A Value-Based Assessment of the Contribution of Information Technology to Firm Performance

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ABSTRACT

Empirical research on the contribution of Information Technology (IT) to firm performance has yielded contradictory and inconclusive findings, thus fueling the debate on the existence of a productivity paradox. Many of these studies used firm-level output, which while useful, provides only a limited understanding of the dynamic process behind the creation, and therefore, the measurement of IT business value. Process-oriented research has been proposed as a possible solution to this predicament.

From an organizational perspective, the value chain is seen as an effective mechanism for modeling the value creation process. For the purposes of creating or enhancing value, management allocate resources, including technological resources, to those processes comprising the value chain. Using this notion, we develop a value-based model of IT business value derived from the impact of IT on processes and inter-process linkages within the value chain. The adoption of a value chain typology allows us to consider two fundamental questions. Firstly, can process-level impacts be used to measure IT business value? Secondly, if process-level impacts are deemed appropriate, can we apply a calibration scale to these processes that will allow us to determine the level of IT business value within an organization? In effect, our ultimate goal is to develop, and calibrate a thermometer of IT business value.

Data for our study was based on survey data from 180 senior executives. Respondents were asked to rate the extent to which IT had contributed to firm performance across a variety of dimensions corresponding to distinct processes along the value chain. Structural equation modeling was then used to provide a formal test of the model. Our findings confirm that perceptual ratings of process-level impacts can be used to measure IT business value. Furthermore, our model reveals how process-level impacts can be calibrated to reveal a measure of IT business value at the organizational level.

1. Introduction

The contribution of information technology (IT) to firm performance remains a classic issue in the information systems (IS) field, stimulating interest among senior executives, chief information officers (CIOs) and IS researchers alike. Despite the uncertainty in recent years surrounding the payback and productivity gains from investment in IT, senior executives and CIOs continue to increase their investment in IT. For example, the largest 500 American corporations had a combined IT budget for 1996 of $93 billion, an increase of 13% over 1995 (Information Week 1996). Indeed, a recent International Data Corporation report (December 1995) predicts that corporate IT investment will double from its current level of 2.5% to 5% of revenues by 2010. Faced with IT investment on this scale, the need for a comprehensive and guiding model of IT business value, defined as the contribution of IT to firm performance (Berger, Kobielius and Sutherland 1988), becomes that much more compelling.

Despite a number of well publicized IT success stories such as American Airlines (SABRE - reservation system), Federal Express (COSMOS - customer service system), and McKesson (ECONOMOST - inventory control system), there remains a dearth of evidence linking IT investment to firm performance. In assessing IT business value, IS researchers have tended to equate business value with productivity gains from IT at the firm-level. Although business value is a multidimensional measure of the contribution of IT to firm performance, studies have predominantly focused on productivity impacts. Unfortunately, the overall findings from this branch of research have been contradictory, fueling the debate on the existence of a productivity paradox (Baily and Gordon 1988). Findings have ranged from identifying negative relationships between IT investment and various organizational performance criteria (Berndt and Morrison 1992; Weill 1992; Loveman 1994), to neutral or bi-modal impacts (Cron and Sobol 1983; Strassman 1990; Harris and Katz 1991; Weill 1992), to suggesting positive and significant returns from IT (Lichtenberg 1993; Barua, Kriebel and

Mukhopadhdyay 1995; Brynjolfsson and Hitt 1996; Hitt and Brynjolfsson 1996). Indeed, Loveman (1994) in a study of the productivity impacts of IT in the manufacturing industry argued that "the marginal dollar would best have been spent on non-IT inputs into production, such as non-IT capital" (p. 85).

Several explanations have been proposed for how the productivity paradox has arisen. Some researchers have suggested that traditional measures of productivity are inappropriate for IT and the contexts in which IT is deployed (Baily and Chakrabarti 1988; Strassman 1990; Loveman 1994). Brynjolfsson (1993) noted that the broad spectrum of benefits attributed to IT spending include a variety of subjective outcomes such as product quality, variety, customer service and responsiveness. These outcomes are not represented in productivity statistics with the result that productivity studies underestimate IT-induced productivity gains. Others indicate that technological impacts are characterized by lag effects, with the result that productivity gains may not have had sufficient time to materialize (David 1989; Brynjolfsson 1993; Wilson 1993). A further suggestion is that while IT is a critical technological innovation, it is being mismanaged (Roach 1989; Attewell 1991; McKersie and Walton 1991; Brynjolfsson 1993). This hints at management's failure to effectively manage IT investments with the result that resources are squandered or fail to be leveraged to the fullest extent possible. However, if we attribute rational behavior to management, one might expect that an increase in IT spending was influenced by evidence of positive results from previous IT investments, rather than being suggestive of resource mismanagement, per se (Brynjolfsson 1993; Quinn and Baily 1994). Brynjolfsson (1993) concludes that "the shortfall of IT productivity is at least as likely due to deficiencies in our measurement and methodological tool-kit as to mismanagement by developers and users of IT" (p. 67). In contrast, other researchers have suggested that technology is inherently unproductive (Attewell 1991), or that technology is privately but not socially productive (Baily and Chakrabarti 1988).

Clearly many questions remain unanswered. While productivity may be the quintessential dimension of business value, there is now a broader acceptance that business value may manifest itself in ways other than productivity gains (Brynjolfsson 1993). For instance, Hitt and Brynjolfsson (1996) identify productivity, business profitability and consumer surplus as the "three faces" of business value. Although productivity studies have served as the bedrock of business value research, many researchers firmly believe that the time has come to adopt a more concise definition of business value (Strassman 1990; Kaplan and Norton 1992). For example, Brynjolfsson (1993) suggests that as the 'information age' begins to unfold, it may be necessary to redefine and reinvent some of our traditional conceptions of productivity to more accurately capture the contributions of the new technology. Ideally, an analysis of IT business value should consider all likely impacts, including productivity. In this respect, theories of industrial organization, business strategy and organizational structure provide an interesting backdrop against which to consider a broader assessment of the value-adding potential of IT.

Unraveling the productivity paradox to arrive at a comprehensive assessment of IT business value, implies going beyond mere measures of economically-derived productivity gains. If measurement error is at the core of the "productivity paradox", we need to adopt a multidimensional approach drawing upon measures of both objective and subjective outcomes. Moreover, our focus should involve organizational and economic perspectives directed at areas within the organization where value is created. We argue that a model of business value creation should serve as a basis for a model of business value measurement. This calls for a clear understanding of why organizations invest in IT. If organizations are goal-oriented, as the organizational literature suggests (Cyert and March 1963; Etzioni 1964; Thompson 1967; Scott 1977, 1992), value creation can be evaluated as a foremost organizational goal. Economic-based measures of firm performance yield incomplete estimates of value creation since many subjective or perceptual impacts of IT are excluded. For this reason, our model of business value focuses on perceptual measures of the impact of IT on the ultimate value creation process -- the value chain.

The remainder of this paper is organized as follows: the next section examines the extant business value literature from both economic and organizational perspectives. Section 3 outlines our research model, while in section 4 we describe the data and methodology used to test this model. Section 5 presents detailed results of our analysis, which we then discuss in section 6. Finally, in section 7, we conclude on the appropriateness of our model as a mechanism for measuring IT business value.

2. Business value literature

The purpose of this review is to project a better understanding of how IT business value research has been conducted in the past. The literature can be considered under two contrasting, though complementary perspectives based on the economic and organizational impacts of IT.

2.1 Economic Perspectives

The most comprehensive body of research to date on business value is grounded in economic and econometric analyses. Economic perspectives provide useful insights for investigating a wide range of IT impacts, using established theories of production economics, information processing and industrial organization (Bakos and Kemerer 1992). Although theoretical papers in the economic tradition take a broader stance, most empirical studies tend to define IT business value largely in terms of a single dependent variable -- productivity.

Other measures of firm performance have appeared in the literature. They include cost-benefit analysis (King and Schrems 1978; Keen 1981; Crawford 1982), return on investment (Franke 1987; Cron and Sobol 1983; Chismar and Kriebel 1985; Brynjolfsson and Hitt 1996), return on assets (Cron and Sobol 1983; Weill 1992; Barua, Kriebel and Mukhopadhdyay 1995; Hitt and Brynjolfsson 1996), return on management (Strassman 1985, 1990), improved cost control (Bender 1986; Harris and Katz 1991), IS usage (Lucas 1975a, 1975b), value-added (Hitt and Brynjolfsson 1996), market share (Barua, Kriebel and Mukhopadhdyay 1995; Hitt and Brynjolfsson 1996) and return on equity (Strassman 1990; Hitt and Brynjolfsson 1996). The sheer diversity of measures shown here indicates that there is no definitive measure of IT business value. However, given the increasing importance of technology to modern corporations, many of whom have now come to depend on technology, the desirability of an all-encompassing measure of IT business value gains momentum.

Economic measures of IT business value are clearly attractive because of the objective nature of the data upon which they rely. However, a primary criticism of economic-based studies concerns their limitations in capturing intangible impacts such as improved product and service quality, increased managerial effectiveness, and enhanced customer relations. Furthermore, although economic perspectives offer a high degree of objectivity, they provide limited insights into the dynamic process by which business value is created and, therefore, ultimately measured. The performance indicators listed above, for example, are unable to investigate the causal nature of the relationship between IT investment and firm performance, or to even determine if such a relationship exists. As an alternative, an organizational assessment of IT business value goes some way towards providing these insights, although the subjective nature of the behavioral data upon which organizational analysis is based remains a point of contention.

