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DOES IT KNOWLEDGE RELATEDNESS DIFFERENTIATE PERFORMANCE OF MULTI-BUSINESS FIRMS?

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Abstract

This study develops and validates the IT knowledge relatedness *construct to measure the extent to which a multi-business firm leverages related IT knowledge across its business units. It hypothesizes that synergies arising from IT knowledge relatedness differentiate performance of multi-business firms. This hypothesis is tested with primary data from senior IT executives of 315 Fortune 1000 firms. The findings support the hypothesis: IT knowledge relatedness has a positive and significant association with firm performance.*

1   INTRODUCTION

How should multi-business firms organize information technology (IT) resources and activities of their business units to achieve superior performance at the corporate level? Cumulative knowledge in information systems (IS) literature indicates that multi-business firms organize their IT resources and activities under centralized, decentralized, or hybrid modes of IT governance (Sambamurthy and Zmud 2000). Researchers have identified various contingency factors that may influence effectiveness of different IT governance modes (Brown 1999; Sambamurthy and Zmud 1999). Yet, empirical tests of the implied linkage between IT governance and firm performance have been lacking.

This paper examines performance effects of IT governance. It construes IT governance in terms of the organization of IT knowledge across business units of the firm. It develops a new construct, *IT knowledge relatedness,* to capture the extent to which multi-business firms use related IT knowledge across their businesses. Relatedness of IT knowledge is hypothesized to differentiate firm performance by creating economies of scale and scope.

2   THEORETICAL FOUNDATIONS

Strategic management research has long studied performance effects of the organizing logic for strategic resources in the context of the multi-business firm. It argued that multi-business firms, which leverage similar strategic resources across their businesses, can outperform multi-business firms whose businesses rely on unique resources (Rumelt 1974). Synergies arising from the relatedness of strategic resources are posited to differentiate performance of the multi-business firm (Chatterjee and Wernerfelt 1991).

Studies that test the relatedness hypothesis conceptualized strategic resources in terms of product knowledge, customer knowledge, managerial knowledge, human skills and know-how, and technological know-how (Farjoun 1998; Markides and Williamson 1994; Prahalad and Bettis 1986; Robins and Wiersema 1995). Strategic management research has not considered IT knowledge of the firm as a strategic resource (Dewett and Jones 2001).

Although the relatedness hypothesis is not a major focus in IS research, IS studies examining the role of IT in large multi-business firms discovered that diversification levels and performance of multi-business firms are significantly associated with their IT investment and IT usage patterns (Bharadwaj et al. 1999b; Hitt 1999). Related diversifiers invest more in IT compared to unrelated diversifiers (Dewan et al. 1998). Collectively, these findings suggest that IT plays a strategic role in multi-business firms and that IT knowledge should be treated as a strategic resource. Hence, this study develops the *IT knowledge relatedness* construct and empirically tests its effects on performance of multi-business firms.

3   IT KNOWLEDGE RELATEDNESS

We define IT knowledge relatedness as the *degree to which underlying strategic IT knowledge of a business unit is also applicable across other business units of the firm.*

IT knowledge is a multidimensional construct because firms develop knowledge about various IT resources, functions, and activities (Sambamurthy and Zmud 2000). Building on previous IS research, we identify: (1) IT strategy; (2) IT relationship management; (3) IT human resource management; and (4) IT infrastructure management as four major dimensions of a firm's strategic IT knowledge (Broadbent and Weill 1997; Brown and Magill 1994; Chan et al. 1997; Earl 1996; Feeny and Willcocks 1998; Henderson 1990; Henderson and Venkatraman 1993; Mata et al. 1995; Rockart et al. 1996; Roepke et al. 2000; Ross et al. 1996; Sabherwal and Chan 2001).

3.1 Relatedness of IT Strategy

We define relatedness of IT strategy as *the degree to which IT strategy of a business unit is also applicable across other business units of the firm.*

IT strategy could be a critical determinant of firm performance when it is aligned with business strategies of the firm (Henderson and Venkatraman 1993; Sabherwal and Chan 2001). However, achieving alignment between business and IT strategies is challenging in the context of large, multi-business firms whose businesses compete in different products and markets. In the absence of common managerial logic for investing in IT, formulating IT strategy, and aligning IT and businesses strategies, individual business units tend to under-invest (Prahalad and Hamel 1990), or make suboptimal choices for the corporation (Robertson and Ulrich 1998). Using common processes across individual business units could help the multi-business firm to institute related IT strategies across the individual businesses. Related IT strategies can lead to optimal IT-business alignment and, hence, differentiate firm performance at the corporate level.

