fit statistics for the independent effects model are comparable to the fit statistics of the second-order factor model ($\chi^2 = 514.55; df = 158; $NNFI = 0.91; $CFI = 0.93; $IFI = 0.93; $GFI = 0.88; $RMSEA: 0.079$), none of the four structural links has a significant effect on Tobin’s q. Three of the links are insignificant (SL1 = 0.17, p > 0.1; SL3 = 0.13, p > 0.1; SL4 = 0.12, p > 0.1). One link has a significant effect, but its sign is in the opposite direction (SL2 = -0.25, p < 0.05). The results with the Treynor ratio are similar. Model statistics stay the same ($\chi^2 = 511.43; df = 158; $NNFI = 0.91; $CFI = 0.93; $IFI = 0.93; $GFI = 0.88; $RMSEA: 0.079$), but none of the four structural links is significant (SL1 = 0.02, p > 0.1; SL2 = -0.10, p > 0.1; SL3 = 0.11, p > 0.1; SL4 = 0.15, p > 0.1). These findings do not support H1b. They rule out independent performance effects of individual dimensions of IT relatedness and reinforce the finding of H1a that performance effects are contingent on the complementarity of the four dimensions.

Test of Moderation Effects

H2 and H3 respectively hypothesize that the diversification level and the IT governance mode of the firm moderate the relationship between IT relatedness and firm performance. The test of moderation has historically been problematic within structural equation models (Cortina et al. 2001). Although Chin et al. (2003) recently developed a new technique for testing moderation in PLS, the technique requires at least 150 samples per four indicators. In simulation studies, Chin et al. (2003, p. 203) find that “smaller sample sizes did not produce significant results for many of the combinations across each of the predictor, moderator, and interaction terms.” They conclude, “small sample sizes clearly should be avoided when analyzing moderator variables.” This study does not meet the sample size requirements of the new technique. Further, the moderation relationships examined in H2 and H3 involve a second-order construct (IT relatedness), whereas the new technique focuses only on first-order constructs. Thus, in testing H2 and H3, this study had to switch from structural equation modeling to moderated regression analysis (MRA).

The use of MRA requires the conversion of the multi-item second-order measurement model of IT relatedness into a single-item measurement model. Obtaining the single-item measure through a simple average of the measurement items is problematic because it assumes that the items are equal in their reliabilities and contributions to the overall construct. To avoid this problem, Chin et al. recommend taking a weighted average of the measurement items based on their contributions to the construct. Thus, this study implements a two-step approach. In the first step, it uses the first-order factor loadings to weight measurement items within each dimension of IT relatedness. Recall that the first-order dimensions of IT relatedness capture sub-additive cost synergies. Taking weighted averages of measurement items with first-order factor loadings produces four single-item measures representing the sub-additive cost synergies. In the second step, the study weights these measures with the second-order factor loadings of IT relatedness. Recall that the second-order factor captures super-additive value synergies arising from the complementarity of the four dimensions of IT relatedness. Thus, the resulting single-item measure takes into account both sub-additive cost synergies and super-additive value synergies.

To assess if the resulting single-item measure is a satisfactory proxy to the multi-item second-order measurement model of IT relatedness, the study assessed if the performance effects, which were uncovered above in LISREL analysis using the second-order measurement model of IT relatedness, could be replicated within a regression framework using the single-item measure of IT relatedness. Table 5 presents the findings of the replication analysis.

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2Results are consistent with Tobin’s q 2000, Tobin’s q 2001, and Tobin’s q 2002.
Table 5. Assessment of the Robustness of Findings Across Multiple Years and Multiple Performance Measures

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.33***</td>
<td>0.38***</td>
<td>0.47***</td>
<td>0.37***</td>
</tr>
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<td>2001</td>
<td>0.28***</td>
<td>0.26***</td>
<td>0.15*</td>
<td>0.26***</td>
</tr>
<tr>
<td>2002</td>
<td>0.01</td>
<td>-0.02</td>
<td>-0.02</td>
<td>-0.01</td>
</tr>
<tr>
<td>3-year average (2000-2002)</td>
<td>0.02</td>
<td>0.06</td>
<td>0.01</td>
<td>0.11</td>
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<tr>
<td>Past performance of the firm</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Industry performance</td>
<td>0.01</td>
<td>-0.08</td>
<td>0.02</td>
<td>-0.06</td>
</tr>
<tr>
<td>Firm size</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total diversification level of the firm (DT)</td>
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<td>-0.02</td>
<td>-0.07</td>
<td>-0.03</td>
</tr>
<tr>
<td>Relatedness of firm’s businesses (DR)</td>
<td>0.06</td>
<td>0.05</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>IT governance dummy 1 (D1)*</td>
<td>0.19*</td>
<td>0.25*</td>
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<td>0.21*</td>
</tr>
<tr>
<td>IT relatedness</td>
<td>0.32***</td>
<td>0.35***</td>
<td>0.33***</td>
<td>0.35***</td>
</tr>
<tr>
<td>Model R²</td>
<td>4.04*</td>
<td>5.95*</td>
<td>5.13*</td>
<td>5.19*</td>
</tr>
<tr>
<td>ΔR² Contributed by IT Relatedness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔF</td>
<td></td>
<td></td>
<td></td>
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</table>