2.2 Organizational Perspectives

Ford and Schellenberg (1982) have identified three perspectives or theories of firm performance that permeate the organizational literature. The first, a goal approach, is closely linked to the attainment of organizational goals (Etzioni 1964). The second, a systems resource approach, considers factors internal and external to the organization upon which it depends for survival (Yuchtman and Seashore 1967; Steers 1977). Finally, the constituent approach, characterizes performance in terms of the behavior of organization members (Thompson 1967; Steers 1977). Although organizational theories clearly interpret firm performance in a different manner from that of theories within the economic perspective, problems have also arisen within the organizational perspective. For instance, reviews of the literature on organization performance (Steers 1977; Dalton, Todor, Spendolini, Fielding and Porter 1980; Lenz 1981) reveal contradictory and inconclusive findings. Disputes as to how firm performance should be interpreted and the context in which certain measures should be used are common throughout the literature (Scott 1977; Dalton Todor, Spendolini, Fielding and Porter 1980). Scott (1977) argued that these contradictory findings were more a function of researchers' failure to adequately model the linkages between organizational characteristics (e.g., strategy, structure) than differences between methodologies or interpretations of the performance concept.

The notion of organizational effectiveness pervades the organizational literature on firm performance (Goodman and Pennings 1977). Venkatraman and Ramanujam (1986) provide an interesting delineation of the organizational effectiveness concept using a series of concentric circles to denote fully contained sets of performance measures. They describe measures of organizational effectiveness as containing a subset of operational performance measures, which in turn incorporate a subset of strictly financial performance measures. Financial performance measures are described as indicators "such as sales growth, profitability (reflected by ratios such as return on investment, return on sale and return on equity), earnings per share, and so forth" (p. 803). These financial performance measures have generally been the focus of studies within the economic perspective. Beyond financial performance lies operational performance, which includes "such measures as market-share, new product introduction, product quality, marketing effectiveness, manufacturing value-added, and other measures of technological efficiency" (p. 804). They further note that "the inclusion of operational performance indicators takes us beyond the 'black box' approach that seems to characterize the exclusive use of financial indicators and focuses on those key operational success factors that might lead to financial performance" (p. 804). Measures of operational performance have appeared in a number of studies under the guise of intermediate level variables (Barua, Kriebel and Mukhopadhdyay 1995; Mooney, Gurbaxani and Kraemer 1995).

Venkatraman and Ramanujam (1986) indicate that studies of organizational strategy have restricted their conceptualization of organizational effectiveness to measures of financial and operational performance. In a later study, Venkatraman and Ramanujam (1987) explain this preoccupation with financial and operational performance measures as an implicit recognition of the goal-oriented nature of organizations. We argue, however, that in asking whether IT investments contribute to firm performance, the use of financial and operational measures is sufficient to resolve the issue of whether there is an association between IT investment and firm performance. It does not, however, completely enlighten us as to “how” or “why” IT might impact firm performance. For that to occur, we must move beyond measures of financial and operational performance towards measures of organizational effectiveness.

One dimension of organizational effectiveness mentioned above alludes to the pursuit of organizational goals. Despite different interpretations associated with the goal-organization model (Scott 1977), we believe that an understanding of the goals and objectives behind organizational IT investment can help to further clarify the “causal” links between IT and organizational performance, thus surpassing studies that concentrate on financial or operational assessments of performance alone.

As we begin to consider the context in which organizational goals are established, we look to management as the purveyors of organizational goals (Hambrick and Mason 1984). One of the core responsibilities of management is that of resource allocation. In the case of IT, management allocate investment resources across a diverse range of activities covering such things as investment in IT infrastructure, software maintenance and development, training and labor costs. If management wish to make the best use of scarce IT resources, they will systematically channel those resources into the most deserving areas of the organization according to some set of established principles or priorities. In this way, we can isolate high priority tasks as being those that offer the greatest "return" on IT investment, irrespective of whether we define "return" using objective or subjective outcomes. Clearly, managerial perceptions of the desirability of organizational outcomes heavily influence the direction of IT spending.

2.3 Perceptual Measures of Business Value

Whereas there is an established body of research founded on economic perspectives, there is a noticeable paucity of business value measures derived from an organizational or behavioral perspective. Nevertheless, perceptual (subjective) measures of firm performance have appeared (Venkatraman 1989; Chan and Huff 1993; Raymond, Paré and Bergeron 1993; Bergeron and Raymond 1995). Despite a perception among researchers that perceptual data is somewhat "soft" and subject to exaggeration by the respondent, perceptual measures of firm performance have been shown to correlate highly with objective measures (Dess and Robinson 1984; Venkatraman and Ramanujam 1987). Venkatraman and Ramanujam (1987) conclude, "it appears that perceptual data from senior managers... can be employed as acceptable operationalizations of BEP" (p. 118). In this context, BEP (business economic performance) refers to measures of sales growth, net income growth and return on investment.

The use of senior executives as key informants on subjective measures of organizational performance is prevalent in behavioral research. However, the validity and credibility of results obtained from such research is conditional on the ability of the informant to accurately evaluate the performance variables in question—in this study, the contribution of IT to firm performance. Researchers have argued that senior executives are sufficiently knowledgeable to act as key informants in a qualitative assessment of IS success in their own organizations (Dess and Robinson 1984; DeLone and McLean 1992). This argument is based on executives functioning as both direct and indirect consumers of IT. For instance, many executives are end-users of IT who rely heavily on computer-based reports, whereupon they form their own impressions of the value of IT (McLean 1979; Rockart and Flannery 1983; Davis and Olson 1985; Kraemer, Danziger, Dunkle and King 1993). In addition, when participating in decisions addressing investments in IT infrastructure and major applications, executives are exposed to the opinions of their direct reports and business unit executives (Starbuck 1985). Thus, there is justification for believing that senior executives are superior informants in subjectively evaluating the contribution of IT to firm performance.

Research on executives' perceptions of IT has appeared in a number of studies. For example, IS researchers have used subjective measures to assess the "success" of IS projects and the IS organization (Lucas 1975b; DeLone and McLean 1992). However, both sets of measures are intermediate in the sense that they are expected to contribute to IT business value; they are not definitive measures of business value in any sense. Parker and Benson (1988) propose that managers' value systems and their interpretation of their organizations' value systems are central to their judgment of the costs, benefits, and risks associated with IT projects. Broadbent and Weill (1993) posit a relationship between managerial perceptions of the role of IT infrastructure, the perceived value of that infrastructure, and their IT investment biases. Research has also determined that a CEO's perceptions and attitudes towards IT and the degree of importance attributed to IT by the CEO, was strongly associated with the organization's progressive use of IT (Jarvenpaa and Ives 1991; Busch, Jarvenpaa, Tractinsky and Glick 1991). Taken together, these studies confirm the importance of executives' perceptions as indicators of the contribution of IT to organizational goals and further support the use of perceptual data in studies of this nature.

3. Research Model

The concept of value creation combines both traditional objective outcomes, such as profitability or revenue growth, with more subjective outcomes, such as customer satisfaction, managerial effectiveness, or service quality. Measuring IT business value using objective outcomes alone, runs the risk of underestimating the impacts of IT investment due to the non-quantifiable nature of certain subjective outcomes. However, excluding subjective outcomes from an assessment of IT business value, as has been the case with previous empirical studies, is tantamount to valuing those outcomes at zero.

A preferred approach is to try to measure IT business value by focusing on areas within the organization where value is created. Crowston and Treacy (1986) suggest that the specific value of IT is determined by the strategic objectives or business goals for which the technology was deployed and further argue that the motivation for deploying IT suggests the best method for evaluating performance impacts. Berger (1988) supports this view arguing that the criteria for measuring an IT system's impact should vary with the rationale for its application. Similarly, Kauffman and Kriebel (1988) suggest that a way of coping with the diversity of potential impacts from IT is through a classification of IT applications that facilitates selection of appropriate measures by type, such as administrative cost reduction, productivity improvement, customer service in marketing, or new product strategies. Barua, Kriebel and Mukhopadhdyay (1995) argue that the first order impacts or contributions of IT investment can be measured at lower operational levels in the organization, since this is typically the level at which the technology is implemented. From this, we argue that firms derive business value from IT through its impacts on intermediate business processes, including the range of operational processes that comprise a firm's value chain and the management processes of information processing, control, coordination and communication (Barua, Kriebel and Mukhopadhdyay 1995; Mooney, Gurbaxani and Kraemer 1995). Resorting to a value-based assessment of IT business value, not only captures subjective impacts of IT investment, but also generates a more accurate assessment of IT business value than has traditionally been provided by objective measures. Since the primary emphasis of the value chain is on value creation, we believe the value chain offers an ideal structured format for measuring IT business value at the process level. Thus adopting a process-oriented perspective of IT business value should provide greater insights into the mechanisms by which value is created, offering an explanation of the technological features, process characteristics, organizational settings, and competitive environments conducive to IT business value creation.

3.1 A Process oriented approach to IT business value using the value chain

Various researchers have indicated the potential benefits from adopting a process oriented view of business value (Crowston and Treacy 1986; Bakos 1987; Gordon 1989; Kauffman and Weill 1989; Wilson 1993). However, where process oriented studies have appeared (Banker and Kauffman 1988, 1991; Banker, Kauffman and Morey 1990), their application has centered on specific technologies thus limiting the generalizability of their findings to other technologies and organizational contexts. These observations led Mooney, Gurbaxani and Kraemer (1995) to develop a process oriented framework based on the premise that organizations derive business value through the impact of IT on intermediate business processes. This study builds upon that framework.