3.2 Relatedness of IT Human Resource Management

We define relatedness of IT human resource management as *the degree to which IT human resource management practices of a business unit is also applicable across other business units of the firm.*

IT human resources are critical for effective use of IT. However, generic IT skills cannot differentiate firm performance because they are available to all firms in the labor market (Mata et al. 1995). It is the firm's IT human resource management knowledge that transforms generic IT skills into firm-specific IT capabilities (Keen 1993). Such knowledge resides in a firm's processes for recruiting, training, motivating, and retaining IT human resources (Ang and Slaughter 2000). These processes are neither trivial nor costless (Agarwal and Ferratt 1998), but multi-business firms enjoy learning scope advantages in dealing with the challenges of creating and maintaining a competent IT workforce. If one business excels in recruiting, training, motivating, and retaining skilled IT talent, other businesses can also benefit from its expertise. Exchange of best practices across business units can create economies of scale and scope in the firm's IT human resource management expertise.

3.3 Relatedness of IT Relationship Management

We define relatedness of IT relationship management as *the degree to which the processes used for managing IT relationships of a business unit are also applicable across other business units of the firm.*

Increasing variety and complexity of IT requires firms to complement their internal IT resources and capabilities through relationships with external vendors and service providers (DiRomualdo and Gurbaxani 1998). However, these relationships do not automatically translate into successful outcomes (Earl 1996). Firms need to dedicate substantial managerial skills and knowledge into determining strategic goals of the relationship, negotiating the terms, making the deal, and managing the relationship after the deal is made (Useem and Harder 2000). In a multi-business firm, managing IT vendors and service providers of each business unit independently can lead to redundant investments, and incompatibilities in hardware, software, and applications, whereas the use of similar IT relationship management principles and processes across all business units can reduce costs and ensure compatibility.

3.4 Relatedness of IT Infrastructure Management

We define relatedness of IT infrastructure management as *the degree to which the policies used for managing IT infrastructure of a business unit are also applicable across other business units of the firm.*

IT infrastructure comprises of a set of managerial policies and hardware, software, and communications standards that provide a common structure for supporting business processes, products, and services of the firm. It determines the degree to which the firm can connect to and access globally dispersed business units, customers, suppliers, and partners (Broadbent et al. 1999; Keen 1991). It can either enable or constrain the firm's operations and strategic choices (Keen 1991). An IT infrastructure, which ensures integration and compatibility, can facilitate efficient business transactions as well as knowledge creation, transfer, integration, and leverage processes across business units, customers, suppliers, and partners. Firms with fragmented and incompatible IT infrastructures, on the other hand, may forgo such advantages.

In summary, multi-business firms can achieve economies of scale and scope by sharing relevant IT knowledge and investments across their business units (Sambamurthy and Zmud 1999). Although individual IT skills and knowledge of business units can differentiate performance at the business unit level, they do not suffice to create firm-wide synergies that differentiate performance at the corporate level. Synergy creation at the corporate level requires identification, transfer, and leverage of related IT knowledge across business units. Despite the potential benefits, there are significant barriers to the creation of IT knowledge relatedness due to the complexity of the multi-business firm (Gupta and Govindarajan 1991), stickiness of knowledge (Szulanski 1996; von Hippel 1994), and challenges involved in identification and transfer of related IT knowledge across business units (Hansen 1999). Firms that can achieve IT knowledge relatedness can gain advantages over other firms that cannot. Hence, *we hypothesize that IT knowledge relatedness is positively associated with performance of multi-business firms.*

4 METHODOLOGY

The sample for this study is the *Fortune 1000* list published in the year 2000. We collected primary data from senior IT executives of *Fortune1000* firms to measure IT knowledge relatedness and IT governance mode of their firms. We obtained secondary data from the COMPUSTAT database to compute objective measures of firm performance, firm size, and diversification and relatedness levels of the firms.

4.1 Construct Operationalization

IT knowledge relatedness. We developed new items to measure relatedness of IT strategy (three items), IT relationship management (seven items), IT human resource management (five items), and IT infrastructure management (seven items) across business units of *Fortune 1000* firms. We also developed a new scale to measure whether such managerial IT processes are unique and specific to each business unit, or common and applicable across multiple business units:

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

Uniqueness and specificity of a process to individual business units mean that the business units are unrelated. Commonality of the process across business units indicates that business units are related.

Firm performance. Following previous IS research we use Tobin's q, a market-based performance measure, as our dependent variable. As a forward-looking performance measure, Tobin's q is among the most widely used measures for capturing performance effects of intangibles such as IT resources and capabilities (e.g., Bharadwaj et al. 1999a). We compute Tobin's q based on 2000 financial data that is readily available in the COMPUSTAT database (Chung and Pruitt 1994).