Table 6. Results of Moderated Regression Analyses (Dependent Variable: Three-Year Average of Tobin’s q during Years 2000-2002)

<table>
<thead>
<tr>
<th>Variable(s) Entered</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
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<tbody>
<tr>
<td>Past firm performance</td>
<td>0.38***</td>
<td>0.37***</td>
<td>0.37***</td>
<td>0.37***</td>
<td>0.36***</td>
</tr>
<tr>
<td>Industry performance</td>
<td>0.26***</td>
<td>0.26***</td>
<td>0.27***</td>
<td>0.26***</td>
<td>0.27***</td>
</tr>
<tr>
<td>Firm size</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Relatedness of firm’s businesses (DR)</td>
<td>-0.08</td>
<td>-0.03</td>
<td>-0.03</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Total diversification level of the firm (DT)</td>
<td>-0.06</td>
<td>-0.03</td>
<td>-0.03</td>
<td>-0.09</td>
<td>-0.05</td>
</tr>
<tr>
<td>IT governance dummy 1 (D1)*</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>IT governance dummy 2(D2)*</td>
<td>0.09</td>
<td>0.07</td>
<td>0.31*</td>
<td>0.26*</td>
<td>0.14</td>
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<tr>
<td>IT relatedness</td>
<td>0.21*</td>
<td>0.20*</td>
<td>0.19</td>
<td></td>
<td>0.14</td>
</tr>
<tr>
<td>DT × IT relatednessb</td>
<td>-0.15*</td>
<td></td>
<td>-0.14*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1 × IT relatedness</td>
<td></td>
<td>-0.04</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2 × IT relatedness</td>
<td></td>
<td>0.26</td>
<td>0.24</td>
<td></td>
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<tr>
<td>R²</td>
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<td>0.35</td>
<td>0.371</td>
<td>0.364</td>
<td>0.38</td>
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<tr>
<td>F</td>
<td>20.18***</td>
<td>11.10***</td>
<td>10.76***</td>
<td>20.18***</td>
<td>9.06***</td>
</tr>
<tr>
<td>ΔR²</td>
<td>0.03</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>ΔF</td>
<td>1.69</td>
<td>5.55*</td>
<td>1.82</td>
<td>2.69*</td>
<td></td>
</tr>
</tbody>
</table>

*aCentralization is coded as the base case (D1 = 0, D2 = 0); D1 represents decentralization; D2 represents hybrid.
+bComponent variables IT relatedness and DT are mean centered for moderation analyses.
+p < 0.1, *p < .05, **p < 0.01, ***p < 0.001
Regression models 1 through 7 include control variables and assess whether the single-item measure of IT relatedness explains additional variance in firm performance over and beyond the variance explained by the control variables. As models 1 through 4 show, the single-item measure of IT relatedness has significant impacts on Tobin’s q values in years 2000, 2001, and 2002, as well as the three-year average of Tobin’s q. Model 5 shows that performance effects also hold with the Treynor ratio. These findings replicate the findings obtained above in the LISREL analysis. They demonstrate that the single-item measure of IT relatedness produces the same results as those produced by the second-order measurement model of IT relatedness. Models 6 and 7 also introduce the accounting-based performance measures. While they do not show a significant effect on 3-year average of ROA (beta = –0.02, p > 0.1), they do show a marginally significant effect on 3-year average of ROS (beta = 0.17, p < 0.1). Collectively, these findings minimize the possibility that the results might be idiosyncratic to a specific year, a specific measure of firm performance, the use of a single-item measurement model for IT relatedness, or the use of MRA versus LISREL. Thus, for brevity, the test of moderation proceeds with the single-item measure of IT relatedness and Tobin’s q. Both variables are mean centered for the moderation analysis.