Insert Figure 1 about here

An important concept which highlights the role of IT in a company's business processes is the value chain (Porter 1985). Porter's generic conception of the value chain, shown in Figure 1, divides a corporation's activities into distinct processes necessary for engaging in business activities (Porter and Millar 1991). These activities are classified into primary activities (inbound logistics, operations, outbound logistics, marketing and sales, and service), and support activities (procurement, technology development, human resource management, and firm infrastructure). Besides being discrete, these processes are also interdependent. Therefore, how well they perform individually and how well they are linked are important determinants of business value. IT creates value for the business by improving individual business processes, or inter-process linkages, or both. For example, when a firm's production schedule is linked to real time sales data and to suppliers' logistics systems, these linkages may not only create production efficiencies but may also markedly improve customer relations through greater responsiveness. In general, the greater the extent to which IT impacts individual business processes and their linkages, the greater the contribution of IT to firm performance.

In an effort to further develop the notion that IT impacts processes within the value chain, we reviewed the academic and professional literature to identify dimensions of business value corresponding to processes and inter-process linkages within the value chain. In keeping with our assessment of IT investment as reflecting the pursuit of organizational goals, we concentrated on identifying dimensions of business value where senior executives might concentrate IT resources as a means of creating or adding value. Our review resulted in 7 distinct intermediate business processes, or dimensions of business value, which we describe below.

Process Planning and Support

IT can be used to improve the provision of information for planning and decision making by improving organizational communication and coordination and by enhancing organizational flexibility (Galbraith 1973, 1977; Bakos 1985; Bakos and Treacy 1986; Kraemer and King 1986; Gurbaxani and Whang 1991; Porter and Millar 1991; Boynton, Zmud and Jacobs 1994; Barua, Kriebel and Mukhopadhdyay 1995). IT can also be used to reduce internal coordination costs relative to external coordination costs (Gurbaxani and Whang 1991). The impact of IT on process planning and control will impact those processes that comprise the value chain (Porter 1985).

Supplier Relations

IT-based initiatives can be implemented to coordinate supplier linkages or to reduce an organization’s search costs (McFarlan 1991; Bakos 1991). Suppliers may use IT-based mechanisms for communicating information about their prices and products (Bakos and Kemerer 1992). Improved forms of communication (Electronic Data Interchange), quality control (Total Quality Management) and delivery techniques (Just-in-Time) can lead to the establishment of a competitive advantage (Cash and

Konsynski 1985; Srinivasan, Kekre and Mukhopadhyay 1994). Improved supplier relations can have obvious implications for the efficiency of the production process (Porter 1985).

Efficiencies in Production

IT can be used to deliver enhanced manufacturing techniques through computer aided design and manufacturing (Kelley 1994). Meanwhile, improvements in the production process can lead to economies of scale in the deliver of products and services (Porter 1985; Malone 1987; Banker and Kauffman 1991). Besides incorporating technology into the end product (Ives and Mason 1990; Porter and Millar 1991), the use of advanced manufacturing processes can also enable a greater range of products and services (Pennings and Buitendam 1987).

Product and Service Enhancement

IT can assist an organization in developing new products and services (Parsons 1983; Brooke 1991; Barua, Kriebel and Mukhopadhdyay 1995), besides streamlining the R&D process (McFarlan 1991; Pennings and Buitendam 1987). From a marketing perspective, products and services can be uniquely differentiated in a wide variety of ways (Bakos and Treacy 1986; Brooke 1992). The IT-enabled development of new products and services can enable an organization to identify and serve new market segments (Pine, Peppers and Rogers 1995).

Marketing Support

IT’s support for marketing and pricing activities can help to increase sales revenues, as revealed by the complex nature of airfares modeled by airline computerized reservation systems. IT can be used to track market trends and responses to marketing programs (Porter and Millar 1991). The recent emergence of Internet-based electronic commerce spells the beginning of a new era for IT-enabled marketing initiatives (Benjamin and Wigand 1995). With the introduction of mass customization, marketing programs can now be tailored to the needs of a specific customer rather than being delivered in the form of mass marketing (Pine 1993; Pine, Victor and Boynton 1993; Pine 1995).

Customer Relations

IT can be vital to establishing, sustaining and improving relationships with customers (Ives and Learmonth 1984). Improving customer relations can result in an improvement in market share (Parsons 1983; Porter 1985), while there is an obvious impact on the ability of the organization to establish and defend a competitive advantage (McFarlan 1991; Porter and Millar 1991). Indeed, several of the most publicized IT success stories are premised on the notion that IT can enhance customer relations; for example, American Airlines (SABRE), American Hospital Supply (ASAP), and Federal Express (COSMOS).

Competitive Dynamics

IT can be used to alter the competitive dynamics of an industry (McFarlan 1991; Bakos and Treacy 1986), raising barriers to entry against prospective competitors (McFarlan 1991). The removal of search costs can have dramatic implications for competition among industry participants (Bakos and Brynjolfsson 1993). Competitive dynamics can be influenced by successful marketing strategies, while competitiveness can be enhanced by improving product choice and cost (Porter and Millar 1991). Competitive dynamics can have significant implications for customer relations, where for instance customers react favorably to lower cost, enhanced product selection or improved responsiveness (Porter and Millar 1991).

3.2 Outline of the Model

The above intermediate business processes or dimensions of business value are clearly contained within the value chain. Since the intermediate business processes span the value chain and represent the set of management and operational processes where senior executives are likely to concentrate IT resources, combining these processes into a single model effectively creates an organization-wide IT business value construct. The impact of IT on these intermediate business processes is a potential source of IT business value, as is the degree of "linkage" between successive processes within the value chain.

Insert Figure 2 about here

Based on the above arguments, we constructed a value chain model of business value. The model, shown in Figure 2, conforms to the generally accepted structural modeling notation where latent variables are depicted as circles, while manifest or observed variables are shown as boxes. Latent variables represent unobservable constructs. The only way that these variables can be measured is through the use of reflector or indicator variables. For example, manifest variables combine to "indicate" or cause a latent variable, whereas manifest variables are a "reflection" of the latent variable. Our model depicts business value as a latent variable on the grounds that it is unobservable. There is no definitive measure of business value; there are only surrogate measures which when combined provide a better impression of the multidimensional business value construct. The intermediate business processes within the value chain were modeled as reflector variables of business value, while process planning and control was included as an indicator variable. Links between processes are shown by directed lines. By way of a simple illustration, the structure of our business value model is analogous to a doctor assessing the health of a patient by measuring (say) a patient's heart rate, blood pressure, and temperature. Rather than saying that these three items combine to "cause" health, we say that they are a consequence or reflection of the individual's health. The doctor then uses this information to infer something about the health of the patient. In the same manner, we hope to infer something about IT business value by measuring the impact of IT on intermediate business processes. Our immediate objective is to assess whether IT business value can be measured using the impact of IT on intermediate business processes. Recalling the medical analogy, we need to determine if measuring a patient's heart rate, blood pressure, and temperature provides sufficient information to enable us to make an informed judgment about that individual's health. We refer to this aspect of our model as the "simple" value chain model. Once we have shown that the impact of IT on intermediate business processes within the value chain yields sufficient information to allow us to measure business value, we can then proceed to calibrate the simple model and so determine an estimate of IT business value at the firm-level. This form of our model is referred to as the calibrated value chain model.

3.3 Generating Business Value Hypotheses

If each intermediate business process is relevant to the assessment of IT business value, we would expect the link between the latent business value variable and the corresponding manifest variable to be positive and significant. Process planning and support should also have a positive and significant influence on the IT business value construct. This leads to the following hypotheses:

Hypothesis 1a: Intermediate process outcomes make a positive contribution to IT business value.

Hypothesis 1b: Process planning and support makes a positive contribution to IT business value.

We earlier remarked that not only would the impact of IT on each intermediate business process contribute to IT business value, but the impact on inter-process linkages would also be a source of business value. This suggests:

Hypothesis 2: Inter-process linkages are an important source of IT business value.

4. Data Collection and Methodology

The data for this study were collected by surveying business executives on their assessment of the contribution of IT to firm performance.[1] Survey packets containing 10 business value questionnaires were mailed to the CIO across 350 Fortune 500 companies during 1995. Each CIO was asked to forward a copy of the survey to key business executives within their firm. The questionnaire asked that individual respondents reply directly to the authors. By soliciting multiple responses from each organization, we sought to avoid problems associated with key respondent bias.

The business value survey contained 36 items (see Appendix I). Each item was carefully chosen based on supporting literature. Respondents were asked to rate the extent to which they believed IT contributed to overall firm performance across a broad range of process-level impacts. Respondents were also asked to restrict their responses to realized impacts of IT, rather than expected impacts. Individual survey items were rated using a ten-point Likert scale where 1 indicated “no realized impact” and 10 indicated “high realized impact”.

Responses were received from 180 senior executives across 42 corporations. To check for non-response bias, we compared the 42 corporations represented in our sample with the Fortune 500 for a set of key financial variables reported by Compustat. The results of this analysis indicate that our sample was not biased.

4.1 Factor Analysis

Instrument validation is essential in empirical research (Straub 1989). When faced with this task, the choice is between exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The default in many empirical studies is to perform an EFA using, for example, principal component extraction as a means of identifying the underlying factors and the items that load on each factor. Where very little is known about the factor-structure of a model, this technique may be appropriate. However, Monte Carlo studies have shown that EFA on small sample sizes can misrepresent the correct number of factors (Gorsuch 1983). Alternatively, CFA can be applied in cases where plausible model structures exist and where the number of factors is specified in advance (Bollen 1989). On the basis that our survey instrument was designed to measure specific factors, we opted for a confirmatory-type approach using a combination of two-factor and three-factor limited information factor analyses. We began by performing a two-factor CFA (maximum likelihood estimation) on every pair of factors (21 different combinations). All items loaded as expected across each of the two-factor combinations with factor loadings exceeding 0.6 in each case. We then performed a three-factor CFA on every possible set of three factors (35 possible combinations) to determine if individual items would load any differently from the two-factor CFA. For the most part, all items loaded on their original factors with factor loadings exceeding 0.60 with the exception of two items under Customer Relations. In 7 out of the 35 possible combinations, the factor loadings for these two items fell below 0.50. Therefore, we decided to drop these two items from the remainder of our analysis. Finally, we performed a CFA (maximum likelihood estimation) on the remaining 34 items with correlating first order factors.

