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A RESOURCE-BASED PERSPECTIVE ON INFORMATION TECHNOLOGY CAPABILITY AND FIRM PERFORMANCE: AN EMPIRICAL INVESTIGATION[1]

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Abstract

The resource-based view of the firm attributes superior financial performance to organizational resources and capabilities. This paper develops the concept of IT as an organizational capability and empirically examines the association between IT capability and firm performance. Firm specific IT resources are classified as IT infrastructure, human IT resources, and IT-enabled intangibles. A matched-sample comparison group *methodology and publicly available ratings are used to assess IT capability and firm performance. Results indicate that firms with high IT capability tend to outperform a control sample of firms on a variety of profit and cost-based performance measures.*

Keywords: IT capability, IT resources, resource-based theory, firm performance

ISRL Categories: AF0401, AI0104, EI0201, GA01

Introduction

Despite the widely held belief that information technology (IT) is fundamental to a firm's survival and growth, scholars are still struggling to specify the underlying mechanisms linking IT to financial performance. Anecdotal evidence and case studies indicate that effective and efficient use of IT is a key factor differentiating successful firms from their less successful counterparts. For example, IT capabilities were found to be an important differentiator of banks that were doing well in the mid-1980s, as compared to those that were less profitable (Nolan 1994). Widely publicized IT programs in firms such as American Airlines, Merrill-Lynch, and Frito-Lay have been associated with superior business performance. At the same time, there is also evidence that many firms, concerned about falling behind on the technology curve, engage in high IT investments without deriving any benefits from IT (Nolan 1994).

This study focuses on the *performance effects* of IT, an issue that has provoked much debate over the last decade. Dubbed the "productivity para-

[1]Sirkka Jarvenpaa was the accepting senior editor for this paper.

dox," the controversy over the business value of computer investments continues to rage even in the face of more encouraging evidence about payoffs from IT (Brynjolfsson 1993; Brynjolfsson and Hitt 1993, 1996; Hitt and Brynjolfsson 1996) For example, in his most recent book, *The Squandered Computer*, Strassman (1997) argues that there is no discernible relationship between IT investments and any measure of firm profitability including return on assets, return on equity, and economic value added. Other empirical studies that have investigated the relationship have also yielded mixed results. These results have been extensively cited and summarized elsewhere (c.f. Brynjolfsson 1993; Hitt and Brynjolfsson 1996; Lucas 1993; Wilson 1993). The findings of past studies have however been questioned on methodological grounds such as (1) use of inappropriate measures of IT intensity, (2) failure to control for other factors that drive firm profits, and (3) problems related to sample selection and sample size (Dos Santos et al. 1993; Hitt and Brynjolfsson 1996; Lucas 1993; Mooney et al. 1995).

Attributing the inconclusiveness to conceptual limitations, several studies have stressed the need for better theoretical models that trace the path from IT investments to business value (c.f. Beath et al. 1994; Grabowski and Lee 1993; Lucas 1993; Markus and Soh 1993; Sambamurthy and Zmud 1994). For example, some recent studies have adopted a "process-oriented" view that examines the effects of IT on intermediate business processes (Barua et al. 1995; Mooney et al. 1995; Soh and Markus 1995). Theoretical developments in process innovation and business process engineering (Davenport 1993; Hammer and Champy 1993) have provided additional support for the process-oriented view which attempts to link the intermediate process variables to firm level performance variables.

A potential framework for augmenting the conceptual analysis of IT's effects on firm performance is the *resource-based* view (RBV) of the firm which links the performance of organizations to resources and skills that are firm-specific, rare, and difficult to imitate or substitute (Barney 1986, 1991). The resource-based view is presently the dominant theoretical perspective in strategic management literature, and focuses on costly-to-copy attributes of a firm which are seen as the fundamental drivers of performance (Conner 1991; Rumelt 1984, 1987; Schulze 1992). Adopting a resource-based perspective of IT, researchers have argued that since investments in IT are easily duplicated by competitors, investments *per se* do not provide any sustained advantages. Rather, it is how firms leverage their investments to create unique IT resources and skills that determine a firm's overall effectiveness (Clemons 1986, 1991; Clemons and Row 1991; Mata et al. 1995). Thus, despite uniformly high investments in technology, IT resources and skills tend to be heterogeneously distributed across firms, leading to different patterns of IT use and effectiveness. However, only a limited number of studies have explored the resource-based view of IT, and the analyses to date have been mostly conceptual. Clearly there is a need for further review and testing of the resource-based view of IT (c.f. Jarvenpaa and Leidner 1998; Mata et al. 1995).