Control variables. To account for industry level effects, we control for *industry Tobin's q*. We define industries by two-digit SIC (standard industrial classification) codes. For a given industry, we compute *industry Tobin's q* by averaging Tobin's q values of all firms in the COMPUSTAT database whose primary activity is in that industry.

To account for firm level effects, we control for size, diversification, and relatedness levels and IT governance modes of the firms. We compute firm size by taking the logarithm of number of employees. We compute entropy measure of total diversification (DT) and its related component (DR) to measure diversification and relatedness levels of the firm (Palepu 1985). We measure IT governance mode of the firm by asking informants the following question (Brown 1999):

> Which of the following best describes the locus of authority and responsibility for managing IT infrastructure (e.g., computers and networks) and IT applications (e.g., customer support systems, transaction processing systems, workflow management systems, etc.) in **<<insert corporation name>>**? Please check only one:

> ❏ 1. **Decentralized:** Business units have the primary authority and responsibility for managing both IT infrastructure and IT applications.

> ❏ 2. **Federal (hybrid):** A corporate IS unit has the primary authority and responsibility for managing IT infrastructure whereas business units have the primary authority and responsibility for managing IT applications.

> ❏ 3. **Centralized:** A corporate IS unit (or other central unit) has the primary authority and responsibility for managing both IT infrastructure and IT applications.

4.2 Survey Development and Administration

We pretested the survey instrument with 10 domain experts in academia and 25 executives in *Fortune 1000* firms. We sent the finalized surveys to the most senior IT executives of *Fortune 1000* firms. *CIO* magazine and *Darwin* magazine sponsored the surveys by writing a joint cover letter. Four follow-up reminders were sent during the second, fourth, eighth, and twelfth weeks after the initial survey mailing (Dillman 2000).

4.3 Response Rate

A total of 32 firms were dropped because they merged with other firms, were acquired, or declared bankruptcy during our data collection timeframe. Another 82 firms declined to participate due to company policy. Out of the remaining 886 firms, 315 firms provided usable responses (36% response rate). Of these firms, 149 (47%) operate in manufacturing industries whereas 166 firms (53%) operate in service industries.

4.4 Assessment of Nonrespondent Bias

Comparison of responding and nonresponding firms did not reveal any statistically significant differences in terms of size ($t = -0.63$, $p > 0.1$), Tobin's q ($t = 1.39$, $p > 0.1$), or diversification levels ($t = -0.25$, $p > 0.1$). Likewise, there were no statistically significant differences between early and late respondents in terms of size ($t = 0.99$, $p > 0.1$), Tobin's q ($t = -1.06$, $p > 0.1$), and diversification level ($t = 0.26$, $p > 0.1$).

4.5 Assessment of Informant Competency

Of the informants in the sample, 81 percent were at or above the level of chief information officer, 6 percent were chief technology officers (CTO), and 13 percent had job positions below the CTO. The average organizational tenure of informants was 10.8 years. They had, on average, been involved in corporate IT strategy formulation for 5.8 years. They were also highly active in formulation of the corporate IT strategies of their firms at the time of the study (average = 4.73 on a five-point scale, 5 representing very active). These measures indicate that informants were highly qualified to answer the questions of this study.

4.6 Approach Used for Assessing Measurement and Structural Properties of the Model

We used a confirmatory factor analytic approach, as implemented in LISREL 8.3 (Joreskog and Sorbom 1996). First, we compared a set of competing measurement models to select the best-fitting measurement model for IT knowledge relatedness. Then, we tested the structural link between IT knowledge relatedness and firm performance (Anderson and Gerbing 1988).