Insert Table 1 about here

Table 1 shows the factor loadings from this analysis.[1] Although the fit statistics for this combined CFA were marginal ($\chi^2 = 1233.163$, df = 506, $p<0.001$; NFI = 0.825; NNFI = 0.875; CFI = 0.888; GFI = 0.712; RMSEA = 0.09)[2], the factor loadings were sufficiently high to allow us to collapse the items under each factor into a composite factor score. The score for each factor was based on an average of the items loading on that factor. A chart showing the resulting mean values for each factor (split between service and manufacturing firms) is given in Figure 3.

Insert Figure 3 about here

[1] As an aside, we performed an EFA on the remaining 34 items (maximum likelihood extraction). By forcing a seven factor structure, we were able to explain 81% of the total variance. The factor structure was comparable to that obtained by CFA (shown in Table 1) -- PSE4 was the only item to load differently. It loaded on "Efficiencies in Production" with a factor loading of 0.39.

[2] A more detailed review of fit statistics is deferred until Section 5.

4.2 Validity and Reliability

In order to validate a measurement instrument, it must first be subjected to tests of both validity and reliability. In this study, we viewed validity as incorporating content and construct validity.

Bollen (1989) defines content validity as “a qualitative type of validity where the domain of a concept is made clear and the analyst judges whether the measures fully represent the domain” (p. 185). Content validity is achieved by grounding the meaning of a concept in a theoretical definition that reflects past research efforts at exploring the concept under review. Furthermore, each definition should have at least one measured item. Since the 7 dimensions of business value used in this study, and the 36 items used in their measurement, were the result of an extensive literature review, we feel that content validity has been adequately supported.

Construct validity, on the other hand, asks whether a measure relates to other observed variables in a manner consistent with theoretically founded propositions (Bagozzi 1980, Bollen 1989). Construct validity refers to the extent to which different constructs are unique and separable from each other. This view has led researchers to subdivide construct validity into two components, convergent and discriminant validity.

Discriminant validity is achieved by testing that the indicators of each dimension load higher on that dimension than on competing dimensions. Convergent validity, as the flip side of discriminant validity, expects that indicators of a dimension should correlate higher with other indicators of the same dimension than with indicators of different dimensions.

Insert Table 2 about here

If our measurement instrument is to pass a test of both convergent and discriminant validity, then the shared variance between each 2 factor pairing should be less than the corresponding variance extracted for each factor in turn. The results of our convergent and discriminant analysis are shown in

Table 2. Entries along the main diagonal represent variance extracted by the items measuring each dimension.[3] All other entries are shared variance found by repeatedly pairing factors and squaring the estimated correlation between the factors. As an assessment of the variance extracted for each dimension, we used Fornell and Larcker's criterion that the mean variance extracted should exceed 0.50 (Fornell and Larcker 1981). Elements along the main diagonal in Table 2 clearly comply with this recommendation. An overall comparison of the shared variances for each dimension pairing with their respective variance extracted confirms that discriminant and convergent validity is present.

Reliability is an assessment of the extent to which a set of items consistently measure a concept. Cronbach's alpha was used to compute the reliability of the items used in measuring each dimension. Reliability estimates ranged from 0.864 to 0.966, clearly surpassing the 0.80 minimum considered necessary for empirical research (Straub 1989).

4.3 Structural Model Specification

Structural equation modeling (SEM) allows the researcher to model relationships between unobserved (latent) variables and observed variables using a combination of factor analysis and multiple regression (Ullman 1996). The objective of a structural model is to estimate the scale and significance of each path, and provide an indication of the overall ability of the hypothesized model to fit or explain the sample data under review.

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[3] The variance extracted is defined as:

$$\frac{\sum_{i=1}^{p} \lambda_i^2}{\sum_{i=1}^{p} \lambda_i^2 + \sum_{i=1}^{p} (1 - \lambda_i^2)}$$

where λ_i is the standardized factor loading relating variable i to the underlying theoretical factor. *p* is the number of items loading on each factor, (Fornell and Larcker 1981).

"Simple" Value Chain Model

The reader is reminded that the first objective of our model is to determine if process-level outcomes can be used to measure IT business value. This objective is accomplished by testing whether the "simple" value chain model shown in Figure 2 provides a good "fit" to the sample data. In structural modeling terminology, "fit" refers to a comparison of the actual covariance matrix with the computed covariance matrix from the hypothesized model. A good-fitting model will, therefore, reproduce the actual covariance matrix with a high degree of precision.

Calibrated Value Chain Model

The second objective, that of determining the level of IT business value within the organization is conditional on the success of the first objective. Only when we have shown that the "simple" value chain model fits the data can we proceed to develop and test the calibrated value chain model (Bentler 1995).

Whereas the "simple" value chain model attempts to reproduce the original covariance matrix, the calibrated model is more complex in that it attempts to reproduce both means and covariances. In this context, goodness of fit will depend on weighted function of the degree of fit of the mean structure and covariance structure. If the reader recalls, we used a medical analogy to describe how we would derive a firm-level estimate of IT business value from the measured process-level impacts in much the same way as a doctor uses a patient's vital signs to infer something about the patient's health. By modeling means, we effectively set in motion the "inference" or calibration aspect of the value chain model.

In order to model observed means, we introduce a dummy variable to denote an intercept parameter. This intercept is used in reproducing the means of the observed variables. The inclusion of this variable is for modeling purposes alone - it is not part of the original model and, therefore, has no specific interpretation outside the model. Since the intercept is designed to reproduce the observed means, it must be "anchored" to each manifest variable. Since we are also trying to generate an estimate of the latent business value variable using the same intercept, it must also be "anchored" to the latent variable. This anchoring process is accomplished using addition links which are inserted into the original "simple" value chain model. To distinguish these additional links from those in the original "simple" value chain, we use dashed instead of solid lines (as shown in Figure 5). Due to the construction of the value chain, we can trace a link from the intercept to every other manifest variable by passing through supplier relations. For a more comprehensive (and technical) discussion of modeling structured means, the reader is directed to Bollen (1986) and Bentler (1995).

The ratio of 180 respondents to 22 estimated parameters (25 in the calibrated value chain model) clearly meets the recommendation given by Bentler and Chou (1987) who advocate a sample size to estimated parameter ratio of 5 to 1, under assumptions of normality. The software used to estimate the adequacy of "simple" and calibrated value chain models was EQS v6.0 (Bentler 1995).

5. Model Estimation and Results

A preliminary analysis of our data yielded evidence of multivariate non-normality (Mardia's normalized coefficient was 14.6, while a rule of thumb for multivariate normality would suggest a normalized coefficient of 3). Non-normality may be explained by the presence of outliers or data that follow a different distribution from the normal distribution. A cursory search for significant outliers failed to remove any observations from our data. For this reason, our models used robust maximum likelihood estimation. The use of robust estimation gives standard errors that are correct where distributional assumptions surrounding the data are unspecified (Bentler and Dijkstra 1985). Bentler (1995) states that "[robust statistics] perform better than uncorrected statistics where the normal distribution assumption is false" (p. 47). In addition to corrected standard errors, robust estimation in

EQS also reports the Satorra-Bentler scaled test statistic. This test statistic produces a distribution that is better approximated by a χ^2 distribution than a test statistic reported under conditions of non-normality (Satorra and Bentler 1988, 1994; Bentler 1995).

One way of avoiding distributional assumptions involves the use of bootstrapping techniques (Efron 1979; Efron and Tibshirani 1993). While certain estimation procedures assume underlying distributional properties, for example multivariate normality, an application of the bootstrap requires no such assumptions. The adoption of the bootstrap can be particularly useful considering that ML procedures will underestimate standard errors when the population distribution is skewed (Boonsma 1983; Ichikawa and Konishi 1995). For this reason, bootstrapping was used throughout this study as a way to assess the robustness of the ML estimates reported by our models.

5.1 Evaluating the Model Fit

The concept of "model fit" is based on the notion that a model is said to fit the sample data if the difference between the actual and reproduced covariance matrices are within acceptable limits. What constitutes an acceptable limit is open to interpretation. However, researchers have performed extensive Monte Carlo studies that seek to develop, refine and improve upon the rules of thumb generally applied in evaluating model fit (Bearden, Sharma and Teel 1982; La Du and Tanaka 1989; Hu, Bentler and Kano 1992). These studies also provide researchers with a better understanding of how fit indices behave in certain situations. For instance, issues such as sample size and distributional misspecification are known to impact differently on certain fit statistics (Browne and Cudeck 1993; Gerbing and Anderson 1993; Tanaka 1993; Hu and Bentler 1995). Therefore, we report a menu of fit statistics on the basis that there is little consensus as to what constitutes the best index of overall model fit in SEM (Bollen 1989; Marsh, Balla and McDonald 1988; Tanaka 1993, Hoyle and Panter 1995). If a model is to be seen as an adequate representation of the data, some convergence across several fit indices would be expected.

The most frequently cited fit statistic in structural modeling is the χ^2 statistic. This statistic tests "badness-of-fit" since a significant χ^2 statistic, relative to the specified number of degrees of freedom, indicates that the model does not adequately reproduce the sample data. Rules of thumb as to what values of *p* indicate a good-fitting model, advocate a significance level in excess of 0.05 (Bentler 1995).