The purpose of this paper is to employ the resource-based view to develop the theoretical links and empirically examine the association between IT capability and business performance. Since the resource-based view explicitly recognizes the importance of intangibles such as customer orientation and organizational knowledge, it offers a significant opportunity to explore these theoretical complimentarities in examining the relationship between IT resources and firm performance. The remainder of this paper is organized as follows. The next section presents a brief outline of the resource-based theory of the firm followed by an examination of the links between IT resources and firm performance. This is followed by the empirical analysis, describing the data sources and the methodology used to address the research questions. Finally, the results and the implications of the study are presented and some concluding comments offered.

A Resource-Based View of IT and Firm Performance

Rooted in management strategy literature, the resource-based view of the firm posits that firms

compete on the basis of "unique" corporate resources that are valuable, rare, difficult to imitate, and non-substitutable by other resources (Barney 1991; Conner 1991; Schulze 1992). The resource-based theory operates under the assumptions that the resources needed to conceive, choose, and implement strategies are heterogeneously distributed across firms and that these firm differences remain stable over time (Barney 1991). Resources tend to survive competitive imitation when protected by isolating mechanisms (Rumelt 1984) such as time-compression diseconomies, historical uniqueness, embeddedness and causal ambiguity[2] (Barney 1991; Dierickx and Cool 1989; Peteraf 1993).

Although proponents of the resource-based view generally tend to define resources broadly, to include assets, knowledge, capabilities, and organizational processes, Grant (1991) distinguishes between *resources* and *capabilities* and provides a classification of resources into tangible, intangible, and personnel-based resources. Tangible resources include the financial capital and the physical assets of the firm such as plant, equipment, and stocks of raw materials. Intangible resources encompass assets such as reputation, brand image, and product quality, while personnel-based resources include technical know-how and other knowledge assets including dimensions such as organizational culture, employee training, loyalty, etc. While resources serve as the basic units of analyses, firms create competitive advantage by assembling resources that work together to create *organizational capabilities*. Capabilities, thus, refer to an organization's ability to assemble, integrate, and deploy valued resources, usually, in combination or copresence (Amit and Schoemaker 1993; Russo and Fouts 1997; Schendel 1994). Capabilities subsume the notion of organizational competencies (Prahalad and Hamel 1990) and are rooted in processes and business routines. Grant (1995) describes a hierarchy of organizational capabilities, where specialized capabilities are integrated into broader functional capabilities such as marketing, manufacturing, and IT capabilities.[3] Functional capabilities in turn integrate to form cross-functional capabilities such as new product development capability, customer support capability, etc. For example, a firm's customer support capability may derive from the cross-functional integration of its marketing, IT, and operations capabilities.

IT and the Resource-Based View

Adopting a resource-based perspective, information systems researchers have identified various IT related resources that serve as potential sources of competitive advantage. For example, Mata et al. (1995) argue that managerial IT skills are rare and firm specific and therefore likely to serve as sources of sustained competitive advantage. Along with competent IT skills (human IT asset), Ross et al. (1996) point out that a reusable technology base (technical asset) and a strong partnering relationship between a firm's IT and business unit management (relationship asset) influence a firm's ability to deploy IT for strategic objectives. Likewise, in a case study of Japan Airline's competitive position, Chatfield and Bjørn-Andersen (1997) describe the airline's inter-organizational system (a physical capital resource) and its people (human capital resource) as the primary sources of its business growth and improved competitiveness.

Extending the traditional notion of organizational capabilities to a firm's IT function, a firm's *IT capability* is defined here as its ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities. Adopting Grant's classification scheme for resources, key IT-based resources are classified in the following order: (1) the tangible resource comprising the physical *IT infrastructure* compo-

[2] *Time compression diseconomies* refers to the time needed to acquire the resource through learning, experience, firm-specific knowledge, or trained proficiency in a skill; *historical uniqueness* refers to advantages that accrue due to unique resources such as distinctive locations or due to first mover advantages such as reputation, brand loyalty, etc.; *embeddedness of resources* refers to the value of a resource being inexplicably linked to the presence of another complementary or cospecialized resource; *causal ambiguity* refers to the ambiguity surrounding the connection between a firm's resource portfolio and its performance.