Tests of H2 and H3

Table 6 presents the results of the moderation analysis. Model 1 introduces only the control variables. Model 2 adds the main effects. Model 3 introduces the interaction effect of diversification level and IT relatedness. Variance inflation factors, tolerance values, condition indexes, and variance proportion values do not indicate any multicollinearity problems. The interaction term significantly increases the model $R^2$ ($\Delta R^2 = 0.02, \Delta F = 5.55, p < 0.05$). Coefficient of the interaction term is also significant (beta = -0.15, p < 0.05). Thus, the findings confirm the moderating role of diversification level (H2). Figure 3 depicts the relationship between IT relatedness and firm performance at low (mean – 2 standard deviations), medium (mean) and high (mean + 2 standard deviations) levels of diversification. As predicted, the relationship between IT synergies (as captured by IT relatedness) and firm performance is positive at all levels, but the strength of the relationship weakens at higher levels of diversification.

In testing the moderation effect of IT governance mode, the study uses two dummy variables, D1 and D2, to code the three IT governance modes. Centralization is the base case (D1 = 0, D2 = 0). D1 represents decentralization. D2 represents hybrid mode of governance. Model 4 of Table 6 introduces the interaction terms: D1*IT relatedness and D2*IT relatedness. Collinearity diagnostics do not indicate any multicollinearity problems. However, the model $R^2$ does not increase significantly ($\Delta R^2 = 0.01, \Delta F = 1.82, p > 0.1$). Coefficients of the interaction terms are not significant either. Thus, the results do not support the moderating role of IT governance mode (H3).
Discussions and Conclusions

Whether and how IT contributes to firm performance, and whether or not there is business value in exploiting firm-wide IT infrastructures are enduring questions in IS research and practice. This study sought to inform these questions in the context of multibusiness firms. IT is the largest capital investment item in many U.S. firms, and multibusiness firms, in particular, have large-scale IT investments and operations. Further, most information technologies and IT management practices are applicable across a wide range of businesses. Thus, this study reasoned that a multibusiness firm has an opportunity to exploit cross-unit IT synergies by applying its IT resources and IT management practices across multiple businesses. Synthesizing the RBV of diversification and the economic theory of complementarities, this study argued that the relatedness and complementarity of IT resources respectively create sub-additive cost synergies and super-additive value synergies.

While the sub-additive cost synergies arising from the relatedness of IT resources do not have independent performance effects on their own (Figure 2), the super-additive value synergies arising from the complementarity of IT resources have significant effects on corporate performance (Figure 1). The results are robust across two market-based measures of firm performance (Tobin’s q and Treynor ratio). They are marginally significant with ROS. They do not show a significant impact on ROA (Table 5). The lack of strong effects on accounting-based measures of firm performance is consistent with the argument that forward-looking market-based performance measures capture the performance effects of IT much better than backward-looking accounting-based measures (Bharadwaj et al. 1999). Overall, the findings of this study provide support for the performance effects of cross-unit IT synergies.

Diversification level of the firm moderates the association between cross-unit IT synergy and firm performance. While the association is consistently positive at low, moderate, and high levels of diversification, the strength of the association becomes weaker as the diversification level increases (Figure 3). IT resources are potentially applicable across a wide range of business segments. However, as the firm expands into more and more business segments, it becomes more difficult to implement a complementary set of related IT resources across those businesses. Many firms diversify through mergers and acquisitions, and these moves may leave the firm with disparate IT infrastructures and IT management practices. Due to technical, political, or financial constraints, it may be difficult and costly for the firm to convert potential IT synergies into actual performance outcomes (Weill and Broadbent 1998).

As expected, the exploitation of cross-unit IT synergy is the highest in firms using centralized IT governance modes (mean = 4.35/5), moderate in firms using decentralized governance modes (mean = 3.62/5), and lowest in firms using hybrid IT governance modes (mean = 2.39/5). However, IT governance mode does not moderate the relationship between cross-unit IT synergy and firm performance. This finding indicates that the locus of IT decision-making rights may not be the dominant contingency in influencing the relationship between IT synergy and firm performance. In case studies of multibusiness firms, Brown (1999) uncovered that regardless of the formal locus of decision-making rights, some firms were able to exploit cross-unit synergies by using horizontal coordination mechanisms. Thus, horizontal coordination mechanisms may be a more important contingency than IT governance mode in influencing the extent to which the firm is able to convert potential cross-unit IT synergies into actual performance outcomes.