Bentler and Bonett (1980) were the first to introduce fit statistics as a means of avoiding problems associated with the χ^2 statistic. One such index, the *Bentler-Bonett Normed Fit Index* (NFI), represents the proportion of total covariance explained by the hypothesized model. A good model will yield a high NFI; values of 0.90 and above are generally accepted as evidence of a good-fitting model (Browne and Cudeck 1993; Hu and Bentler 1995). Unfortunately, the NFI can underestimate the fit of an otherwise good-fitting model in situations involving small samples (Bearden, Sharma and Teel 1982).

Bentler and Bonett (1980) supplemented the NFI with a second fit index, known as the *Non-normed Fit Index* (NNFI). A noted feature of the NNFI is that it rewards parsimony or alternatively penalizes model complexity. However, Anderson and Gerbing (1984) report that the NNFI can underestimate model fit under conditions of small sample size, while other researchers found that the NNFI is subject to significant sampling variability in Monte Carlo studies (Bentler 1990; Bollen and Long 1993; Gerbing and Anderson 1993). In an extended Monte Carlo study of several fit indices, Marsh, Balla and Hau (1996), found that there was still much to support the adoption of the NNFI, especially considering its treatment of parsimony and complexity. A general rule of thumb for the NNFI suggests that 0.90 and above indicates a good-fitting models.

The *Comparative Fit Index* (CFI), developed by Bentler (1990) has an important advantage over many indexes in that it successfully reports model fit under all sample sizes, thus avoiding the underestimation of fit sometimes associated with NFI and NNFI. Rigdon (1996), in a comparative study of CFI and the RMSEA statistic (described below) argued that the CFI was more suitable for exploratory studies with small sample sizes, whereas RMSEA was more appropriate for confirmatory-type analysis with large sample sizes. A CFI of 0.90 is generally taken as a lower bound on good-fitting models, though Rigdon (1996) noted that researchers are beginning to favor CFI values of at least 0.95 due to the exploratory nature of the statistic.

In recognition of the fact that the χ^2 statistic is likely to reject models based on large sample size, Jöreskog and Sörbom (1989) introduced the *Goodness of Fit Index* (GFI). The GFI is based on a ratio of the relative amount of variances and covariances in the sample that is explained by the model (not unlike the R^2 statistic in standard regression). A rule of thumb of 0.90 has been applied by researchers in the past. However, Hu and Bentler (1995) report that this rule penalizes models with dependent latent variables at samples sizes below 250, while it is unlikely to reject models with independent latent variables at sample sizes of 250 or greater.

One interpretation of this study concerns the acceptance or rejection of a hypothesized model of IT business value. On that basis, it seems appropriate that we include the *Root Mean Square Error of Approximation* (RMSEA), due to Steiger and Lind (1980) and Browne and Cudeck (1993). RMSEA is based on the sample size, the number of degrees of freedom and a noncentrality parameter derived from the χ^2 statistic. Rigdon (1996) argues that "when researchers wish to determine whether a given model fits well enough to yield interpretable parameters and to provide a basis for further theory development, RMSEA appears to be a better choice [over CFI]" (p. 378). Browne and Cudeck (1993) indicate that a RMSEA value of 0 is suggestive of a perfect fit. Although they suggest that a value of 0.05 indicates close fit, they qualify this by saying that a value of 0.08 would still be a reasonable approximation of good-fit. However, Rigdon (1996) has shown that RMSEA (=0.05) could reject a perfectly valid model when sample size is low (N=500). Thus the fit criteria suggested by Browne and Cudeck (1993) may need to be reassessed for models with smaller sample sizes.

Insert Table 3 about here

The goodness-of-fit statistics obtained for both the "simple" and calibrated value chain models are shown in Table 3[4]. The "simple" value chain model is clearly within the suggested cut-off range for all goodness-of-fit indices. Indeed, considering the excellent fit across all indices, one might argue that the "simple" model is "near perfect". This leads us to conclude that the suggested model specification behind the measurement of IT business value (Figure 2) is appropriate; namely intermediate process outcomes can be used to measure IT business value. The fit statistics for the calibrated value chain also suggest a high degree of fit. This leads us to conclude that it is possible to determine an estimate of IT business value at the firm-level using information about the impact of IT on the intermediate businesses processes.

Insert Table 4 about here

As shown in Table 4, both models succeeded in explaining a large proportion of the variance in the observed and latent variables. Studies cited earlier suggest that the bootstrap reports superior (less biased) standard errors. However since variance explained is directly related to standard errors, bootstrap estimates are provided alongside ML estimates. Table 4 reports ML estimates similar to those for the bootstrap. Furthermore, the mean bootstrap fit statistics reported for both models consistently support goodness-of-fit ("simple" value chain model: χ^2 = 11.713, df = 6, p=0.069; NFI = 0.986; NNFI

[4] Power analysis was applied to both models using the technique outlined in MacCallum, Browne and Sugawara (1996). This procedure, based on the RMSEA statistic, determines the probability of rejecting a flawed model. Cohen (1988) recommends 0.80 as an appropriate level of power. Using a RMSEA of 0.08, we computed a power level of 0.460 for the "simple" value chain model, and 0.614 for the calibrated model. Raising the RMSEA statistic to 0.10 according to what we are willing to accept as a good fit, would raise power of both models to 0.681 and 0.845, respectively.

= 0.977; CFI = 0.993; GFI = 0.982; RMSEA = 0.06; calibrated value chain model: χ^2 = 39.459, df = 10, p<0.001; NFI = 0.970; NNFI = 0.952; CFI = 0.977; GFI = 0.912; RMSEA = 0.10). this supports our earlier conclusion that both models are acceptable as a basis upon which to measure and estimate IT business value.

Fit statistics are, by definition, model-based measures of goodness-of-fit. They cannot be used to determine if the relationship between one variable and another is positive or negative, significant or insignificant. For that, we need to examine our original hypotheses.

5.2 Hypothesis Testing

Insert Figure 4 about here

Hypothesis 1a: Figure 4 indicates that the path from business value to each of the processes within the value chain is positive and highly significant. This allows us to conclude that each intermediate business process within the value chain makes a positive contribution to IT business value. Further evidence for this claim is provided in Figure 5 where the equivalent links are also positive and highly significant (p<0.001).

Insert Figure 5 about here

Hypothesis 1b: The influence of process planning and support on IT business value is apparent from the positive and highly significant (p<0.001) coefficient shown in Figures 4 and 5. Clearly, therefore, management practices embodied within planning and support for IT business value creation are a crucial determinant of business value. The influence of process planning and support can be seen from a highly significant χ^2 difference test between the "simple" value chain model and an equivalent model in which the coefficient of the link from process planning and support to business value is set to 0 (χ^2 = 141.864, df = 1, p<0.001; scaled χ^2 = 118.4094, df = 1, p<0.001).

Hypothesis 2: We earlier argued that the impact of IT on the links between intermediate business processes would be an important source of IT business value. To evaluate how important these links were to IT business value, we performed a χ^2 difference test between the "simple" value chain model and an equivalent model where the inter-process links were removed. The resulting χ^2 and scaled χ^2 statistics were highly significant ($\chi^2 = 46.839$, df = 8, $p<0.001$; scaled $\chi^2 = 28.2066$, df = 8, $p<0.001$) indicating that inter-process linkages are an important source of IT business value.

Although this shows that the combined set of inter-process links are significant, it is worth noting from Figure 4 and 5 that two links are negative, namely the link from supplier relations to efficiencies in production, and the link from marketing support to customer relations. Applying χ^2 difference tests to each model supports the retention of both sets of links, since discarding these links produces a significant drop in goodness-of-fit. A closer look at our data suggests that one possible explanation for why IT-based improvements in supplier relations fail to result in production efficiencies involves the organization's inability to translate closer coordination with suppliers into reduced order handling costs, shorter lead times and improved quality control. Therefore, although improved coordination is possible, gains in production throughout from shorter production cycles or equipment utilization will not be possible. The negative relationship between marketing support and customer relations is identified from the perspective of marketing being more market-focused than customer-focused. In our analysis of total effects, we found that marketing support had the lowest impact on customer relations while competitive dynamics had the highest impact, followed by efficiencies in production, product and service enhancement, and supplier relations. This would suggest that improvements in customer relations are more likely to come from customer-focused improvements in the actual product or service itself, rather than from the marketing of that product or service. One might further speculate that while marketing identifies the opportunities, it is the production and design process that ultimately delivers the benefits.

6. Discussion

Researchers using SEM techniques are on occasion inclined to accept their models purely on the basis of fit statistics alone. In such cases, failure to examine and interpret the path or parameter estimates (equivalent to regression coefficients) could lead the researcher to misinterpret the underlying model. This section explores our findings to try to gain a better appreciation for what aspects of the value chain are particularly attractive from the perspective of IT business value creation. We also indicate how the calibrated model can be used to determine a firm-level estimate of IT business value.

6.1 Determinants of IT Business Value

Managerial decision making on how best to deploy IT resources would be much easier if there was some ex-ante mechanism for ranking the potential for business value creation within each component of the value chain. We argued that business value is created through a combination of IT impacts on individual intermediate business processes and on the linkages between these processes. One could further argue that IT will have both direct and indirect effects on each intermediate business process. For example, management may introduce CAD/CAM technology aimed at improving design and production techniques. Any related improvement in production would constitute a direct effect on IT business value. In addition, indirect effects may arise from impacts on processes further down the value chain such as greater scope for product enhancement. Hence the total effect of each process on the creation of IT business value can be separated into direct and indirect effects.