[3] Grant (1995, p. 131) refers to an IT-related functional capability as an MIS capability.

nents, (2) the *human IT resources* comprising the technical and managerial IT skills, and (3) the *intangible IT-enabled* resources such as knowledge assets, customer orientation, and synergy. The notion of IT as an organizational capability is well illustrated by the example of Provident National Bank of Philadelphia. When its chief competitor announced a free checking service, Provident was able to immediately announce a similar service to its customers, based on the IS management's guarantee that the required applications would be implemented before the next billing cycle (Duncan 1995). Providing such a guarantee meant that Provident had (1) a flexible IT infrastructure on which a new application could be launched in a very short time; (2) competent IT skill base that allowed them to envision the strategic benefits of countering the competitor's strategy and deliver a critical application within one billing cycle; and finally (3) a strong customer orientation, an intangible organizational resource, enabled by the strength of their IT infrastructure and IT skill base. In the following paragraphs, the identification of IT as an organizational capability created by the interaction of IT infrastructure, human IT resources, and IT-enabled intangible resources are explicated. Hypotheses linking a firm's IT capability to financial performance are then presented.

IT Infrastructure

The physical IT assets which form the core of a firm's overall IT infrastructure comprise the computer and communication technologies and the shareable technical platforms and databases (Ross et al. 1996; Weill et al. 1996). The IT infrastructure is a shared information delivery base, the business functionality of which has been defined in terms of its *reach* and *range* (Keen 1991). While the reach determines the locations that the platform can access and to which it can link, its range defines the kind of information that can be seamlessly and automatically shared across systems and services.

A firm's IT infrastructure has been described as a major business resource and a key source for attaining long-term competitive advantage (Keen 1991; McKenney 1995). The infrastructure underpins a firm's competitive position by enabling initiatives such as cycle time improvement, cross-functional processes, and cross-selling opportunities (Sambamurthy and Zmud 1992; Weill and Broadbent 1998). As Keen (1991, p. 184) notes, "it is the IT platform that determines the business degrees of freedom a firm enjoys in its business plans." A non-integrated IT infrastructure dominated by system incompatibilities severely restricts an organization's business choices. Creating an integrated IT infrastructure, however, requires both considerable time and expertise. As firms develop IT infrastructures that span entire organizations, linking key suppliers and customers, they evolve elaborate rules regarding the distribution and management of hardware, software, and other support services (Ross et al. 1996). Although the individual components that go into the infrastructure are commodity-like, the process of integrating the components to develop an infrastructure tailored to a firm's strategic context is complex and imperfectly understood (Weill and Broadbent 1998). Successful firms also learn to redesign their products and services in a manner that exploits their infrastructure capabilities. For example, developing a new order processing system may require the infrastructure services of mainframe processing, customer databases, personal computers, local area and national communication networks. Having these components in place will significantly reduce the time and cost to build the system (Weill and Broadbent 1998).

Resource-based theorists contend that physical assets, in and of themselves, can serve as sources of competitive advantage only if they "outperform" equivalent assets of competitors (Barney 1991; Rumelt 1984). Due to the fact that IT systems can be purchased or duplicated fairly easily by competitors, it is often argued that physical IT resources are unlikely to serve as sources of competitive advantage (Mata et al. 1995). Such a reductionist view of technology, however, seeks to value the infrastructure solely in terms of its individual components, assumes the separability of the IT assets, and ignores the synergistic benefits of integrated systems. However commodity-like the technology components may be, the architecture that removes the barriers of system incompatibilities and makes it possible to build a corporate platform for launching business applications is clearly not a commodity (Keen 1991). Building such integrated infrastruc-

tures takes time and effort[4] and involves experiential learning. Neo (1988), for example, found that the most successful IT implementers were the ones that had already implemented similar systems and had accumulated experience. Time compression diseconomies (Deirickx and Cool 1989) make it difficult for newcomers to catch up by simply "throwing money" and purchasing the IT systems. A case in point: when Kaiser Permanante embarked on a plan to develop an integrated IT architecture, it reversed its longstanding policy of regional autonomy for IT decisions. As the program evolved within Kaiser, the firm had to deal with major logistic challenges and overcome huge cultural clashes. Other firms cannot simply copy Kaiser without experiencing similar upheavals.

Viewed from the RBV perspective, the IT infrastructure provides the resources that make feasible innovation and continuous improvement of products (Duncan 1995; Venkatraman 1991). The unique characteristics of the IT infrastructure that enable firms to implement the right applications at the right time render the cost and value of technological innovation different for different firms. Indeed, IT infrastructures that enable firms to (1) identify and develop key applications rapidly, (2) share information across products, services, and locations, (3) implement common transaction processing and supply chain management across the business, and (4) exploit opportunities for synergy across business units represent the type of causally ambiguous resources (Reed and DeFillipi 1990) that are central to the resource-based view. Such infrastructures, however, evolve over time and in a manner that make their value and description difficult to define even for their developers (Cash et al. 1992).

