The Influence of the Demand for Integration on the Structure of IT in Multi-business Unit Firms

Introduction

The theory described here suggests that the demands of the overall enterprise impact the structural characteristics of the IT function. Specifically, the need for more information processing in the form of demand for integration of the subunits of the firm causes the structure of the IT function to be modified to address the demands of the rest of the firm. The theory emanates from our observations of large, multi-business unit corporations and how they have modified the structure of their IT functions to address specific demands for integration in their firms. The research has important implications as it sheds light on how the IT function may act as an enterprise-wide performance lever, identifies contingency factors that impact the expectations of the CIO and the IT function in a given company and provides a refreshed view of some of the contingencies of the governance and structure of the IT function.

The principle research question of interest is: "what are the relative effects on the IT structure of the demand for integration in the large, multi-business unit firm?" We use two theoretical perspectives, the information processing view (e.g., Thompson, 1967); Galbraith, 1974; Tushman & Nadler, 1978) and coordination theory (Malone & Crowston, 1990; C. V. Brown, 1999; Lawrence & Lorsch, 1967; Mintzberg, 1979; Hart & Moore, 2005), to build on prior work considering the antecedents of IT structure (C. V. Brown & Magill, 1994; Sambamurthy & Zmud, 1999) and select a set of key factors that are expected to influence the structure of the IT function via their influence on the demand for integration of the firm. Two empirical tests are conceived to determine the effects of these firm-level factors on the structure of IT.

A common theme that we have noted in our observations of large multi-business unit firms over the past five years is that decisions regarding the design and implementation of applications and their associated business processes are increasingly being made from a corporate perspective. Where firms once supported customized and localized applications for each of their subunits, it appears that more and more firms are selecting a common approach across the enterprise to their applications and the business processes they support. We have also noted an increasingly influential role for the IT function in the

overall operations of the firm. The expectation of the IT function today in many firms is that it not only supports the information technology needs of the enterprise in an efficient manner, but it also enables and contributes to the firm's strategic, top-line financial objectives. The following three instances of firms that we have observed exemplify the trend in IT structure that this research is designed to explain:

International Food and Agricultural Conglomerate - In one firm, a $100+ billion conglomerate composed of more than 50 highly autonomous business units, IT acted as a simple support function into the early 2000s. A divisional CIO in each business worked to align the activities of the division-level IT function with the specific needs of the business that the IT function supported. Applications, data and business processes were unique to each business unit. There was little concern for how IT might be deployed across the enterprise and how information sharing across units might benefit the overall corporation. IT investment decisions were made almost entirely in the autonomous business units, not at the corporate level. In 2006, the firm identified common needs or synergies across small groups of five to eight business units in the firm. Decisions were not made at the corporate level, but rather among committees linking the IT functions of small groups of business units. Just a few years later, the firm is now undertaking a major transformation initiative to implement common business processes across the entire firm, while maintaining the local autonomy in the business operations that is a trademark of the firm. The corporate CIO is viewed as a key player in this business transformation, one of the top executives in the firm charged with sponsoring and driving this change initiative. A single instance enterprise resource planning (ERP) system is an important component of this organizational transformation. This is a dramatic shift from a highly decentralized IT structure that mimicked the corporate structure to a much more centralized IT structure that now diverges from the corporate structure.

National Health Care Provider - Another example of this type of significant change in the IT organization structure is in a national health care organization. This well-respected health care provider is organized geographically by its main hospital and clinic locations. Its IT function has undergone a two-step organizational change in the past five years. Originally, the IT function had three managers each responsible for both infrastructure and applications in his/her own geographic area. The first step was to

combine responsibility for infrastructure across the geographic locations under a new corporate level director position. The second step is the more surprising move. Responsibility for business applications was brought under a single director across all geographies. The health care organization itself remained autonomous by geography with separate business leadership in each location; however, the IT organization was centralized to drive "clinical convergence," the consistent delivery of quality care across the firm utilizing best practices. As with the first example, this example shows how the structure of IT has become more centralized and the IT function has been given broader responsibilities in the firm. The firm structure remains decentralized, while the move to a more centralized IT structure is intended to drive consistent business processes across the subunits of the firm.

Major International Airline – At a major international airline, the Chief Information Officer plays a role in the firm much more like the traditional role of Chief Operating Officer. The IT function is being asked to provide innovations in the firm's applications to achieve efficiency in the customer experience, minimum cost scheduling and improved brand loyalty. The role extends well beyond that of supporting the business operations of the airline and into a more strategic one. The Chief Information Officer now is part of the top management team at the airline. Interestingly, IT played a prominent role in the recent combination of this airline with one of its competitors. Rather than allowing disparate systems to continue to exist within two separate businesses, the first priority of the merger was to integrate frequent flier programs, scheduling and operational applications to promote the combination of the two airlines. This particular case shows how the CIO and the IT function may play the role of coordinating different functions of the organization, in this case linking operations and marketing. The result in this case is a more prominent position for the CIO and a more corporate-wide perspective for the IT function of the corporation.

Consistent with the above observations, there is empirical evidence that also indicates that the structure of IT is becoming more centralized in the areas of applications and business processes. Recent research indicates that the locus of IT decision making in a majority of firms is centralized not only in expected areas such as managing IT operations and technology assets, but also in the areas of improving

and changing business processes, with CIOs also forecasting more centralization to come (Adams, Larson, & Xia, 2007). Existing theory suggests that the structure of the IT function mimics that of the corporation (Sambamurthy & Zmud, 1999). As the economic environment becomes more global, volatile and uncertain, there is a tendency to push the broader organization's decision making to the interface with the business environment (Prahalad & Krishnan, 2008), so decisions regarding IT would be expected to follow. However, recent changes in the IT organization by many large multi-business unit enterprises as exemplified above suggest an alternative approach based on enterprise-wide integration of information systems. In order to achieve this integration, the IT function is increasingly taking a centralized, corporate view. While this centralization in IT is expected in the area of infrastructure to achieve efficiency (C. V. Brown & Magill, 1994) and to meet increased communication needs, it is somewhat unexpected in the areas of applications and business processes, especially among firms that depend on local autonomy and differentiation for competitive success. Together, this preliminary evidence of a more centralized approach to IT suggests that we sharpen our understanding of the factors that determine the appropriate structure for the IT function. Knowledge of these factors and their influence is important to the top management of large firms as they attempt to design organizations that are optimal for the unique contingencies faced by each firm. It is also relevant information for the CIO and other leaders of the IT function to better understand the contingencies that may influence the overall expectations of the IT function in the firm. In the next section, an explanation is provided for how enterprise demand for integration in the large, multi-business unit firm influences the structure of the IT function.