Using this notion, we examined the calibrated value chain model with a view to determining the total effect of each intermediate business process on IT business value. Ranking the total effects in order of contribution to IT business value identifies customer relations as the principal contributor to IT business value (coefficient 1.089), followed by efficiencies in production (1.057), supplier relations (1.000), competitive dynamics (0.969), product and service enhancement (0.963) and marketing support

(0.886). We repeated this analysis by splitting our dataset into service-firm executives (N=113) and manufacturing-firm executives (N=67). Our analysis found that the top 3 rankings were consistent across both sectors - customer relations emerged the clear winner, followed by efficiencies in production and supplier relations.

The identification of customer relations as the most important process behind IT business value creation comes at a time when researchers are beginning to expound the benefits of organizations practicing the cliché “customer is king” (Hammer and Champy 1993; Brynjolfsson and Hitt 1996). For example, Brynjolfsson and Hitt (1996) report that “customer focus is the best predictor of IT value” (p. 50). They further argue that “the clearest distinction of... highly effective IT users was their focus on customer benefits like quality, flexibility, timeliness and service” (p. 50). Interestingly, the same study also identified customer-oriented strategies as representing the top reasons for why CIOs invest in IT.

6.2 Assessing IT Business Value within the Organization

Perhaps the most useful application of the calibrated value chain model is determining a firm-level estimate of IT business value. Referring to Figure 5, the reader can see that the latent construct “business value” is influenced by the process planning and support variable and the intercept (dummy variable). We earlier explained that the function of the dummy variable was to enable us to model the means of the manifest variables, from which we would derive a firm-level estimate of IT business value. Using the coefficients shown in Figure 5, we calculate a value for the latent business value variable of 5.120.[5] This estimate can be interpreted in the context of the range of possible values ascribed to the manifest variables from which the estimate of IT business value is derived. We remind the reader that

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[5] The calculation behind the estimate of IT business value is ((5.967 * 0.656) + 1.206). Bootstrap sampling (994 replications) was used to test the robustness of the IT business value estimate. The mean of the business value estimate across all bootstrap samples was 5.120, unchanged from that reported by ML estimation techniques in Figure 5.

the data behind the manifest variables was based on a 10-point Likert scale, where 1 indicated "no realized impact" of IT on firm performance, while 10 indicated "high realized impact". As this scale is applicable to all the observed variables, the estimate of the latent variable can be directly interpreted within the confines of the same 10-point Likert scale. This allows us to conclude that, on a perceptual basis, executives evaluate the contribution of IT to firm performance as "average".

This conclusion was further tested by splitting the dataset into service-firm executives (N=113) and manufacturing-firm executives (N=67). Each model was then tested independently. Both models indicated good fit (service-firm executives: χ^2 = 17.027, df = 10, p=0.074; NFI = 0.967; NNFI = 0.970; CFI = 0.986; GFI = 0.896; RMSEA = 0.08; manufacturing-firm executives: χ^2 = 9.149, df = 10, p=0.518; NFI = 0.975; NNFI = 1.005; CFI = 1.000; GFI = 0.924; RMSEA = 0.000). When each model was then used to compute a firm-level estimate of IT business value, executives in service organizations returned a value of 5.314, as against 4.976 for executives in manufacturing firms[6]. This is an interesting observation when one considers that the original productivity paradox was premised on service firms' inability to indicate IT-based productivity gains. However, if one accepts that productivity is only one component of IT business value, then our findings would seem to suggest that service firms in their efforts to apply IT in pursuit of improved organizational performance.

7. Conclusion

We began this study by asking if IT business value could be measured by focusing on those areas within the organization where value is created. The value creation process is, we argued, directly related to the pursuit of organizational goals. Consequently, senior management allocate resources

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6 Bootstrap sampling techniques were also applied here to assess the robustness of the estimates of IT business value in service and manufacturing firms. The mean of the bootstrapped sample estimates of business value for executives in service firms was 5.308 (994 replications) as against 4.967 for executives in manufacturing firms (1000 replications)

across the organization based on some preconceived assessment of value optimization. Therefore, our conception of IT business value was founded on executives' perception of the contribution of IT to firm performance. Previous research had indicated that executives play a key role in determining resource allocation in pursuit of organizational goals, and that their perceptions of IT closely mirror both the extent to which IT resources are used and their satisfaction with the performance of those resources. Therefore, we posited that an important component of executive's perceptions would be their assessment of the realized or historical contribution of IT to firm performance. We further argued that executives can distinguish this contribution along multiple dimensions corresponding to intermediate business processes, through which a firm creates value.

We examined this proposition by assessing the extent to which executive perceptions of the impact of IT on intermediate business processes could serve as a measure of IT business value, and by investigating how process-level interactions could influence this measure. This led us to propose a value-based model of IT business value, centered around the use of the value chain as a mechanism for creating value within the organization. This allowed us to address two key issues. Firstly, can IT business value be measured using the impact of IT on intermediate business processes? Secondly, if intermediate process outcomes are appropriate, can we then use this information to determine an estimate for the level of IT business value within the organization? The first question was resolved in the context of a "simple" value chain model, while the second used a calibrated value chain model.

Our findings suggest that the contribution of IT to firm performance can be measured by examining the impact of IT on intermediate business processes. We also found evidence to support Porter and Millar's (1991) claim that an important source of IT-supported value-added is support for coordination between value-adding activities. We were then able to provide a perceptual-based estimate of IT business value at the firm-level. Our results indicate that IT appears to be making an "average" contribution to firm performance. This contribution was marginally higher for service firms than for manufacturing firms. Since this estimate of IT business value is perceptual, an obvious question asks if these perceptions are borne out in an organization's financial statistics. One would hope to find a positive correlation between perceptual and financial-based measures of IT business value. A future extension of this research will attempt to resolve this issue.

The potential for value creation from focusing on customer relations is an emerging theme among business researchers and practitioners. Not only do our findings support this view, but we also show how IT can be used to generate business value through customer relations and through value chain linkages that are designed to support customer relations.

Regardless of whether organizations are actually delivering IT business value or not, there is general agreement that the pursuit and attainment of business value is desirable. What is clear from this study is that IT business value is not merely created in isolated pockets of activity within an organization. Instead the structure of the value creation process allows the effects of IT investment to cascade throughout the organization. Our conceptual of IT business value measurement parallels the value creation process in recognition of the many direct and indirect effects of IT investment. This approach combines both objective and subjective impacts into a single perceptual measure of IT business value. Clearly IT business value is a multidimensional construct. A continuation of our traditional unidimensional perspective involving productivity-based measures of IT business value can only prolong the productivity paradox and frustrate efforts at using IT to improve organizational performance.

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Table 1 Confirmatory Factor Analysis - Factor Loadings

	Process Planning and Support	Supplier Relations	Efficiencies in Production	Product and Service Enhancement	Marketing Support	Customer Relations	Competitive Dynamics
PPS1	0.757	-	-	-	-	-	-
PPS2	0.869	-	-	-	-	-	-
PPS3	0.786	-	-	-	-	-	-
PPS4	0.764	-	-	-	-	-	-
PPS5	0.823	-	-	-	-		-
PPS6	0.816	-	-	-	-	-	-
SR1	-	0.726	-	-	-	-	-
SR2	-	0.920	-	-	-	-	-
SR3	-	0.966	-	-	-	-	-
SR4	-	0.848	-	-	-	-	-
EP1	-	-	0.926	-	-	-	-
EP2	-	-	0.933	-	-	-	-
EP3	-	-	0.810	-	-	-	-
EP4	-	-	0.812	-	-	-	-
PSE1	-	-	-	0.869	-	-	-
PSE2	-	-	-	0.826	-	-	-
PSE3	-	-	-	0.865	-	-	-
PSE4	-	-	-	0.857	-	-	-
MS1	-	-	-	-	0.884	-	-
MS2	-	-	-	-	0.901	-	-
MS3	-	-	-	-	0.827	-	-
MS4	-	-	-	-	0.906	-	-
MS5	-	-	-	-	0.894	-	-
MS6	-	-	-	-	0.911	-	-
MS7	-	-	-	-	0.858	-	-
MS8	-	-	-	-	0.884	-	-
CR1	-	-	-	-	-	0.850	-
CR2	-	-	-	-	-	0.912	-
CR3	-	-	-	-	-	0.767	-
CR4	-	-	-	-	-	0.626	-
CD1	-	-	-	-	-	-	0.919
CD2	-	-	-	-	-	-	0.896
CD3	-	-	-	-	-	-	0.882
CD4	-	-	-	-	-	-	0.885
Proportion of variance explained	78.1%	64.5%	76.1%	80.2%	75.6%	63.4%	73.0%

Note: CR5 and CR6 have been excluded from the above confirmatory factor analysis.

Table 2 Convergent and Discriminant Validity, with Reliability Estimates

	1.	2.	3.	4.	5.	6.	7.
1. Organizational Effectiveness	0.645						
2. Supplier Relations	0.384	0.754					
3. Efficiencies in Production	0.366	0.246	0.759				
4. Product and Service Enhancement	0.450	0.408	0.655	0.730			
5. Marketing Support	0.457	0.468	0.367	0.558	0.781		
6. Customer Relations	0.478	0.388	0.360	0.388	0.333	0.626	
7. Competitive Dynamics	0.384	0.348	0.437	0.484	0.484	0.504	0.803
Reliability: Cronbach's Alpha	0.915	0.923	0.924	0.914	0.966	0.864	0.942

Note: Diagonal elements indicate variance extracted while off-diagonal elements indicate shared variance.