Human IT Resources

Organizational human resources generally comprise the training, experience, relationships, and insights of its employees (Barney 1991; Grant 1995). The critical dimensions of human IT resources include: (1) *technical IT skills*, such as programming, systems analysis and design, and competencies in emerging technologies, and (2) *the managerial IT skills*, which include abilities such as the effective management of IS functions, coordination and interaction with user community, and project management and leadership skills (Capon and Glazer 1987; Copeland and McKenney 1988).

Firms with strong human IT resources are able to (1) integrate the IT and business planning processes more effectively, (2) conceive of and develop reliable and cost effective applications that support the business needs of the firm faster than competition, (3) communicate and work with business units more efficiently, and (4) anticipate future business needs of the firm and innovate valuable new product features before competitors. The managerial ability to coordinate the multifaceted activities associated with the successful implementation of IT systems has been found to be a key distinguishing factor of successful firms (Sambamurthy and Zmud 1992).

Technical and managerial IT skills typically evolve over long periods of time through the accumulation of experience (Katz 1974). Furthermore, managerial IT skills are often tacit, dependent on other interpersonal relationships which may take years to develop (Chatfield and Bjørn-Andersen 1997; Mata et al. 1995), and tend to be highly local or organization specific (Sambamurthy and Zmud 1997). For example, creating a user community that welcomes technological change and embraces new systems takes several years over which the IS group has to engage in mutual trust building and commitment to shared goals. Likewise, application development skills such as those needed for large software development projects often require interactive teams of IT staff that are far more immobile than individual members. These teams develop distinctive styles and coordination mechanisms, which are perfected over time through learning-by-doing and repetition. Nelson and Winter (1982) use the term "organizational routines" to describe the regular and predictable patterns of activity that govern coordinated activities within organizations. Firms that have developed and perfected sophisticated IT development routines such as JAD (joint application

[4]Weill and Broadbent estimate a lead time of five to seven years to develop IT infrastructures.

development) and RAD (rapid application development) are able to significantly reduce both development costs and development time. For example, Cambridge Technology Partners, a software company, uses a multifunctional organizational routine called Co-RAD (for cooperative rapid application development) that is specifically designed to bring together the diverse resources and skills necessary for successful software development (LaPlante 1997). When new employees join the firm, they are trained not only in software systems but also in development methodologies unique to the firm. Thus there are increasing returns to the firm as they add qualified professionals to an existing network of programmers. Such team-embodied knowledge also suffers a slower decay rate as it is passed on without much degradation to successive generations of team members (Dierickx and Cool 1989). There is no known way to short circuit these path dependent processes.

The adaptability of employees to organizational change is another factor that determines the strategic flexibility of the firm (Grant 1991). Clark et al. (1997) characterize an organization's ability to rapidly develop and deploy critical IT systems as its *change-readiness* capability and attribute it primarily to the availability of a skilled internal IS workforce. Organization architectural elements (Nadler and Tushman 1997), such as empowered and autonomous systems design teams, enriched and shared jobs, team processes, and incentives for collaborative learning and sharing of work practices, serve as key levers in building such organizational resources. These organization design elements serve to create an environment in which IT personnel can leverage not only their own technical and managerial skills but can also effectively bring to bear the assets of the entire socio-technical network to which the member belongs. For example, Citibank recently incorporated an organizational routine for launching web-based applications that requires managers to specify how they think the project should evolve and predict unexpected developments (Hibbard 1998). Viewed from a resource-based perspective, it is clear that human IT resources are difficult to acquire and complex to imitate, thereby serving as sources of competitive advantage. In fact the wide difference in competitive organizational and economic benefits that companies gain from IT has been attributed largely to their managerial IT resources (Keen 1993; Mata et al. 1995). For example, Keen (1993) attributes Federal Express's commitment to high levels of customer service as a strategy rooted in their managerial IT capability.