Underlying Theory

Centralization and/or decentralization of IT have been studied at length (C. V. Brown & Magill, 1998; King, 1983; Sambamurthy & Zmud, 1999). This stream of research is part of the broader organizational literature that addresses the trade-off between differentiation and integration (Lawrence & Lorsch, 1967). Most IT organizations in large, multi-business unit firms are believed to take some form of federal governance model (Sambamurthy & Zmud, 2000) in which the infrastructure decisions are

centralized for efficiency while decisions regarding applications remain more decentralized to best fit the unique needs of each subunit of the enterprise. But this contrasts with our more recent observations.

We argue that demand for integration has intensified in most large multi-business unit firms and the structure of the IT function is becoming more centralized in order to provide the integration that is demanded by the rest of the firm. The trend identified in the early 1990s of increasing interdependence among subunits of the large, multinational firm (Hagstrom, 1992) seems to be gaining momentum. In many firms, the subunits of the firm are no longer treated as independent operating businesses. Instead, identification of common business processes improves efficiency while exploitation of synergies among the subunits generates revenue growth opportunities.

A very different, but significant view that we take is to conceptualize the IT function as a new type of "integrating device" (Lawrence & Lorsch, 1967), a second order organizational entity linking the subunits of the firm. This is both a technological linking and an organizational linking of the subunits. The technology itself provides a mechanism for increased information processing across the boundaries separating the subunits of the firm while the IT organization plays a coordinating role in the firm as IT personnel serve in a variety of coordinating roles (e.g., liason, steering committees, cross-unit collaboration). Especially when the IT organization is more centralized, IT is uniquely positioned with a systemic view of the enterprise, is familiar with key individuals across the subunits and has an appreciation of the diversity and commonality of language that exists in the subunits. In playing the role of integrating device, it is likely that the IT function may provide a wide spectrum of coordinating mechanisms, including authority, standardization of inputs, processes and outputs, and mutual adjustment (Mintzberg, 1979). Depending on the power afforded the CIO and IT function, there may be some level of hierarchical authority that the IT function may bring to bear with regard to driving common infrastructure, applications, and business processes across the firm. The IT function also plays an important role in standardization through the technology it provides, but also with respect to its frequent involvement in business process improvement. And its ability to allow timely and high volume information sharing is a key contributor to facilitate mutual adjustment when that form of coordination is

required among the subunits of the firm. In summary, there are a number of technological and organizational means by which the IT function may play a integrating role for the rest of the firm in linking the activities of the subunits of the firm.

Part of our argument for highlighting the IT function as being impacted by the intensity of the demand for integration is the importance of matching the information processing capability to the information processing needs of the firm. The environment is increasingly volatile and uncertain (Bartlett & Ghosal, 1998), requiring additional information processing in order to manage the uncertainty (Galbraith, 1974). The business units look to IT to provide additional information processing capabilities, matching the information processing capabilities to the demands for information processing. "The efficiency of any particular structure varies with the processing power of the agents in the organization" (DeCanio & Watkins, 1998). If the use of IT is able to modify the processing power of the individuals that comprise the organization, then the organizational structure is likely to change to most efficiently address the information processing demands. The organizational structure is likely to adapt to the information processing demands faced by the organization (Tushman & Nadler, 1978). As a result, the IT structure is likely to adapt as increasing information demands are placed directly on it or as a result of demands felt by the rest of the firm. There are a number of structural characteristics that address information processing requirements by reducing uncertainty and equivocality of information (Daft & Lengel, 1986). Many of these structural characteristics (boundary spanning positions, planning and formal information systems) are prevalent in the IT function in large multi-business unit firms and are further evidence that the structure of the IT function is likely to be influenced by the firm's overall information processing demands.

Increased information processing requirements of the firm as a whole impact the IT function since the function is a primary enabler of information processing capability in the form of applications, data and the exchange of information. In taking an information processing view, the firm is conceived as an open social system organized to manage the uncertainty of the tasks it must perform, as a set of information processing systems and as a collection of differentiated subunits (Tushman & Nadler, 1978).

The importance of information processing to the firm, especially in volatile and uncertain environments, emphasizes the role of IT in delivering information processing capability to enable the coordination of the subunits. IT may enable direct performance effects or complement the organization's strategic decision making by "facilitating coordination and responsiveness" and increasing speed and accuracy to improve decision making (Andersen, 2001). It is also true that the quality of information improves with horizontal coordination among subunits of the corporation (Alonso, Dessein, & Matouschek, 2008), creating further incentive or demand for integration among business units.

For the purpose of this research, the terms integration and coordination are used interchangeably. They are defined as "integrating or linking together different parts of the organization to accomplish a set of tasks" (van de Ven, Delbecq, & Koenig, 1976), p. 322). Although communication is an important aspect of integration, integration is more than simply sharing information. In establishing a multi-disciplinary study of coordination, Malone defined coordination (integration) as "the additional information processing performed when multiple, connected actors pursue goals that a single actor pursuing the same goal alone would not perform" (Malone, 1988). The actors in our context are the organizational subunits (business units, divisions, and/or functional units) of a multi-business unit firm. Integration of subunits of the firm may be thought of as "interdepartmental integration," a combination of the interaction of the employees across departments and their level of collaboration toward common goals (Kahn, 1996). Integration is the discovery and exploitation of synergies across subunits of the firm. Having defined integration in the context of the large multi-business firm, we next consider the factors that are both enabling enterprise-wide integration and intensifying the demand for integration.

An important aspect of this trend toward more corporate level decision making in IT is the prevalence of ERP systems today, especially in large, multi-business unit firms. The value of ERP is highest in organizations with high interdependence among business units because such systems have the "ability to coordinate activities and facilitate information flows" (Gattiker & Goodhue, 2004, p. 431). ERP accomplishes a number of top-line and bottom-line objectives of the enterprise by integrating disparate business systems and processes, coordinating activities, connecting flows of information and

improving information sharing (Newell, Huang, Galliers, & Pan, 2003). ERP drives corporate standardization of data, applications and business processes. Centralized IT may be required to efficiently create such standardization and enable coordination among the subunits of the firm.

One key factor that potentially impacts all companies is what the current level of technology allows the firm to do or what capabilities might be afforded by the technology. A key change that occurred in the past fifteen years is that the technology became available so that it is possible to manage enterprise-wide data and applications in a single instance of hardware and software. The ability to do so does not make it a requirement of the firm to integrate data across its business units, but it means that integration through technology is possible. For example, databases no longer act as a limitation on the data integration of a large firm, but instead serve as the platform for such integration. So, any latent demand for integration that existed prior to the ability to fully address this demand may suddenly manifest itself and need to be addressed.