We hypothesized IT knowledge relatedness to be a second-order factor comprising of four first-order factors: IT strategy, IT human resource management, IT relationship management, and IT infrastructure management. We obtained full evidence for measurement efficacy of the hypothesized second-order factor in four stages (Segars and Grover 1998). First, we used an item purification process to identify a set of items that parsimoniously captures the variance in the data. Substantive and empirical criteria are used to guide the item purification process. Substantive criteria include theoretical content covered by factors, consistency of content tapped by individual factor items, and clarity of substantive meaning of the items. Empirical criteria include composite measure reliability (ρ_c) and fit statistics such as significance and goodness of fit of the overall measurement models for factors. Items are deemed noisy and deleted when their error variance is equal to or greater than their trait variance. Second, we assessed measurement properties of the first-order factors. Third, we assessed relative fit among alternative first-order factor models. Finally, we assessed the presence of a second-order factor.
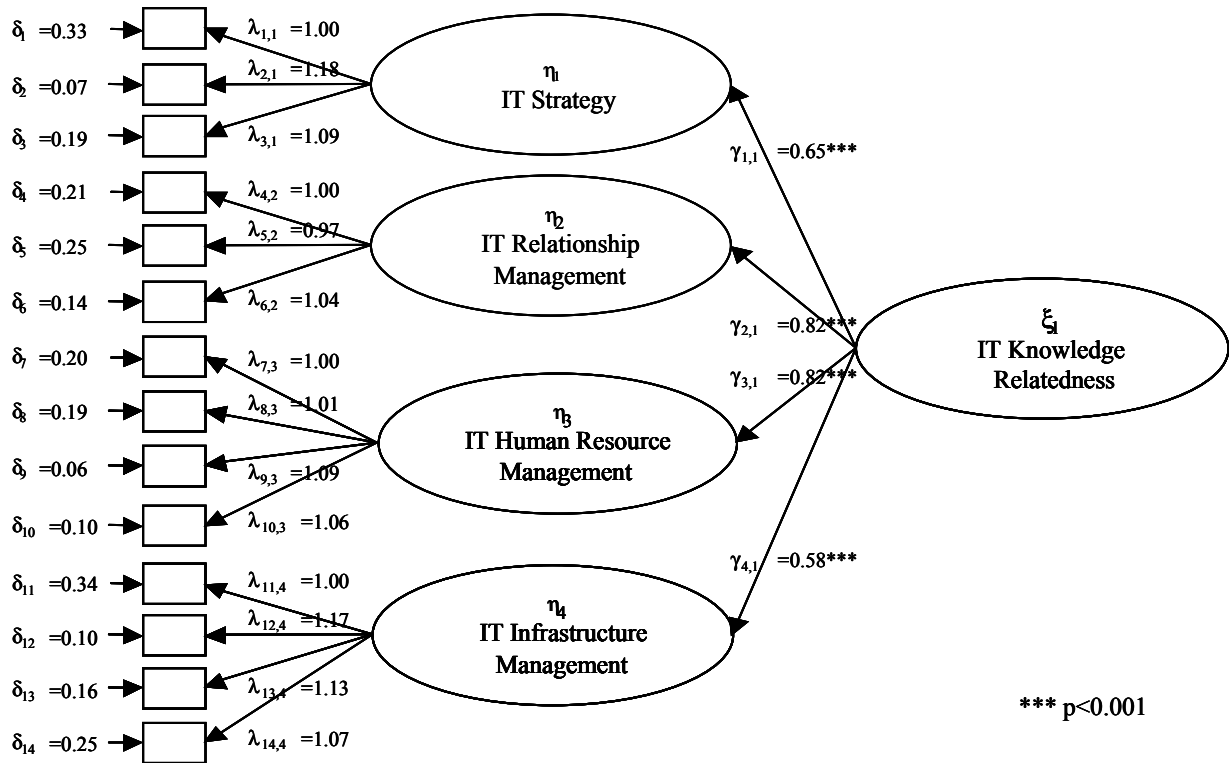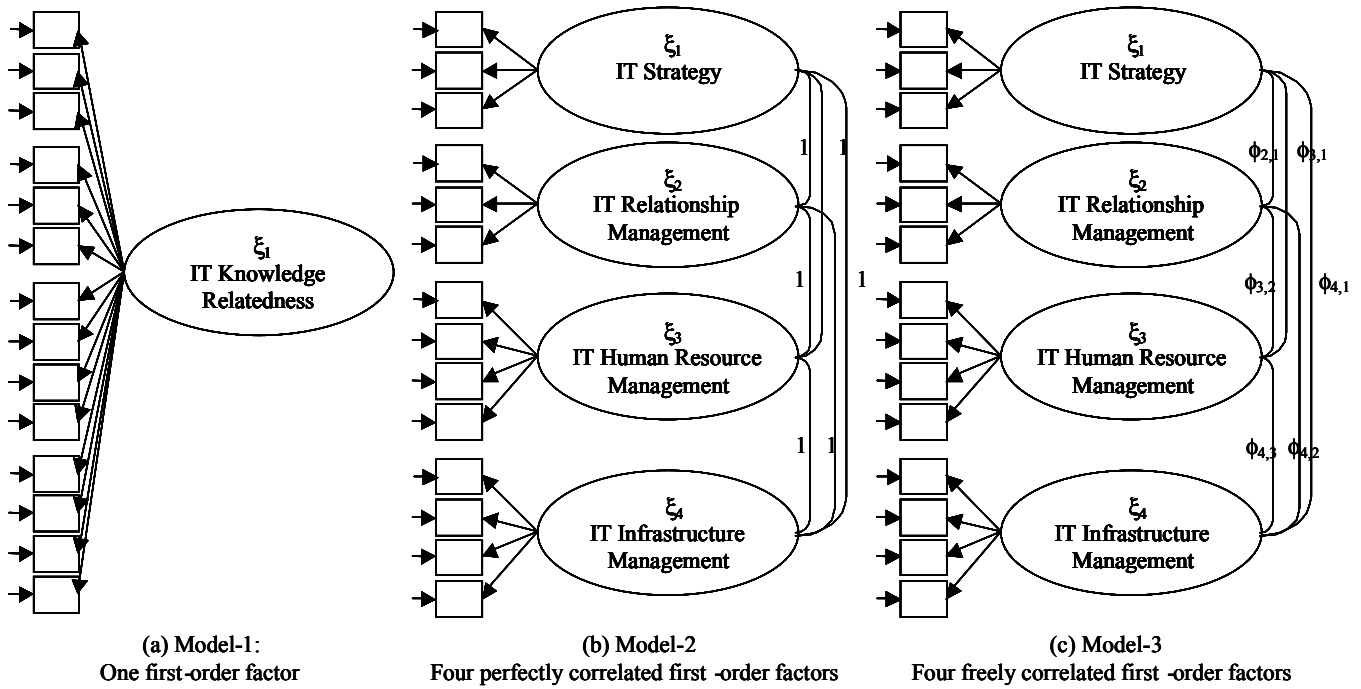
5 RESULTS