IT-Enabled Intangibles

A major contribution of the resource-based theory is its explicit recognition of the value of intangible organizational resources. Several key organizational intangibles such as know-how (Teece 1998), corporate culture (Barney 1991), corporate reputation (Vergin and Qoronfleh 1998), and environmental orientation (Russo and Fouts 1997) have been recognized as key drivers of superior performance. In general, firm-specific intangibles tend to be tacit, idiosyncratic, and deeply embedded in the organization's social fabric and history (Winter 1987). In the context of a firm's IT capability, a question that is becoming increasingly important for CIOs and other senior managers is "how do investments in technology create superior intangible resources for the firm?" In fact, according to a recent survey, highly effective IT users tend to pay greater attention to the intangible benefits of IT such as improved customer service, enhanced product quality, increased market responsiveness, and better coordination of buyers and suppliers in evaluating IT systems (Brynjolfsson and Hitt 1997).

Skeptics of IT's direct effects on firm performance have long argued that firms benefit from IT only when they embed IT in a way that produces valuable, sustainable resource complementarity (Clemons 1986, 1991; Clemons and Row 1991; Powell and Dent-Micallef 1997). IT is a resource that generates competitive value only when it leverages or enables pre-existing firm resources and skills. Although the enabling role of IT with respect to several organizational intangibles such as product quality, customer service, market orientation, knowledge assets, organizational memory, organizational learning, synergy, etc. has been indicated in the business literature (c.f. Quinn and Baily 1994), due to constraints of space, IT's enabling role is illustrated here by utilizing three key organizational intangibles:

customer orientation, knowledge assets, and *synergy*.

Customer Orientation. The emphasis on customer orientation is apparent in virtually every industry, and the positive impact of customer orientation on firm performance has been widely documented (c.f. Jaworski and Kohli 1993; Narver and Slater 1990). In achieving high levels of customer orientation, firms have found IT to be an indispensable factor. In fact, customer orientation strategies such as customer relationship management are rooted in the core IT capability of the firm. For example, Prudential recently invested in an IT system designed to improve its knowledge of customers across all business units. According to Prudential's CIO,

> a customer who has a low business value with one unit might have a very valuable relationship if you look at it across the entire enterprise. So we're building an information warehousing capability that allows us to recognize those relationships (Janah 1998).

A key capability for superior customer orientation is the ability to track and predict changing customer preferences, especially in volatile markets. IT enables firms to track shifts in customer choices much more rapidly. At National Semiconductor, a web-based broadcasting system is used to capture customer information online and present it immediately to managers. This has resulted in more accurate forecasts of product demand and boosted the sales of key components (Cronin 1997).

Although customer management systems are widely available, few firms are able to achieve the tight integration and coordination of the functional units required for efficient processing of information. In these firms, the information systems are tightly integrated with management decision making, the IS personnel have close working relationships with line managers, and the management information system becomes a vital tool in the day-to-day running of the firm. Merely purchasing IT systems will not ensure competitive parity, because it is the socially complex link between IT and other parts of the organization that serves as the source of the advantage (Barney 1997).

Knowledge Assets. A key aspect of a firm's intangible resources is its intellectual capital or knowledge assets. This is embedded in the skills and experience of its employees, as well as in its processes, policies, and information repositories. A firm's knowledge capital is widely recognized as a unique, inimitable, and valuable resource (Matusik and Hill 1998; Prahalad and Hamel 1990). The relationship between organizational knowledge and competitive advantage is moderated by the firm's ability to integrate, transfer, and apply knowledge (Matusik and Hill 1998). According to Nonaka and Takeuchi (1995), knowledge management requires a commitment to create new task-related knowledge, disseminate it throughout the organization, and embody it in products, services, and systems. IT is critical to knowledge management as technologies such as groupware and multimedia systems assist in clarifying assumptions, speeding up communications, eliciting tacit knowledge, and constructing histories of insights and cataloging them (Brown and Duguid 1991; Dodgson 1993; Grantham and Nichols 1993). Increasingly, the extent to which a firm's knowledge is embedded in its databases and decision support systems is determining its ability to respond to environmental changes (Sabherwal and King 1991). Embedding knowledge in such systems also enables its rapid transfer to novices and other new members. For example, Hughes Space and Communications has built a "lessons learned" database that captures the unstructured knowledge of its design team in the form of wisdom, experience, and stories. The database aids in the design of new satellites by providing access to reports of past defects. While other firms can make similar investments, they would be hard pressed to emulate the structure for categorizing and searching the knowledge bases and to sustain the level of ongoing support needed for the maintenance of knowledge bases (Davenport 1996).