By considering the structural implications in IT, the research contributes to our understanding of "the contextual elements affecting the relationship between IT spending and firm performance" (Dehning & Richardson, 2002), providing evidence of the process level contribution of IT to the performance of the firm. The research runs in parallel to recent work that considers the effects of various environmental, organizational and technological factors on the level of IT budgets (Kobelsky, Richardson, Smith, & Zmud, 2008). However, it makes a unique contribution by considering the impact of various factors on the organizational structure, rather than the expenditures, of the IT function and considers the additional impact of strategic choices made by the firm. It is important to note that we clearly acknowledge that there is not a "one size fits all" IT organizational structure. Generalizations regarding trends across companies do not apply in all situations and contexts. Depending on the contingencies or the unique context faced by the firm, certain factors may conflict, reinforce or dominate other factors that combine to determine the IT structure of the firm (Sambamurthy & Zmud, 1999). As such, general trends are of interest to us, but also understanding the unique contingencies that create variation in IT structure provide value to top management and IT leadership.

As firms attempt to address intense demands for integration, the role and structure of IT may move in parallel to tackle the demand and thus contribute to better overall firm performance. We posit that a firm that aligns its IT structure with its specific level of integration demand will outperform firms that do not. The research model presented in the next section is designed to test the general effects of a number of factors related to the demand for integration on the IT structure in large firms. It is ultimately our objective to understand to what extent the IT structure of the firm, given the contingencies faced by the firm, influences firm performance.

Research Model and Hypotheses

The underlying theory portrayed in the research model is that enterprise-wide demand for integration influences the structure of IT in large multi-business unit firms. A series of factors that taken together represent the demand for integration are tested. Hypotheses associated with each factor all follow from the same basic premise that demand for integration impacts IT structure. A depiction of the research model is shown in Figure 1. A list of the factors that we suggest influence demand for integration, along with the hypothesized direction of influence on the centralization of IT structure, is included as Table 1. The performance implication of the model is that firms that address the demand for integration with an appropriate IT structure outperform those firms that do not. A firm that centralizes the IT function in order to drive standardization and enable mutual adjustment among subunits when integration demands are high is expected to outperform a firm that remains less centralized in IT in the same context. But the inherent tradeoff between integration and differentiation suggests that a firm that centralizes more than is necessary may give up differentiation opportunities and sacrifice performance.

Table 1 Variables Influencing Demand for Integration

	Variable	Description	Primary Reference	Data Source(s)	Hypothesized Influence on Demand for Integration
FIRM ENVIRONMENT	Public Scrutiny	Buy/sell recommendations of broker analysts regarding the firm of interest.	Womack 1996	Compustat	Positive
	Regulatory Pressure	Annual audit fees incurred by the firm.	Pong & Whittington 1994	Security and Exchange Commission - EDGAR Online (Definitive Proxy Statements 14A)	Positive
	Industry	The two-digit NAICS industry of the firm (or equivalent SIC industry for years prior to 1997).	Rumelt 1991	Compustat	(Contingent on Industry)
CORPORATE STRUCTURE	Related Diversification	A combined measure of the number of related segments in which a firm does business, weighted by revenue attributed to each of the segments.	Jacquemin & Berry 1979, Palepu 1985	Compustat	Positive
	Unrelated Diversification	A combined measure of the number of unrelated segments in which a firm does business, weighted by revenue attributed to each of the segments.	Jacquemin & Berry 1979, Palepu 1985	Compustat	Negative
	Vertical Integration	A measure of the degree to which a firm does business in industries that buy from or sell to each other.	Fan & Lang 2000	Bureau of Economic Analysis (Input/Output Tables), Compustat	Positive
	Specialization	The number of different occupations in the industries in which the firm does business.	Pugh, Hickson, Hinings, Turner 1968	Bureau of Labor Statistics (Occupation Codes)	Positive
	Knowledge Intensity	The portion of empoloyees in the firm in knowledge intensive occupations (scientists, engineers, professionals and technicians).	Beck and Connolly 1996	Bureau of Labor Statistics (Occupation Codes)	Negative
STRATEGIC CHOICES	Acquisition Value	Dollar value of acquisitions made by the surviving firm, based on the valuation of the transaction.	Singh & Montgomery 1987	Compustat	Negative
	Brand Equity	The value of the corporation's brand, estimated by determining the portion of intangible assets of the firm attributable to brand.	Simon & Sullivan 1993	National Bureau of Economic Research, Bureau of Labor Statistics, Compustat, U.S. Patent and Trademark Office	Positive

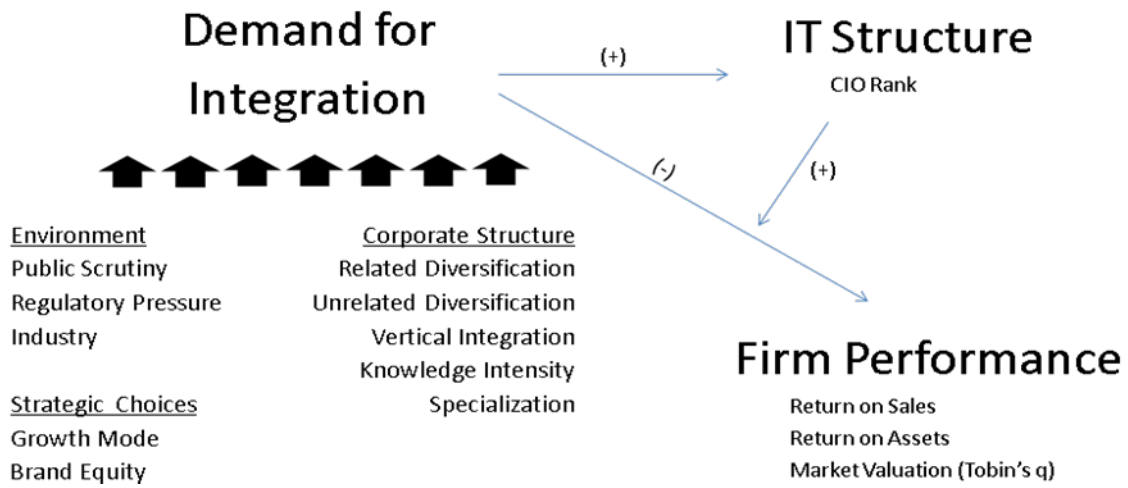

Figure 1 Research Model

Selection of factors for inclusion in the study was based on two criteria. The first criterion for consideration in the study is that the factor must be exogenous to the IT function itself. In other words, the factor must be environmental from the standpoint of the IT function (ie. the factor is not itself a characteristic of the IT function). However, the factors may or may not be considered environmental to the rest of the firm. The second criterion is that the factor theoretically is an indicator of demand for integration of the subunits of the firm. This criterion requires that there be a strong theoretical basis for its impact on the demand for integration in the large multi-business unit firm. We develop a framework based on one way of thinking about the different impacts on the IT structure related to the demand for integration. In this framework, the factors fall into one of three categories: the environment of the firm, the environment of the IT function created by the structure of the rest of the firm, and the strategic choices made by the firm. We subscribe to the notion that environment plays a significant role in the determination of organization structure, but that, additionally, the structure is dependent on strategic choices exercised by the firm (Child, 1972).