5.1 Measurement Model

Internal Consistency of Measurements. Table 1 provides the measurement scale, purified measurement items, and reliability measures of the first-order factors. Coefficient alphas are all above the 0.70 threshold, providing evidence of measure *reliability* (Nunnally 1978). Likewise, composite measure reliability (ρ_c) scores are above the suggested thresholds (Venkatraman and Ramanujam 1987), demonstrating internal consistency of the measures.

Dimensionality and Convergent and Discriminant Validity. We tested for dimensionality and convergent and discriminant validity of the IT knowledge relatedness construct by comparing three alternative first-order factor models and a second order-factor model shown in Figure 1.

In selecting the best-fitting measurement model, relative fit statistics across the competing models are far more important than absolute fit statistics of the individual models because absolute fit statistics are sensitive to degrees of freedom involving the number of elements in the sample covariance matrix and the number of parameters to be estimated (Byrne 1998). Comparison of model-1 ($\chi^2 = 1776.40$, d.f. = 77) and model-2 ($\chi^2 = 474.40$, d.f. = 77) shows that model-2 is a better-fitting model, indicating that a multidimensional model comprising of four perfectly correlated first-order factors is superior to a unidimensional first-order factor model. Further comparison of model-2 ($\chi^2 = 474.40$, d.f. = 77) with model-3 ($\chi^2 = 422.33$, d.f. = 71) indicates that the four freely correlated first-order factors model is superior to the four perfectly correlated first-order factors model ($\Delta\chi^2 = 52.07$, Δd.f. = 6; p < 0.00001).

Superiority of the multidimensional factor models provides support for *multidimensionality* of IT knowledge relatedness. 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 unity. They are also below the cut-off value of 0.90 (Bagozzi et al. 1991), demonstrating distinctiveness of theoretical content captured by the first-order factors. Since measurement items converge on their respective factors and the factors are distinct from each other, we obtain support for *discriminant validity* (Anderson 1987; Bagozzi et al. 1991).

(a) Model-1:
One first-order factor

(b) Model-2
Four perfectly correlated first-order factors

(c) Model-3
Four freely correlated first-order factors

χ^2 =433.55, d.f.=73, p=0.00; GFI: 0.84; NFI: 0.91; CFI: 0.92; RMSEA: 0.125

(d) Model-4: Four first-order factors, one second-order factor

Figure 1. Knowledge Relatedness: Alternative First-Order and Second-Order Factor Models

Table 1. IT Knowledge Relatedness: Measurement Scale, Purified Measurement Items, and Reliability Measures

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.