IT systems thus enable knowledge formalization and consolidation of previous knowledge gains and their leverage across the organization. Technologies such as groupware and expert systems, when populated with firm-specific knowledge and insights, are transformed into *specialized assets* that are almost impossible to imitate by competitors. Furthermore, effective

knowledge management is an inherently social process that requires tremendous organizational change. Creating a culture for knowledge management entails changes to the organization structure, control and communication systems, and rewards structures. Few organizations are able to manage effectively both the technological and social aspects of knowledge management for competitive advantage (Marshall et al. 1996).

Synergy. Synergy refers to the sharing of resources and capabilities across organizational divisions. Beyond operational efficiencies, knowledge and information sharing across functional units enables firms to be more flexible and to respond faster to market needs. As Brown and Duguid (1998) point out, information technologies geared toward creating organizational synergies can aid in the delivery of needed resources by removing the physical, spatial, and temporal limitations to communication. For example, Andersen Consulting's "Knowledge Exchange" connects over 20,000 consultants around the world and consists of over 2,000 databases into which consultants can tap. As a result, problems that once took two weeks to solve are now solved overnight. Technologies such as CAD/CAM permit inter-organizational design teams to share engineering drawings and foster greater cooperation in buyer-supplier relationships (Bensaou 1997). Ives et al. (1993) cite several examples of firms that have globally coordinated their functions of procurement, logistics, and inventory management through systems running at the corporate headquarters.

Flexible IT systems also enable firms to realize cost and demand synergies by marketing new products and services with little added costs. However, competitive advantages associated with synergy are less likely to be imitated, as they are often achieved under a unique set of circumstances and on the basis of firm-specific resources (Bharadwaj et al. 1993). IT has a great enabling capacity for making other organizational resources more easily accessible and shareable. However, to derive competitive benefits from synergy, firms need to create a social context and reciprocity inherent in shared practice. This interaction of IT with other socially complex organizational intangible resources is at the heart of many of the difficulties that firms have when trying to imitate their more successful counterparts.

IT Capability and Firm Performance

In summary, the resource-based view of IT suggests that firms can and do differentiate themselves on the basis of their IT resources. A firm's IT infrastructure, its human IT skills, and its ability to leverage IT for intangible benefits serve as firm-specific resources, which in combination create a firm-wide IT capability. While each of the individual IT resources are complex to acquire and difficult to imitate, firms that achieve competitive advantage through IT have also learned to combine effectively their IT resources to create an overall IT capability. For example, a flexible IT infrastructure when combined with strong human IT skills becomes a potent organizational capability. Likewise, successful firms employ their technology base and human IT skills for developing IT-enabled intangibles such as customer orientation, synergy, and superior organizational knowledge. Knowledge about the productive application of IT and the manner in which individual IT resources must be combined to create superior applications become embedded in these organizations in the form of organizational routines (Nelson and Winter 1982) further bolstering the IT skill base of the firm. Firms that are successful in creating superior IT capability in turn enjoy superior financial performance by bolstering firm revenues and/or decreasing firm costs. Firms that incur the costs of IT without developing an IT capability will be at a comparative disadvantage. This directly leads us to the two main hypotheses:

H_1: Superior IT capability will be associated with significantly higher profit ratios.

H_2: Superior IT capability will be associated with significantly lower cost ratios.

Methodology

The "matched sample comparison group" methodology is employed to empirically assess the relationship between superior IT capability and firm performance. This is a popular methodology that has been used in several research studies in the accounting, finance, and marketing literatures (c.f. Balakrishanan et al. 1996; Jain and Kini 1995; Kalwani and Narayandas 1995) to compare the levels of interest variables across two samples: the *treatment sample*, in this case, a sample of firms with high IT capability, and a carefully selected *control sample* of firms matched to the treatment sample by size and type. The performance of the matched control sample of firms serves as a benchmark and helps remove the confounding effects of extraneous variables and market forces that could influence firm performance. A variety of profit and cost measures are used to compare the financial performance of the two groups. Details about sample selection, methods, and measures used follow.

Sample Selection

To identify firms with superior IT capability within an industry, the rankings provided by *InformationWeek* (IW) in their annual special issue were used. Each year, since 1989, IW has published a special issue listing various items of data related to IT such as IT budgets, size of IT staff, and percentages of IT budget devoted to various technologies such as client-server computing, telecommunications, and other hardware and software classifications. IW and *ComputerWorld are* the only two publicly available sources of data on corporate IT spending and other measures of IT use in the U.S. Data from both sources have been used in a number of studies in the past (c.f. Bharadwaj et al. 1999; Brynjolfsson and Hitt 1996; Hitt and Brynjolfsson 1996; Lichtenberg 1995). Lichtenberg (1995) also showed that there is a high correlation between the estimates of IT data from the two sources.