Firm Environment

Firm environmental factors that influence the demand for integration include *public scrutiny*, *regulatory pressure* and some industry-specific demands. Intense *public scrutiny* creates demand for integration in the multi-business unit firm. A much broader population of individuals monitors the performance of each firm because information is available and convenient to them via the Internet or other transparent mechanisms. *Public scrutiny* creates demands from top management and the board of directors for greater volume and more timely and consistent information regarding the financial position of the firm. Firms that face particularly high levels of outside scrutiny are likely to adopt tools for aggregated, enterprise level reporting such as the balanced scorecard (Kaplan & Norton, 1996) to monitor performance across the firm. Such measures require coordination to ensure that the transactional data that is produced in a given subunit is standard or is easily modified to allow the compilation of multiple subunits' transactional data. *Regulatory pressure*, most notably the Sarbanes-Oxley Act of 2002, has pushed firms to develop formal documentation of their business processes and raised accountability for financial reporting to the top-level executives. This intense new *regulatory pressure* incents companies to standardize business processes to economize on the documentation process required to meet such regulatory requirements. It also increases the value that top executives place on accurate, corporate-wide metrics regarding the performance of the firm since those executives are now personally accountable for accurate financial reporting. Financial reporting is no longer the relatively straightforward accumulation of the financial transactions from each of the subunits, but is a continuously coordinated effort involving finance, IT, corporate risk management and the business units. As such, the IT function and the CIO play critical roles in meeting the requirements of Sarbanes-Oxley (Sutton & Arnold, 2005). Finally, the nature of the industry is also expected to impact the demand for integration in the firm. The level of competition, common practices within an industry, and performance expectations that differ by industry may impact the structure of IT.

Corporate Structure

The corporate structure is another important contingency regarding the appropriate locus of decision making regarding IT (Sambamurthy & Zmud, 1999); (C. V. Brown & Magill, 1994). It is environmental with respect to the IT function; however, it is endogenous to the firm as a whole. Diversification, a common strategy among large firms, coupled with local autonomy of the business units in order to better address the specific needs of the environment, are expected to drive decentralized governance regarding information systems (C. V. Brown, 1997). Firms with business segments in related industries (high *related diversification*) are expected to have higher integration demand as the activities of the business units may benefit from the sharing of information regarding similar areas of knowledge, processes and customers. Firms with high *unrelated diversification* are expected to have lower integration demand because the businesses may operate independently. Another measure of the structure of the firm is the level of vertical integration, or the extent to which one business unit of the firm supplies its output to another business unit of the firm as its input (Fan & Lang, 2000). Vertical integration requires coordination, especially regarding inventory levels, demand forecasts and production schedules. As a result, companies that are vertically integrated will demand more integration among the subunits to manage the sequential and reciprocal interdependence of their work. It is also expected that high levels of *knowledge intensity* in the firm leads to very specific IT applications tailored to the specific needs of knowledge workers. As a result, we expect that IT decision making would be decentralized to accommodate the specific needs of each unit, emphasizing differentiation over integration. Our hypothesis is therefore that knowledge intensity has the effect of decentralizing the IT structure. Finally, the level of *specialization* is also an important driver of integration demand. A specialized work force requires additional effort to integrate diverse capabilities (Heath & Staudenmayer, 2000), creates interdependence and is associated with leading edge IT usage (Harris & Katz, 1991).

Strategic Choices

There are strategic choices made by the firm that will also influence the demand for integration in the firm. An acquisition-oriented *growth mode* is expected to be accompanied by decentralized IT structure in order to efficiently accommodate the diverse portfolio of information systems in the combined firm, whereas internal growth is likely to be accompanied by more centralized IT governance for cost efficiency (Sambamurthy & Zmud, 1999). However, our most recent anecdotal experience indicates that the opposite is true today. Firms seem to work to rapidly integrate their information systems immediately following mergers and acquisitions to achieve the synergies that made the merger attractive in the first place. A second strategic choice that may influence the IT organizational structure is the importance placed on a strong brand, or *brand equity*. The importance of consistent, high quality products or services across a firm's business units is expected to drive IT decisions that cut across those business units. One such example is FedEx and how it integrated Kinko's (now known as FedEx Office) into its brand. It is now possible to track a copy order using the precise web interface that customers use to track packages sent via FedEx or FedEx Ground. The ability to drive consistent service in distinct businesses across the FedEx brand is dependent on the ability of IT to create a standard approach that meets the needs of all business units. In firms where a consistent customer experience is an imperative of the brand, we expect more centralized IT governance in order to drive standards across the firm.

In the following sections, the first of two empirical studies proposed is described that tests the influence of the contingency factors on one measure of IT structure, CIO Rank. The second empirical study uses an alternative measure of IT structure to test the influence of the same contingency factors on IT structure, but is not detailed in this paper.

Data/Sample

216 companies were randomly selected from the 2008 Fortune 1000 list (Fortune 2008) for inclusion in this study. These companies represent the largest U.S. firms based on annual revenue. 30 companies were dropped from the sample for three specific reasons related to the availability of quality

data on those firms. 16 of the firms became privately held, meaning that measures of business segmentation are not available, six of the companies are banks that do not report business segment data in the same fashion as all other firms, making comparisons with other firms ill-advised and top executive data from Corporate Affiliations was available from Corporate Affiliations for only one year during the study time period, usually due to recent change in ownership status of the company. The remaining 186 firms comprise the sample used in the analysis.

Data were matched from a number of secondary sources. The names and titles of the top executives of each firm were collected from Corporate Affiliations (Lexis Nexis 2008), business segment and overall corporate annual performance data (sales, returns, sales by segment, diversification, assets, liabilities, etc.) were sourced from Compustat, vertical integration was calculated by incorporating the Bureau of Economic Analysis (2008) input-output tables, and audit fees were taken directly from the definitive proxy statetments (Form 14a) of the firm's annual reports made to the Securities and Exchange Commission.