Contributions to Research

An important contribution of this study is the identification of IT resources and management processes as an important source of cross-unit synergy in multibusiness firms. This study articulates distinctive characteristics of IT resources and management processes that extend their range of applicability across diverse business segments. It distinguishes between cross-unit IT synergies and cross-unit business synergies and explains why the exploitation of a complementary set of related IT resources across multiple business units creates IT synergies even across a diverse set of businesses that has limited opportunity to exploit business synergies. While prior studies recognize that multibusiness firms may enjoy IT-related cross-unit synergies (Brown and Magill 1998; Sambamurthy and Zmud 1999), they do not develop the theoretical foundations of cross-unit IT synergy, nor do they link cross-unit IT synergy to corporate performance. This study builds on and extends the prior studies by developing theoretical foundations of IT synergy, sources of cross-unit IT synergy, and the contingencies under which cross-unit IT synergies improve corporate performance. It integrates the RBV of diversification and the economic theory of complementarities to conceptualize IT synergies in terms of the relatedness and complementarity of IT resources. While the relatedness of IT resources creates sub-additive cost synergies, the complementarity of IT resources creates super-additive value synergies. This study also explains why sub-additive cost synergies are necessary but not sufficient for superior corporate performance and why performance effects are contingent on the super-additive value synergies.

An important implication of this study is for the RBV-based analysis of strategic importance of resources. The traditional RBV-based analysis assesses the strategic importance of a given resource by examining the value, rareness, inimitability, and nonsubstitutability attributes of the resource (Mata et al. 1995). If the resource does not satisfy these attributes, the RBV-based analysis concludes that the resource is not strategic. This study uncovers that such RBV-based analyses could produce misleading results in the context of interconnected, complementary resources. For example, an RBV-based analysis of IT infrastructure technologies (e.g., hardware, software, and communications technologies) concludes that these technologies are not strategic since they are readily available to all firms in factor markets and that they do not satisfy the rareness, inimitability, and nonsubstitutability criteria (Mata et al. 1995). However, as shown in this study, IT infrastructure technologies complement other IT
resources such as IT strategy-making processes, IT-HR management processes, and IT vendor management processes. While these resources are not strategic when examined in isolation, as a system of complements, they become strategic and have a significant impact on corporate performance. Thus, this study generates an important new insight for RBV-based analysis of the strategic importance of resources. Resources that are not strategic on their own can gain strategic significance as part of a complementary system of resources. In assessing the strategic importance of a resource, RBV-based analysis should consider complementarities of the resource with other resources, and if complementarities exist, the analysis should focus on the value, rareness, inimitability, and nonsubstitutability attributes of the whole system of complementary resources rather than on the attributes of each resource in isolation.

Moreover, RBV of diversification predicts that the relatedness of nonstrategic resources cannot create strategic synergies, and hence, cannot improve corporate performance. It recommends that multibusiness firms focus their cross-unit synergy exploitation efforts only on strategic resources (Farjoun 1998; Robins and Wiersema 1995). Consistent with these predictions, the individual dimensions of IT relatedness are not strategic, they do not create strategic synergies, and hence, they do not improve corporate performance. However, the complementarities among the four dimensions make IT relatedness a strategic resource that creates strategic cross-unit IT synergies and improves corporate performance. Thus, this study extends the RBV of diversification by uncovering that a complementary set of nonstrategic resources could create strategic cross-unit synergies and improve corporate performance of multibusiness firms.

Another implication of this study is for the complementarity theoretic perspective on the business value of IT. Studies using this perspective focus mainly on complementarities between IT resources and business resources. They argue that the business value of IT resources receives a synergistic boost from complementary business resources such as the redesign of business processes, training of human resources or modification of incentive systems and organizational structures (Barua and Mukhopadhyay 2000; Brynjolfsson and Hitt 2000). This study uncovers that complementarities among IT resources can create significant synergies and serve as a significant source of business value and competitive advantage on their own. This study empirically demonstrates that super-additive value synergies arising from the complementarity of IT infrastructure technologies and IT management processes have significant positive effects on corporate performance of multibusiness firms.

Finally, this study makes an important methodological contribution to IS research. Brown and Magill (1998) have called for considerable research attention to the measurement of cross-unit IT synergies. They observe, “we are unaware of any instruments that purport to capture IT-related cross-unit synergies.” This study heeds their call by developing a new instrument for capturing cross-unit IT synergies arising from IT relatedness of business units. The new instrument is applicable in both manufacturing and service sectors because it was developed and validated with a representative sample of multibusiness firms from both sectors.