Since 1991, IW has identified about 40 to 50 firms (out of the 500) each year as the "leaders" of technology in their respective industries. The IT leaders are determined by a select group of industry analysts, IT executives, IS researchers, and other practitioners who are asked to vote for the firms they consider to be most effective and efficient in use of IT. Within each industry group, the firms receiving the highest number of votes are selected as the IT leaders[5]. While the IT leaders are not ranked on specific IT resources or skills, firms are peer-ranked on the basis of their overall IT strengths. Thus, firms that are known to have successfully launched innovative or strategic applications or who have a strong reputation for being a technology leader tend to be ranked as the leaders. For example, Wal-Mart Stores, which has been widely recognized for its intensive use of IT, was ranked consistently as an IT leader in the retailing industry. The peer rankings of IT leaders were used as a measure of a firm's overall IT capability. In other words, the IT leaders of each year are deemed to be the firms with high levels of IT capability. Industry experts tend to rank firms on the basis of their manifested IT capability, which, as argued earlier, can only result from underlying strengths in IT resources and skills. The IT leaders are the firms that have successfully combined their IT resources and skills to create superior IT capability.

Using the rankings of IT leaders from 1991 through 1994,[6] a sample comprising of all firms that were ranked as IT leaders in any of the four years was created first. This yielded a list of 149 firms, of which 34 firms were ranked as IT leader in two of the four years, 16 firms in three of the four years, and six firms in all four years. In order to develop a more robust sample of IT leaders, the sample was further restricted to firms that were selected as IT leaders in at least two of the four years. This reduced the sample to 56 firms, but resulted in a sample with a more enduring IT capability. The next step was to create a matching set of control firms drawn from the *Compustat* database. The following procedure

[5]IW, September 21, 1992, p. 154; September 27, 1993, p. 25; October 10, 1994, p. 30; September 18, 1995, p. 38.

[6]In 1995, IW changed its procedure for ranking IT leaders by tying it to financial and operating performance measures. We therefore use data only up to 1994, since including data beyond that would be tautological.

was used for selecting the control sample. First, the IT leaders were grouped into different industry categories based on their four digit primary SIC. A two-step process was then used to identify a matching firm for each firm in the IT leaders sample. First, for each firm in the IT leaders sample, the choice was narrowed to a set of only those firms with the same primary four-digit SIC code as the leader firm. Next, from the set of potential control firms, the matching control firm chosen was one that reported a five-year average sales level that was closest to the level reported by the leader firm. Following Barber and Lyon's (1996) specification for defining industry comparison groups, a specification was made that the average sales of the control firm must lie within 70% to 130% of the leader firm.[7] Additionally, there was assurance that none of the control firms were ranked as an IT leader in any of the years.

The process outlined above helped us match pairs of firms on two dimensions. The firms in each pair are drawn from the same industry and are of equal size. Several recent studies of operating performance have used a similar procedure of matching sample firms to similar-size firms in the same industry (c.f. Denis and Denis 1993; Kaplan 1989). The underlying assumption is that operating performance varies by industry and firm size and that some of the cross-sectional variation in operating performance can be explained by an appropriate industry benchmark. Further, literature in accounting has acknowledged that firm size and industry type are strong predictors of the choice of accounting methods and procedures used to compute costs such as depreciation and amortization (Holthausen and Leftwich 1983; Pincus 1993). Hence, there is reason to believe that the firms in each pair have used similar accounting methods and therefore their profitability and cost ratios are directly comparable. The primary difference between the two firms in each pair is that the target firm in the treatment sample was ranked as a leader in IT use whereas the firms in the control group were not ranked as such. The two groups were also compared using commonly employed measures of firm size such as sales, total assets, and number of employees. A t-test carried out to check if there were any differences between the two groups on the various size measures did not reveal any significant differences between the groups. Table 1 provides descriptive statistics for the two groups. The mean (median) sales figure for the effective IT users and the control samples were $17.9b ($10.4b) and $16.1b ($10.1b) billions of dollars respectively. The two samples appear to be well matched on size, since the means test (t-test) did not reveal any significant differences between the two groups. The median (sign) test, however, indicated that the control group differed from the IT leaders group on the number of employee measure (at the 10% level of significance). Finally, as both the treatment and control samples are skewed toward larger firms, it is likely that the firms are highly diversified. In order to verify if the extent of diversification for the two groups was significantly different, the entropy measure of related diversification (Davis and Duhaime 1992; Robins and Weirsema 1995) was calculated for both groups. The mean related component of total entropy for the IT leaders sample was 0.85 and for the control sample was 0.93 across all four years. A t-test did not reveal any significant difference between the two groups for any of the years. A complete list of the firms that were included in each group is shown in Appendix A.