Measurement

CIO Rank

The dependent variable, CIO Rank, is based on an annual list of top executives in each firm as maintained by Corporate Affiliations. Corporate Affiliations identifies the top ten executives in each firm based on compensation, title and overall influence ad authority in the corporation. The CIO or top information systems/information technology (IT) executive is located (if available) from among these top ten executives by identification of title. The generic term, CIO Rank, is used; however, the generic title CIO represents a wider range of titles that identify the top information systems or information technology executive in the firm. Titles determined to be top information systems or technology executives commonly included key words such as information, technology, data processing, systems, MIS, CIO or CTO.

In the majority of cases, the top IT executive is easily identified by title from the Corporate Affiliations list. In other cases, it is not apparent that a title represents an information systems or technology executive. For example, the title of Chief Investment Officer (CIO) is common among financial institutions, while the title Chief Technology Officer (CTO) often represents the executive in charge of research and development in R&D intensive firms. These titles are frequently indistinguishable from their IT counterparts of CIO and CTO. In case of ambiguity, we used additional sources (corporate annual reports, press releases, internet networking sites) to ensure that the title represents the top IT executive.

Table 2 summarizes the characteristics of the titles of the top IT executives in the sample for three of the study years, 1993, 2000 and 2007, to describe the trend in titles over time. For example, 43.2% of the firms in our sample reported a top executive with "CIO" or "Chief Information Officer" in the title in 2007, while that was true of just 5.5% of the firms in 1993. While the titles of most top IT executives suggest that they are focused primarily on IT, the proportion of firms where the top IT executive has a title indicating additional responsibility beyond the IT function more than doubled in our sample of firms during the study period (4.4% in 2007).

Table 2 Characteristics of Top IT Exec Titles

	1993	2000	2007
Title Contains CIO	5.5%	28.8%	43.2%
Title Contains EVP	1.8%	1.9%	7.0%
Title Contains SVP	1.8%	10.6%	17.3%
Title Contains VP	15.5%	16.9%	17.3%
Title Contains CTO	0.0%	3.8%	8.1%
Title Contains Director	4.5%	1.9%	0.0%
Additional Function Beyond IT	2.1%	3.0%	4.4%
Top IT Executive Rank	1.14	2.58	3.03

Corporate Affiliations lists the executives with values of 1 through 10, with 1 being the most influential executive in the firm. The Corporate Affiliations ranking of the top IT executive was then transformed (CIO Rank = 11 - Corporate Affiliations Rank) so that our measure yields a larger value for a more influential executive. This transformation has no impact except to make interpreting the results

more intuitive. With the transformed scale, the CEO or Chairman typically has a rank of 10. Lower ranking executives receive subsequent ranks 9, 8, 7, etc. Our measure of the CIO Rank is the rank of the top IT executive according to Corporate Affiliations. If the IT executive does not appear in the list of executives, we assign a rank of 0. This is actually a conservative approach for our study as we are measuring the change in rank over time. Assigning 0 when the top IT executive is unlisted has the influence of reducing the effect of the change in rank over time, if anything, meaning that any effect we detect may in fact be larger in reality. A graphic showing the average CIO Rank in the sample of firms for the period 1993 to 2007 is shown as Figure 2.

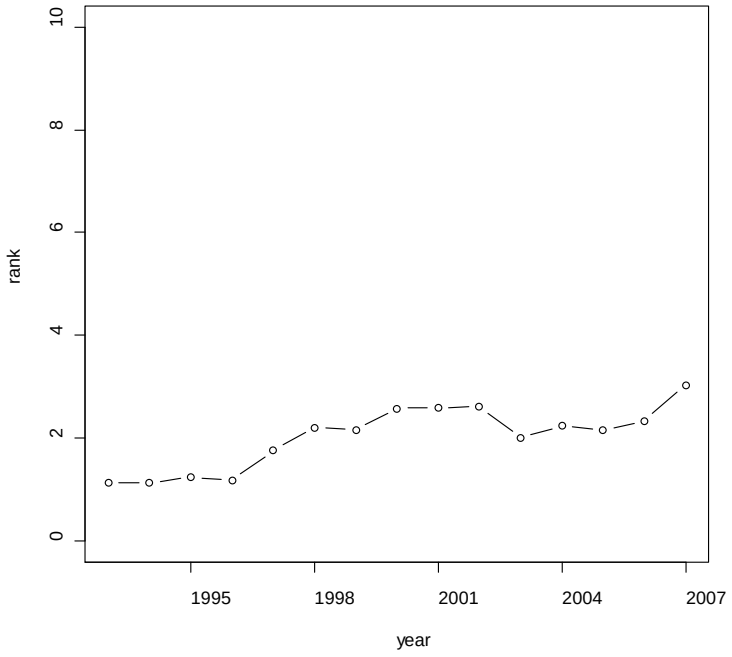

Figure 2 CIO Rank 1993-2007

A series of factors related to the demand for integration and described above are the independent variables of interest in this study. The factors include public scrutiny, regulatory pressure, industry, related diversification, unrelated diversification, vertical integration, specialization, knowledge intensity, growth mode, and brand equity. Their measurement is described below.

Public Scrutiny

The level of public scrutiny felt by a particular firm is measured by the volume of stock recommendations made by the major U.S. brokerage firms regarding that firm's stock. The volume of stock recommendations made for a given firm reflects the inherent interest in the marketplace regarding that firm's stock. There is incentive for brokerage firms to create recommendations for a firm's stock when there is sufficient public interest in the stock to produce revenue opportunities for the brokerage firm (Womack, 1996). In other words, the number of brokerage houses willing to invest in monitoring the firm in order to realize revenue is a direct reflection of the public scrutiny of the firm. The variable representing public scrutiny is an annual count of the number of buy or sell recommendations made by major U.S. brokerage firms for the given firm as reported by the Institutional Brokers Estimate Service (I/B/E/S) and made available by Compustat.

Regulatory Pressure

The regulatory pressure felt by the firm is measured by the dollar amount of audit fees paid by the firm for a given fiscal year. Significant financial regulation places additional financial reporting requirements on the firm and increases the expenditure by the firm on audit fees, among other expenses incurred to manage the increased regulatory burden. As an example, Old Republic International stated in its 2008 definitive proxy statement that increased audit fees are "primarily reflective of the firm's added work to comply with its interpretation of the requirements imposed by the Sarbanes Oxley Act and the Public Companies Accounting Oversight Board." (Old Republic 2009). Audit fees are adjusted to 1993 equivalent dollar values to control for inflation using the Bureau of Labor Statistics' Consumer Price Index (Bureau of Labor Statistics, 2010).