### Contributions to Practice

This study provides evidence in support of the existence and performance effects of cross-unit IT synergies. While it is not appropriate to impose uniform IT strategies and uniform IT solutions onto business units operating in different industries, it is appropriate to use common IT infrastructure technologies and to coordinate the strategic IT decisions of the business units by using common IT strategy making, IT human resource management, and IT vendor management processes. It may not be surprising to IT managers that the coordination of IT vendor relationships pools the negotiation and purchasing powers of the business units, cuts prices, and increases the quality of hardware, software, and communications technologies. Likewise, it may not be surprising that the use of a common IT-HR management process reduces recruitment and training costs, or that the use of a common IT strategy-making process reduces the administrative costs of IT strategy making and enhances coordination of IT strategies. What is likely to be surprising to IT managers is that, when taken in isolation, these activities do not have any noticeable impact on the corporate performance of the firm. These activities complement and reinforce each other. The absence or weakness of one of them weakens the benefits obtained from the others. It is critical for IT managers to implement all four dimensions of IT relatedness simultaneously, since performance effects are contingent on their coexistence and complementarity.

However, IT managers should be cautious in pursuing cross-unit IT synergies as the diversification levels of their firms increase. Although the association between IT synergy and firm performance remains positive at increasing levels of diversification, the strength of the association weakens. The increasing level of diversification may raise implementation barriers to the creation and exploitation of IT synergies. IT managers may face technical, political, and financial barriers, especially when the firm diversifies through mergers and acquisitions. It may be risky to try to implant a system of mutually reinforcing IT management activities into the new businesses. Complementarities among the activities may increase the risk of implementation failures. Failure in one activity may lead to failures in others as well. Before pursuing IT synergies, IT managers should carefully assess the potential risks and costs, especially at higher levels of diversification.

This study also finds that the use of a centralized, decentralized, or hybrid mode of IT governance does not make a significant difference in the relationship between IT synergy and firm performance. Contrary to conventional wisdom, the formal locus of IT decision-making rights may not be the dominant contingency in exploiting the performance effects of cross-unit IT synergies. In addition to the locus of IT decision-making rights, IT managers may need to use horizontal coordination mechanisms to convert potential IT synergies into actual performance outcomes.
Limitations and Future Work

This study has some limitations that warrant further research. First, out of a concern to parsimoniously capture the most significant sources of cross-unit IT synergy, this study limited the dimensionality of IT relatedness to four types of IT resources. Future research can explore whether the inclusion of additional dimensions can increase the explanatory power of the IT relatedness construct. Second, this study focused on the performance consequences of IT synergies. Given the empirical support for the performance effects of IT synergies, the next logical extension is to uncover the antecedent mechanisms by which multibusiness firms create and exploit cross-unit IT synergies. Future studies can explore the role of horizontal coordination mechanisms (Brown 1999) and emerging IT governance mechanisms (Agarwal and Sambamurthy 2002; Sambamurthy and Zmud 2000) in the creation and exploitation of cross-unit IT synergies. Third, this study focused on measuring cross-unit IT synergies. It did not measure cross-unit business synergies. The IT synergies alone account for 2 percent of the variance in corporate performance. Considering that the sample used in this study has an average net sale of $10.2 billion and an average market capitalization of $9.6 billion, 2 percent of corporate performance represents significant economic value. In addition to creating cross-unit IT synergies, the use of related and complementary IT resources can create an IT-based coordination mechanism in a multibusiness firm, and enhance boundary-spanning organizational capabilities that exploit cross-unit business synergies (Tanriverdi 2005). Thus, another promising avenue for future research is the development and validation of the nomological relationships among IT relatedness, boundary-spanning organizational capabilities, and firm performance. Finally, this study focused on large, multibusiness firms. Although the concepts developed in this study are potentially applicable in smaller firms too, further research is necessary for understanding if the results hold in the context of smaller firms.

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References


**About the Author**

Hüseyin Tanriverdi is an assistant professor at the University of Texas at Austin. His work has been published or is forthcoming in the *Strategic Management Journal, MIS Quarterly, Journal of the Association for Information Systems, European Management Journal, Organizational Dynamics*, and *Telemedicine Journal*. Hüseyin received a doctorate in information systems from Boston University, an M.Sc. in information systems from London School of Economics and Political Science, and M.Sc. and B.Sc. degrees in electrical and electronics engineering from the Middle East Technical University in Ankara, Turkey.