Table 3 Fit Statistics

	Suggested for Good Fit	Simple Value Chain Model (Figure 4)	Calibrated Value chain Model (Figure 5)
χ^2 (df)	$p > 0.05$[1]	1.749 (6), $p = 0.941$	16.300 (10), $p = 0.091$
Satorra-Bentler Scaled χ^2 (df)	$p > 0.05$[1]	1.109 (6), $p = 0.981$	(not available)
Normed Fit Index (NFI)	≥ 0.90[2]	0.998	0.980
Non-normed Fit Index (NNFI)	≥ 0.90[2]	1.019	0.984
Comparative Fit Index (CFI)	≥ 0.90[3]	1.000	0.992
Goodness-of-Fit Index (GFI)	≥ 0.90[4]	0.987	0.930
Root Mean Sqr. Error of Approx. (RMSEA)	$= 0.05$[5]	0.000	0.060

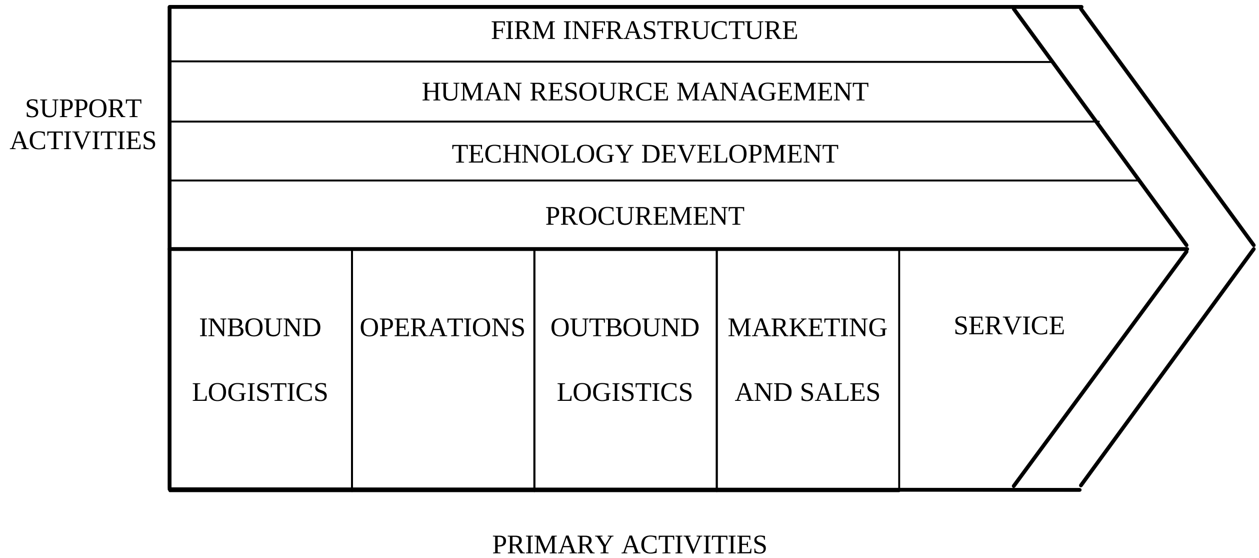
1. Bentler (1995: p. 93) 2. Bentler and Bonett (1980: p. 600) 3. Rigdon (1996: p. 374)
4. Hu and Bentler (1995: p. 95) 5. Browne and Cudeck (1993: p. 144)

Table 4 Variance Explained (R^2) - Comparison of ML and Bootstrap Estimates

	"Simple" Value Chain Model		Calibrated Value Chain Model	
	ML Estimation	Bootstrap Est.[1]	ML Estimation	Bootstrap Est.[2]
Supplier Relations	0.6436	0.6445	0.6566	0.6564
Efficiencies in Production	0.5170	0.5216	0.5827	0.5833
Product and Service Enhancement	0.6842	0.6899	0.6291	0.6314
Marketing Support	0.6694	0.6809	0.5444	0.5499
Customer Relations	0.6531	0.6913	0.6853	0.6973
Competitive Dynamics	0.5748	0.5984	0.5551	0.5656
Business Value Latent Variable	0.6218	0.6239	0.6242	0.6259