Industry

To control for unobserved environmental variation among firms based on the industry in which they compete, industry membership is accounted for by a series of dummy variables. Industry

membership is accounted for at the two-digit NAICS code level, is based on the primary business of the firm annually and reported by Compustat for each firm in the sample.

Related Diversification

Related diversification measures the extent to which a firm is diversified into multiple, closely related business segments. The measure is based on the entropy measure separating related from unrelated diversification, as documented by (Palepu, 1985) and taken from the measure of total diversification originally devised by (Jacquemin & Berry, 1979). The contemporary 2 digit NAICS codes are used to identify segments that are related to the firm's overall industry.

The related diversification of the firm is calculated in multiple steps. The diversification of the firm is measured by assessing the proportion of the firm's sales for each business segment (i), the industry groups (j) of the firm and then determining the diversification of each of the related industry groups (RD_j) in which the firm competes. First, the related diversification attributed to the firm's participation in multiple segments within each industry group is determined as a weighted average of the proportion of firm sales in each segment (P_i^j), weighted by the logarithm of the inverse of the segment's proportion of sales as shown in equation (1).

$$RD_j = \sum_{i=1}^{j} P_i^j \ln\left(\frac{1}{P_i^j}\right) \qquad (1)$$

The related diversification of the firm (RD) is then a weighted average of the related diversification attributed to each industry group (RD_j) based on the proportion of the firm's sales in each industry group (P^j) as shown in equation (2).

$$RD = \sum_{j=1}^{M} RD_j P^j \qquad (2)$$

Unrelated Diversification

Unrelated diversification arises from the participation by a firm in multiple unrelated industry groups. It measures the extent to which a firm is diversified into multiple, but unrelated business

segments. The specific calculation is also detailed in (Palepu, 1985). It is a measure of the weighted average of sales in multiple unrelated industry groups, weighted by the logarithm of the inverse of the proportion of industry group's sales, as shown in equation (3).

$$UD = \sum_{j=1}^{M} P^j \ln\left(\frac{1}{p^j}\right) \quad (3)$$

Specialization

Specialization is a measure of the number of different tasks an organization performs. Specialization exists when decisions are made by individuals in the organization with local expertise (Hart & Moore, 2005), expertise that is unique to each individual due to the nature of their job requirements.

We use the Occupational Employment Statistics from the Bureau of Labor Statistics to measure the level of specialization by industry (Bureau of Labor Statistics, 2007). The Bureau of Labor Statistics estimates the number of people employed in each of over 800 specific occupations in the U.S. by NAICS code (or industry). The Bureau of Labor Statistics samples 1.2 million companies on a three-year rolling basis in reporting employment by occupation. The measure specialization is a count of the number of unique occupation codes reported in each 2-digit NAICS code industry. We use the most recent industry data for the primary industry for each firm and year in the study. For a given firm in our sample, it therefore reflects the number of different occupations employed in the primary industry of the firm.

Knowledge Intensity

We measure the knowledge intensity of an industry by the proportion of employees in knowledge intensive occupations. Knowledge intensive occupations include scientists, engineers, professionals and technicians (Beck & Connolly, 1996). Knowledge intensity of the firm or industry is the number of scientists, engineers, professionals and technicians in the firm or industry as a proportion of total employees (Beck & Connolly, 1996). Occupation codes for each industry are taken from the Bureau of Labor Statistics' Occupational Employment Statistics. Each occupation code is evaluated as to whether it

falls into the categories of scientists, engineers, professionals, and technicians. The measure of knowledge intensity for each firm in the sample is the knowledge intensity of the primary industry of the firm.

Growth Mode

The growth mode of the firm, whether the firm grows through acquisition or organic growth, is an important contingency that influences IT structure (Sambamurthy & Zmud, 1999). The level of acquisition activity is measured as the annual dollar value of the all merger and acquisition transactions made by the principal firm closing in that fiscal year. This measure accounts for the relative size of the transaction by considering the dollar value of the transactions. This measure emphasizes the scale of the merger in its influence on the structure of IT. However, an alternative measure – acquisition activity – assumes that any merger/acquisition activity regardless of size will influence the governance of the IT structure. Acquisition activity is a simple count of the number of merger and acquisition transactions made by the firm in a given year. Models are tested using both specifications; however, acquisition value is reported unless otherwise noted.

Acquisition value is adjusted to 1993 equivalent dollars based on the Bureau of Labor Statistics average consumer price index (Bureau of Labor Statistics, 2010) in order to account for the effects of inflation.

Brand Equity

The estimate of brand equity for each firm-year in the sample is adapted from the classic methodology from the marketing literature that uses publicly available data to estimate brand equity (Simon & Sullivan, 1993) by separating tangible and intangible assets of the firm and then further estimating the portion of intangible assets influenced by brand. The longitudinal nature of our data requires the additional consideration of correlation of brand equity and its components within firms over time. In other words, we expect that brand equity for a given firm will be highly correlated with its brand equity from the prior year. Firms do not wipe the slate clean every year from the perspective of the brand, but instead build on the historical strengths and weaknesses of the brand. So, our estimate of brand equity

accounts the determinants of the brand from Simon and Sullivan, but also for the enduring effect of the brand across the years in our sample.

The first assumption made in this estimation of brand equity is that the intangible assets of the firm may be separated into four components as defined in equation (4): demand-enhancing value attributable to brand (V_{b1}), the value related to the reduction in marketing costs of branded products as compared to unbranded products (V_{b2}), non-brand factors that influence firm value (V_{nb}) and any premium in value associated to participation in a more lucrative industry (V_{ind}).

$$V_I = V_{b1} + V_{b2} + V_{nb} + V_{ind} \qquad (4)$$

Influence of Brand and Non-Brand Factors on Market Share

We estimate the market share for each firm as a function of brand factors, such as the order of entry into the market and advertising expenditure, and non-brand factors, such as patent share and R&D share via the specification in equation (5). A firm's market share ($S_{i,t}$) is the total sales of the firm *i* divided by the total sales of the two-digit industry in which the firm principally does business in a given year *t*. Advertising share (advshr) is actual advertising expense for the firm divided by the advertising expense in the firm's two-digit industry for that year. Advertising share for the prior year is also modeled due to the enduring effect that advertising has on market power. Likewise, patent and R&D shares are firm variables representing number of patents granted (patshr) and expense on research and development (rndshr) respectively, scaled by the total values for the firm's two-digit industry. Equation 1 represents the estimation of market share based on this combination of brand and non-brand factors. In addition, we deploy a Cochrane-Orcutt (Cochrane & Orcutt, 1949) correction to account for auto-correlation within firms across multiple time points. The parameter ρ in equation (5) accounts for this auto-correlation and measures the magnitude of the auto-correlation of the error terms.