Measurement Items	Alpha	ρ_c
RELATEDNESS OF IT STRATEGY	0.89	0.86
Strategic rationale for investing in IT is…		
Processes used for formulating IT strategy are…		
Processes used for aligning IT strategy with business strategy are…		
RELATEDNESS OF IT RELATIONSHIP MANAGEMENT	0.87	0.83
Strategic goals for entering into IT outsourcing relationships are...		
Processes used for negotiating and making deals with IT vendors and service providers are...		
Processes used for managing relationships with IT vendors are...		
RELATEDNESS OF IT HUMAN RESOURCE MANAGEMENT	0.94	0.89
Training programs and opportunities provided to IT talent are...		
Incentives used for aligning interests of IT talent with business goals are...		
Strategies used for retaining IT talent are...		
IT human resource management policies, which lead to success in recruiting, training, and retaining IT talent are...		
RELATEDNESS OF IT INFRASTRUCTURE MANAGEMENT	0.90	0.85
Policies used for managing IT infrastructure are...		
IT hardware standards are...		
IT software standards are...		
IT communications standards are...		

First-Order Versus Second-Order Factor Models. Finally, we tested whether a more restrictive second-order factor accounts for the relationships among the first-order factors. Model-4 in Figure 1 depicts the hypothesized second-order factor model. To test for the presence of a second-order factor model, Marsh and Hocevar (1985) developed the target coefficient (T) statistic, which computes the ratio of the chi-square value of the first-order factor model to the chi-square value of the second-order factor model. Support for the existence of a second-order factor becomes stronger as T approaches unity (Marsh and Hocevar 1985). A complementary set of statistics is given by the significance of the parameters reflecting the second-order factor loadings (Venkatraman 1990).

The target coefficient is T = 0.97 ($\chi^2_{Model-3}$ = 422.33/$\chi^2_{Model-4}$ = 433.55 = 0.97), indicating that a second-order factor accounts for 97 percent of the relations among the first-order factors. This value suggests acceptance of the second-order factor model. In addition, all second-order factor loadings ($\gamma_{1,1}$ to $\gamma_{4,1}$) are highly significant (p < 0.001), providing further justification for the acceptance of the second-order factor model. Overall composite measure reliability (ρ_c) of the IT knowledge relatedness construct is 0.85, indicating strong internal consistency among construct measures (Venkatraman and Ramanujam 1987).

5.2 Structural Model

Table 2 provides the descriptive statistics and correlations. IT knowledge relatedness has a positive and significant correlation with IT governance mode (r = 0.68, p < 0.001). However, unlike the IT governance mode, which does not have a significant association with firm performance (r = 0.09, p > 0.1), IT knowledge relatedness has a positive and significant association with

firm performance (r = 0.15, p < 0.05). This finding provides preliminary support for performance effects of IT knowledge relatedness.

We conducted a more formal test of our hypothesis within a structural equation framework as shown in Figure 2. The structural link between IT knowledge relatedness and firm performance is positive and significant ($\gamma_{5,1} = 0.15$, p < 0.05), providing evidence that IT knowledge relatedness does indeed differentiate firm performance.

Table 2. Summary Statistics and Correlation Matrix

	Mean	SD	1	2	3	4	5	6	7
1. Tobin's q	1.51	1.54	1.00						
2. Industry Tobin's q	1.17	0.33	0.42**	1.00					
3. IT knowledge relatedness[a]	3.91	0.90	0.15*	0.09	1.00				
4. IT governance mode	2.41	0.70	0.09	0.08	0.68***	1.00			
5. Related Diversification (DR)	0.39	0.37	-0.07	0.04	0.00	-0.08	1.00		
6. Total Diversification (DT)	0.94	0.54	-0.05	0.03	-0.06	-0.22***	0.51***	1.00	
7. Firm Size	4.20	0.50	0.07	0.11+	0.16**	0.03	0.09	0.29***	1.00

[a]Correlations with IT knowledge relatedness are obtained by specifying structural links from the second-order IT knowledge relatedness construct to the variable of interest.
+p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001

5.3 Assessment of Rival Explanations

To understand whether there might be rival explanations for our findings, we tested performance effects of IT knowledge relatedness after controlling for various industry and firm level effects as shown in Figure 3. To run this model, the second-order IT knowledge relatedness construct is converted into a composite single indicator construct based on a consideration of its measurement error component. We obtained trait variance of the single indicator construct by taking weighted averages of the factor loadings of the corresponding second-order construct. We set error variance of the single indicator construct equal to zero.