1. Based on 1000 replications 2. Based on 994 replications

Figure 1 The Generic Value Chain



Adapted from M. Porter, "Competitive Advantage," (1985), p. 37

Figure 2 Value chain Model of Business Value

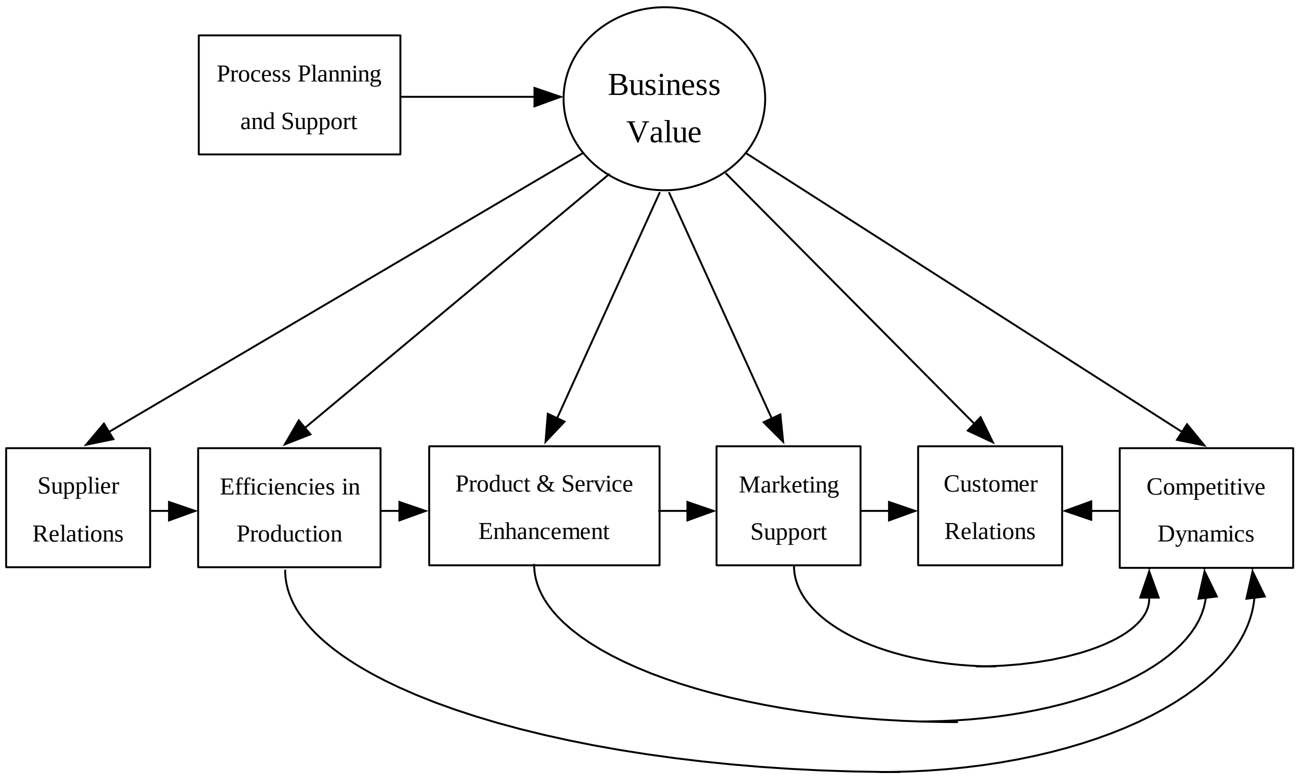


Figure 3 Mean Values Reported for each Dimension of the Value Chain

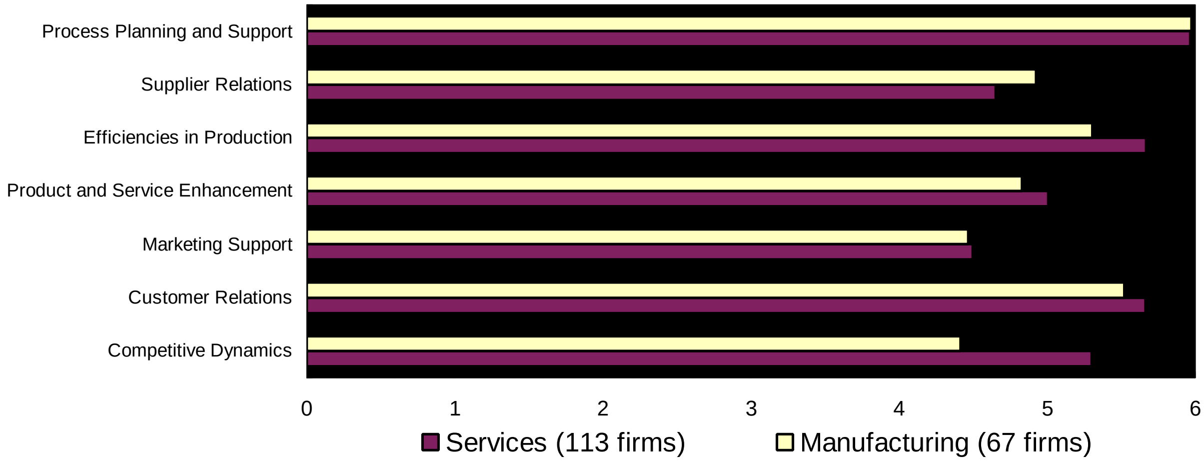
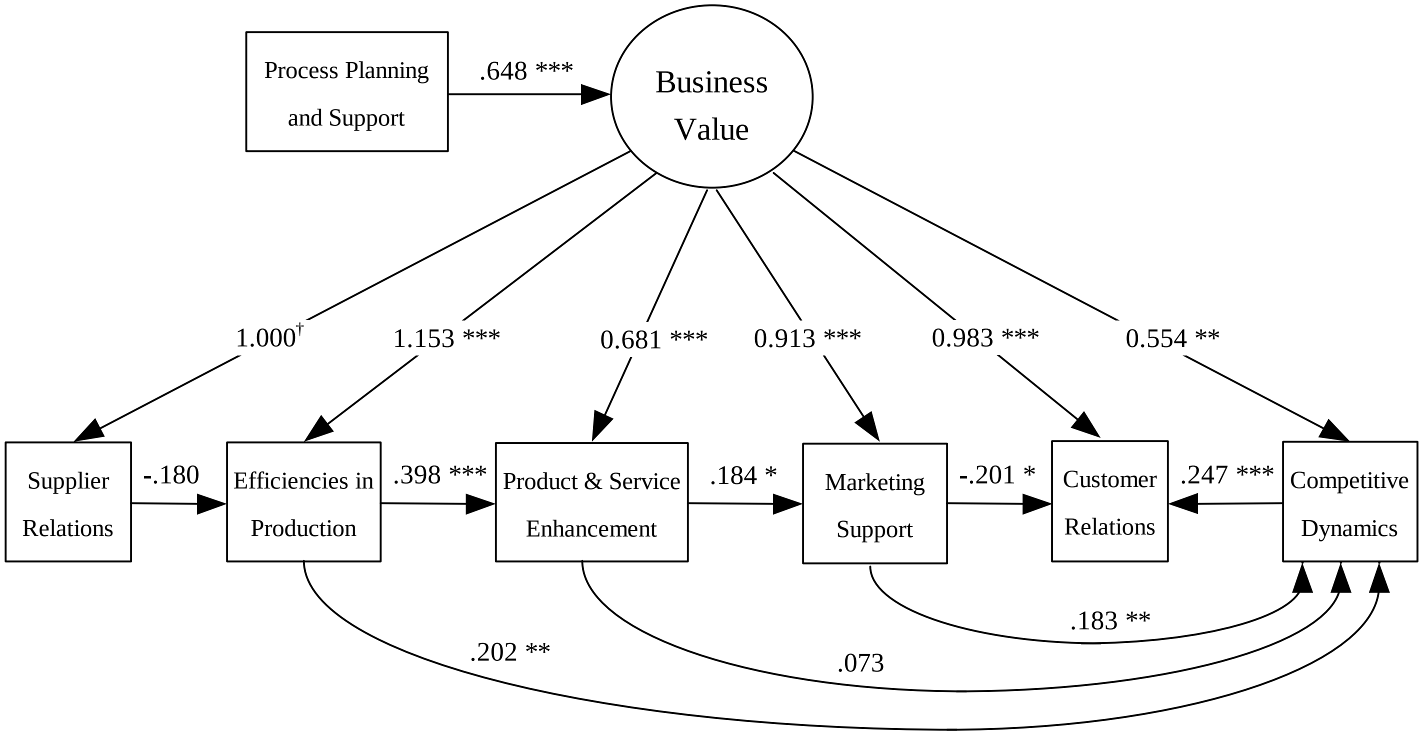
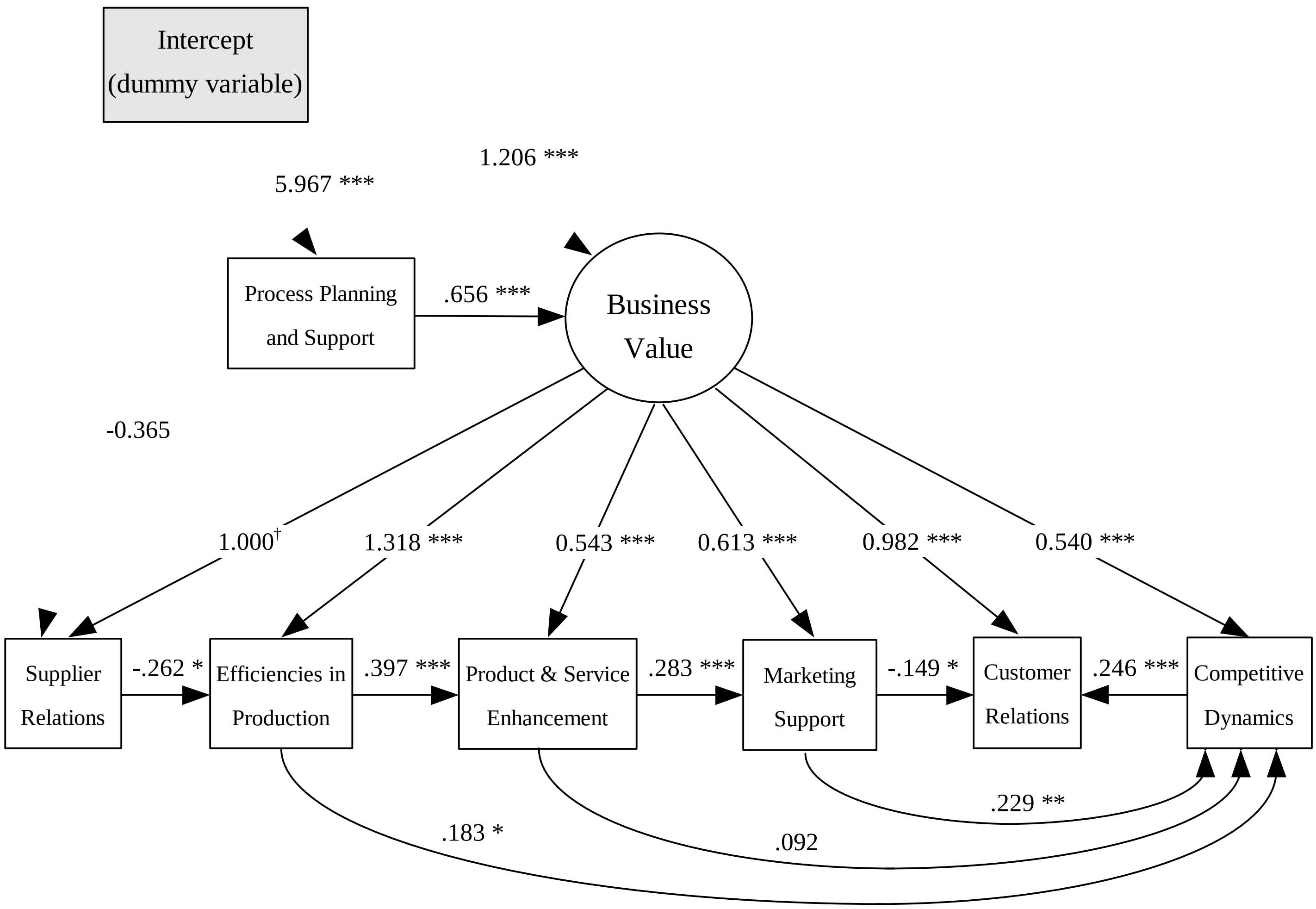


Figure 4 Coefficients of the "Simple" Value Chain Model



Note: significance: *** $p < 0.001$, ** $p < .01$, * $p < .05$; † fixed at 1.000; disturbance terms have been omitted

Figure 5 Coefficients of the Calibrated Value Chain Model



Note: significance: *** $p < 0.001$, ** $p < .01$, * $p < .05$; † fixed at 1.000; disturbance terms have been omitted.
Dashed lines are not part of the original value chain model, and are only included here as a means of "anchoring" the dummy variable to the value chain and the business value variable.

APPENDIX 1

Survey Instrument: Items Used to Measure Each Dimension of Business Value

Process Planning and Support

PPS1 Facilitate the automation of core business processes
PPS2 Improve the process and content of decision making
PPS3 Improve internal communication within your corporation
PPS4 Improve strategic planning
PPS5 Provide better coordination among functional areas in your corporation
PPS6 Facilitate implementing new processes that constitute a better way of doing business

Supplier Relations

SR1 Help your corporation coordinate closely with its suppliers
SR2 Reduce transaction costs by making it easier for suppliers to handle orders
SR3 Help to reduce variance in supplier lead times
SR4 Enhance the ability to monitor the quality of products/services received from suppliers

Efficiencies in Production

EP1 Improve the levels of production or throughput
EP2 Reduce the level of production/service delivery required for economies of scale
EP3 Improve the utilization of machinery
EP4 Improve the productivity of labor through automation

Product and Service Enhancement

PSE1 Reduce the development time for new products/services
PSE2 Facilitate the tailoring of products/services to individual market segments
PSE3 Reduce the cost of designing new products/services
PSE4 Reduce the production cost of tailoring products/services to market segments

Marketing Support

MS1 Provide support for identifying market trends through powerful analytical tools
MS2 Assist your corporation in serving new market segments
MS3 Enhance the accuracy of sales forecasts
MS4 Increase your corporation's effectiveness in locating new markets
MS5 Increase your corporation's ability to anticipate customer needs
MS6 Help to track market response to pricing strategies
MS7 Track market response to promotional or introductory pricing
MS8 Facilitate targeted response to competitor's pricing strategies

Customer Relations

CR1 Enable your corporation to provide administrative support to customers
CR2 Facilitate a higher level of flexibility and responsiveness to customer needs
CR3 Facilitate the development of detailed customer databases
CR4 Position customers to rely increasingly on your corporation's electronic support systems
CR5 Help your corporation coordinate closely with its customers
CR6 Reduce the variance and uncertainty in product/service delivery times

Competitive Dynamics

CD1 Support your corporation in offering a product/service that your competitors cannot immediately match
CD2 Help your corporation to provide substitutes for your competitors' products/services
CD3 Help to delay competitor entry into your corporation's product/service areas because of new investments required in information technology
CD4 Make it easier to capture distribution channels and thereby increase the cost and difficulty for competitors to enter a new or existing market segment

[1] The executive business value survey is part of the (*name deleted*), a joint project between the (*name deleted*) at the (*name deleted*), University of (*name deleted*), and (*name deleted*) Corporation. (*Name deleted*) involves an annual survey of IT managers and business executives across Fortune 500 companies on a range of IT value management issues.