$$S_{i,t} = \beta_0 + \beta_1 ordratio_{i,t} + \beta_2 advshr_{i,t} + \beta_3 advshr_{i,t-1} + \beta_4 patshr_{i,t} + \beta_5 rndshr_{i,t} + \rho v_{i,t} + \varepsilon_{i,t} \quad (5)$$

The influence of brand on market share is attributable to the advantage of the firm due to early entry into the industry and its advertising expenditures relative to its competitors in the same industry. As a result, we estimate the market share attributable to brand in equation (6) as:

$$E(S_{b2}) = \hat{\beta}_1 ordratio_{i,t} + \hat{\beta}_2 advshr_{i,t} + \hat{\beta}_3 advshr_{i,t-1} + \hat{\rho} v_{i,t} \quad (6)$$

This estimation includes the firm-specific error term specifying the correlation between sequential time points because the brand and most notably the influence of advertising is expected to endure over time. Meanwhile, the market share attributable to the technology or non-brand factors of the firm is estimated in equation (7) as a function of patent share and investment in research and development. The constant term and the residual are both included here as non-brand factors to be conservative in our calculation of brand equity.

$$E(S_{nb}) = \hat{\beta}_0 + \hat{\beta}_4 patshr_{i,t} + \hat{\beta}_5 rndshr_{i,t} + \hat{\varepsilon}_{i,t} \quad (7)$$

Estimating the Influences on Intangible Value Together

As mentioned earlier, the intangible value of the firm may be thought of as four components. In equation (4), the intangible value V_I is estimated by combining the influence of industry, demand-enhancing brand-related value, value from cost-advantage associated with brand and non-brand factors where cr4 is the four-firm concentration ratio of the industry, adv is the annual advertising expenditures by the firm, age is the age of the firm in years, $E(S_{b2})$ is the estimate of market share attributable to brand-related cost advantage and $E(S_{nb})$ is the estimate of market share from other non-brand (technology) factors.

$$V_I = \beta_0 + \overbrace{\beta_1 cr4_{i,t}}^{\text{Industry}} + \overbrace{\beta_2 adv_{i,t} + \beta_3 \text{age}_{i,t}}^{\text{Brand Demand-Enhancing}} + \overbrace{\beta_4 E(S_{b2})_{i,t}}^{\text{Brand Cost-Advantage}} + \overbrace{\beta_5 E(S_{nb})_{i,t}}^{\text{Non-brand}} + u_{i,t} \quad (8)$$

It is then possible to estimate the value of the brand, or the brand equity, for a given firm in a given year by equation (9):

$$V_b = V_{b1} + V_{b2} = \hat{\beta}_2 adv_{i,t} + \hat{\beta}_3 age_{i,t} + \hat{\beta}_4 E(S_{b2})_{i,t} \quad (9)$$

Brand equity is adjusted to 1993 equivalent dollars based on the Bureau of Labor Statistics average consumer price index for each year (Bureau of Labor Statistics, 2010) to control for the effects of inflation.

Methodology

A Tobit regression model (Tobin, 1958) is used in all analyses where CIO Rank is the dependent variable to account for the left-censored nature of the distribution of the measure CIO Rank. Nearly half of the company-years in our study show a CIO Rank of 0 (the CIO was not listed among the top 10 executives in the firm) leading to a distribution of the dependent variable that violates the normality assumption as shown in Figure 3. The Tobit regression model allows for estimation given that the value of CIO Rank is not precisely known for that portion of the sample that is censored (ie. no IT executive among the top 10 company executives).

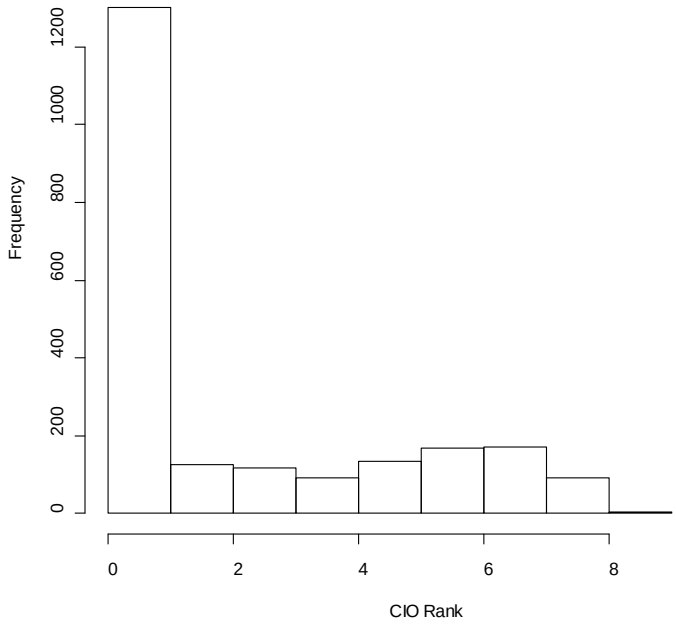

Figure 3 Left-Censored CIO Rank Distribution

The structure of the Tobit regression model is given in equation (10), where CIO Rank (rank) for firm i and year t is a function of each of the contingency factors related to the demand for integration. Regression analysis was performed using STATA's Tobit estimator, accounting for auto-correlation among repeated measures using the Corchrane-Orcutt correction, indicated by the correction factor ρ. Other potential influences on the CIO Rank such as R&D expenditure, advertising expenditure, the size of the firm and the firm's age are controlled in this specification.

$$CIORank_{it}^{*} = \beta_0 + \beta_1(Regulatory_{it}) + \beta_2(Scrutiny_{it}) + \beta_3(VI_{it}) + \beta_4(RD_{it}) + \beta_5(UD_{it}) + \beta_6(KnowledgeIntensity_{it}) + \beta_7(Specialization_{it}) + \beta_8(Acquistion_{it}) + \beta_9(BrandEquity_{it}) + \beta_{10+}(IndustryDummies_{it}) + \beta_{20+}(YearDummies) + \rho e_{t-1} + \nu_t$$

(+ controls for R&D Expense, Advertising Expense, Firm Size & Maturity)

$$CIORank_{it} = \max(CIORank_{it}^{*}, 0) \qquad (10)$$

Preliminary Results

Estimation results are presented for three models in Table 3. Three analyses are presented, each differing by the window of time that is represented in that subsample. Analysis 1 is based on the full sample from 1993-2007. Analysis 2 is reported from a subsample that contains only the data from 1993-2001. Analysis 3 is based on the subsample that comprises the most recent years, 2002-2007. Regulatory pressure is not measured for the period 1993-2001 because firms were not required to report data regarding our measure prior to 2002. Knowledge intensity is only considered in the subsamples due to problems of consistency across the transition from SIC to NAICS industry reporting that occurred in 2002. Industries are not reported in these analyses due to their correlation with the specialization and knowledge intensity measures and were addressed in separate analyses.