Industry Tobin's q has a positive and highly significant effect on firm performance ($\gamma_{1,2} = 0.41$, p < 0.0001). Firm size has a positive, but insignificant effect on firm performance ($\gamma_{1,3} = 0.02$, p > 0.1). Total diversification level (DT) of the firm has a negative but insignificant effect on firm performance ($\gamma_{1,4} = -0.02$, p > 0.1). Relatedness of firm's businesses (DR) also has a negative but insignificant effect on firm performance ($\gamma_{1,5} = -0.08$, p > 0.1). Finally, IT governance mode does not have a significant association with firm performance ($\gamma_{1,6} = -0.04$, p > 0.1). IT knowledge relatedness has a positive and significant effect on firm performance ($\gamma_{1,1} = 0.13$, p < 0.01) after controlling for all industry and firm level effects.

6 DISCUSSION AND CONCLUSIONS

Results confirm our *ex ante* expectation that IT knowledge relatedness is a second-order construct. Relatedness of the firm in IT strategy, IT relationship, IT human resource, and IT infrastructure management domains are simply different manifestations of the corporate-level IT knowledge relatedness construct (Law et al. 1998). The significant association between the second-order IT knowledge relatedness construct and firm performance indicates that an internally consistent organizing logic for IT activities result in superior firm performance (Venkatraman 1990). Managing IT strategies, IT human resources, IT relationships, and IT infrastructures of multiple business units in isolation is not likely to differentiate firm performance as indicated by the inferiority of the corresponding measurement models and, hence, structural models of this study.