Table 3 Preliminary Results - Effects on CIO Rank

	Model 1 1993-2007	Model 2 1993-2001	Model 3 2002-2007
Time (Year)	0.2608 (0.042)***	0.5967 (0.1073)***	0.2274 (0.1124)**
Public Scrutiny	39.35 (23.73)*	47.17 (29.62)	21.55 (58.72)
Regulatory Pressure [1]			22.89 (26.7)
Unrelated Diversification	-2.529 (0.619)***	-3.162 (0.972)***	-2.285 (0.805)***
Related Diversification	-1.077 (0.351)***	-1.082 (0.641)*	-1.127 (0.409)***
Vertical Integration	44.36 (11.26)***	38.32 (16.05)**	60.09 (17.2)***
Acquisition Value	-69.47 (55.9)	-154.36 (83.74)*	597.83 (252.48)**
Specialization	0.00279 (0.00133)**	0.00098 (0.00235)	0.00388 (0.00161)**
Knowledge Intensity [2]		0.415 (3.422)	-3.916 (26.702)*
Acquisition Value	-69.47 (55.9)	-154.36 (83.74)*	597.83 (252.48)**
Brand Equity	0.3365 (0.2602)	0.6937 (0.3183)**	-1.4577 (0.9391)
Firm Size	0.4416 (0.1399)***	0.4614 (0.221)**	0.3784 (0.2007)*
Constant Term	-7.482 (1.254)***	-8.885 (2.017)***	-6.256 (2.366)***

* significant at $p < 0.10$; ** significant at $p < 0.05$; *** significant at $p < 0.01$.

1) Regulatory pressure is only measured in Model 3 due to lack of data prior to 2001 since firms were not required to report audit fees until 2002.
2) Knowledge intensity is only estimated in the subsample models due its inconsistency across subsamples as a result of the SIC/NAICS conversion.

We find weak statistical evidence that the environment of the firm influences the CIO Rank, as evidenced by the lack of statistical significance of the Public Scrutiny and Regulatory Pressure coefficients across the three analyses. Public scrutiny was found to be marginally significant in model 1 and the direction of the effect is as theorized, however it is difficult to make any dramatic conclusions based on such evidence. In analyses not reported here, we do find evidence that higher CIO Rank is associated with firms whose businesses are primarily transportation and insurance and financial products industries. Other industry effects are not significant.

We do find evidence that the structure of the firm is a predictor of CIO Rank. Both related and unrelated diversification are associated with a lower CIO Rank, indicating that the CIO Rank is lower in firms that are diversified into different business segments. While we predicted that related diversification would positively influence CIO Rank, our analysis seems to indicate that diversification of any type is associated with lower CIO Rank. However, the relative relationship between related and unrelated

diversification is as theoretically expected. The magnitude of the effect of related diversification is approximately half the effect of unrelated diversification. So, the rank of the CIO is higher in firms that participate in related business than firms that participate in unrelated businesses. Vertical integration is consistently associated with higher CIO Rank, as predicted. Specialization is also associated with higher CIO Rank. A firm whose primary industry requires a highly specialized work force experiences the challenge of coordinating that diverse work force. It appears that this additional demand for integration is associated with higher CIO Rank. Finally, the knowledge intensity of the firm is negatively associated with CIO Rank. This is in line with our expectation that knowledge intensive businesses require local, customized IT solutions and this emphasis on differentiation may trump demands for integration.

As far as the two strategies of the firm that we consider, we find no evidence that the value of the brand influences CIO Rank. While there are some companies where a compelling argument may be made for this association, it appears that this relationship is not generally true. We do find an interesting set of results regarding the growth mode (acquisition activity) of the firm. In the overall sample, we find no statistical evidence of growth mode influencing the CIO Rank. However, this appears to be confounded by two distinct results in the subsamples. We find that prior to 2001, firms that grew through merger and acquisition tended to have lower CIO Rank, as extant theory predicts (Sambamurthy & Zmud, 1999). In other words, firms that grow through acquisition tend to decentralize IT decision making in order to avoid the complexity of having to integrate the companies' different systems. However, after 2002 in our sample of firms, this relationship is opposite – firms growing through acquisitions are associated with higher CIO Rank. We did not set out to test for this difference over time, but it is in line with the notion that management philosophy regarding the IT implications of mergers and acquisitions may have shifted dramatically in recent years, emphasizing integration of the target and acquirer.

Limitations, Conclusions and Ongoing Work

One of the assumptions of this work is that the firm is composed of multiple, differentiated business units. Depending on the firm, segmentation may be based on geographical regions, product markets or function. Future work is being considered to test whether the type of segmentation influences

the IT structure. For example, it is certainly conceivable that a firm segmented by geography would have significantly different integration demands than a firm segmented by product line. This distinction is not made in the proposed study. Due to the nature of the population, the results of this study should not be generalized beyond the multi-business unit firm. Smaller firms, especially single business unit firms, are likely to differ dramatically in size and character from the population of firms reflected in this research.

There are three significant contributions emanating from this work. The research provides an explanation of a recent trend in corporate level decision making in IT, specifically conceptualizing the IT function as playing the role of an integrating device (technological and organizational) for the broader firm. The work provides refreshed, empirical evidence of some of the important factors that influence IT structure. The work also provides new methods for measuring the organizational structure of the IT function. The results are important for senior executives who may struggle with the inherent tradeoff between differentiation and integration in structuring their organizations. It is also useful for IT executives to understand their changing role in the large, multi-business unit firm in order to prepare themselves and their organizations to meet the expectations of the rest of the firm.

The results presented here are considered preliminary because efforts are ongoing to improve the study. Plans include modeling the time variable with year dummies in order to relax the assumption that the CIO Rank varies linearly over time, fully addressing autocorrelation of firm variables over time especially in the determination of brand equity, incorporating all of the control variables conceived in the research design and identifying a measure for the construct of technology affordance.

Also ongoing is a second empirical study in which an alternative IT structure is utilized in order to attempt to disentangle the role of the IT function from the level of centralization of the IT function. The data required to produce the alternative means for measuring IT structure also affords us the ability to measure the structure of the rest of the firm in addition to the IT structure.

Our ultimate interest is in knowing the extent to which the structure of the IT function, given the contingencies faced by the firm, influences firm performance. Further work is planned to probe this important notion as well.

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