The strong correlation between IT knowledge relatedness and IT governance mode (r = 0.68, p < 0.001) indicates a nomological association between the two constructs. However, it is important to note that IT governance mode does not have a significant association with firm performance (r = 0.09, p > 0.1) while IT knowledge relatedness does (r = 0.15, p < 0.05). These findings suggest that, when selecting an IT governance mode (centralized, decentralized, or hybrid), multi-business firms should base their decisions on knowledge-based relatedness of IT resources and activities of their business units.
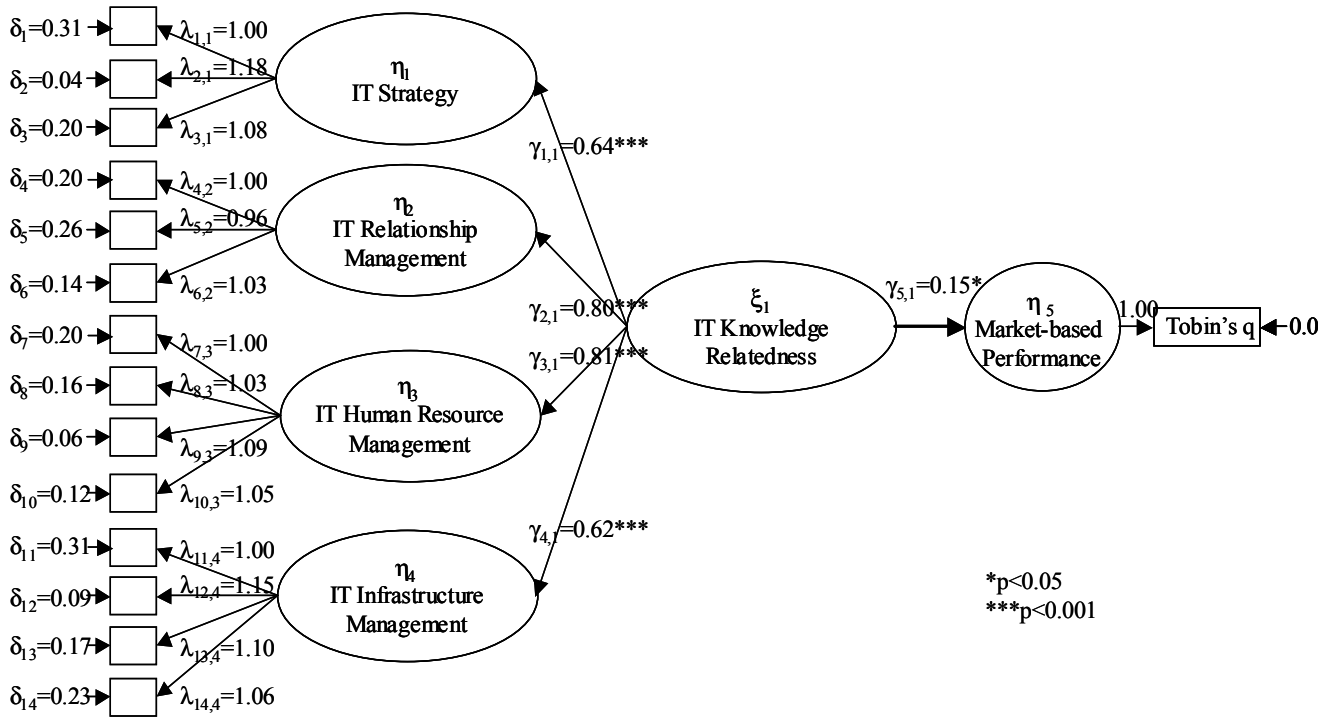
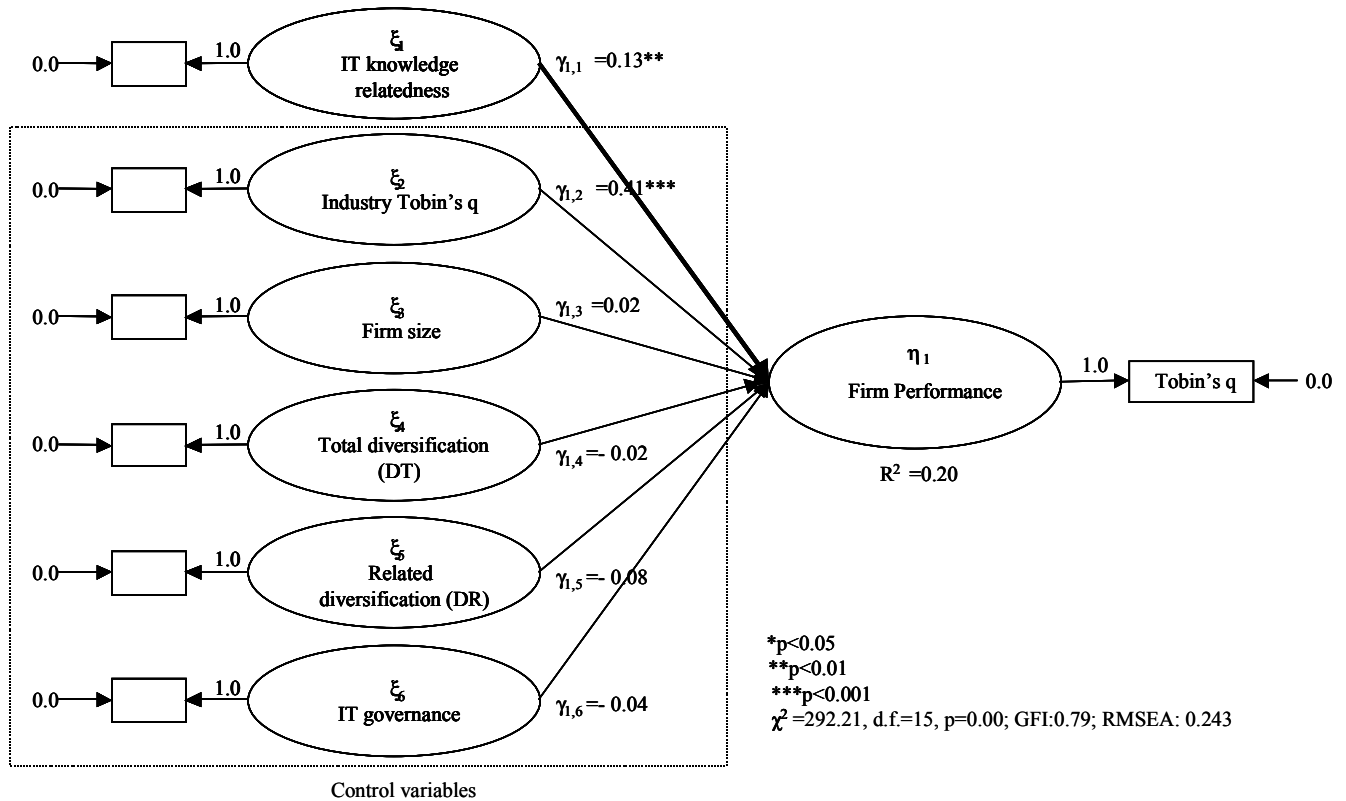**Figure 2. Performance Effects of IT Knowledge Relatedness**

Figure 3. Overall Structural Model of Performance Effects of IT Knowledge Relatedness

Findings and operational measures of this study are likely to be applicable across a variety of research settings because we used a representative sample of multi-business service and manufacturing firms. We avoided the common method bias by using an objective measure of firm performance. We ruled out rival explanations to our findings by testing competing measurement models and controlling for industry effects, firm size, diversification level, relatedness level, and IT governance mode of firms.

This study demonstrates that IT knowledge is a strategic knowledge domain of the firm and that IT knowledge relatedness differentiates performance of multi-business firms. The *IT knowledge relatedness* construct developed in this study can be used to study the role of IT in other firm-level phenomena such as knowledge management capability of the firm.

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