Data Quality Assessment

Large-scale surveys similar to the one published in IW that purport to rank companies based on direct effectiveness measures are periodically reported in several business publications. For example, *Fortune* publishes an annual reputation survey that ranks companies based on attributes such as quality of management, product quality, innovativeness, social responsibility, use of corporate assets, etc. Results from such surveys are often circulated widely and also cited in several other press outlets. Although problems related to data reliability and validity exist with such data, it has several advantages as well. First, these surveys provide a longitudinal database for comparing firms on various constructs for which, often,

[7]For leader firms that did not have any matching control firm within 70% to 130% of sales level at the four digit SIC, we identified a corresponding control firm at the two or three digit SIC.

Table 1. Descriptive Statistics

Descriptive Variables	IT Leaders Sample		Control Sample		T-test for Difference of Means	Sign Test for Difference of Medians
	Mean	Median	Mean	Median	T	Z
Sales (billion $)	17.91	10.45	16.12	10.10	-0.93	-.053
Assets (billion $)	35.82	14.51	35.09	14.86	-0.13	-.04
Related Entropy (Diversification)[c]	0.85	0.86	0.93	1.05	1.29	-2.32[a]
Number of Employees	89,000	49,000	84,000	42,000	-0.46	-.145[b]

[a]Significant at the 1% level

[b]Significant at the 10% level'

[c]*Firm diversification (total):* The entropy measure of diversification defined as the sum of related diversification (DR) and unrelated diversification (DU), where:

$$DU = \sum_{i=1} X_1 \ln 1/X_1$$

$$DR = \sum_{i=1}^{G} \sum_{k=1}^{S} X_{ik} \ln X_{ik}/X_i$$

where: X = % of sales
i = 1, 2,...G (Industry Groups—two digit SIC code)
k = 1, 2,...S (Segments—four digit SIC code)

other secondary sources of data do not exist (e.g., effectiveness of IT usage, environmental friendliness, innovativeness, social responsibility, etc.). Second, the average response rate reported in these surveys is at least comparable to and often better than most academic studies of this sort. For example, IW's response rates tend to be around 60% of all companies surveyed. Third, knowledgeable industry analysts and executives, who are often intimately familiar with the industry characteristics and trends, carry out the rankings. Finally, the rankings are often corroborated through qualitative reports and business case studies focusing on the best performers. For example, the IW special issue includes case studies describing how the best users deploy IT more innovatively than their competitors.

While the use of such large-scale survey results has been minimal in the IS literature, other research disciplines have a longer tradition of using publicly available survey data. For example, *Fortune* magazine's annual survey of most admired corporations has been used in several management strategy studies (cf. Chakravarthy 1986; McGuire et al. 1988; O'Bannon and Preston 1993; Sharfman 1996) and other rankings in the business press, such as *Business Week's* ranking of top MBA schools, have been used in organization theory studies (c.f. Elsbach and Kramer 1996; Tracy and Waldfogel 1997). Chen et al. (1993) also conclude that industry analysts and executives within an industry are reliable and accurate raters of corporate strategy.

A major concern with the use of such perceptual rankings, however, is that the rankings are likely to be influenced by financial performance variables, thereby affecting the validity of the

results. For example, in the case of *Fortune's* reputation survey, it has been shown that a firm's rankings are influenced by its previous financial performance. If these errors are pervasive, then a "financial performance halo" effect is said to exist. Brown and Perry (1994) describe a procedure to remove the financial performance halo effects from such large-scale surveys and present a statistical method for removing a significant portion of the halo if it exists. Their technique is generalizable to other contexts and is recommended when researchers use measures derived from survey results that may be heavily influenced by factors extraneous to the construct of interest. Since it is likely that the respondents' evaluations of firms for superior IT performance were influenced by the past financial performance of those firms, the Brown and Perry approach was used to examine if any such financial performance halo effect existed in the IW data.

Testing for Financial Performance Halo

If the selection of IT leaders by industry experts is in fact influenced by the past financial performance of the firms, then we should expect to see strong correlation between the IW rankings and a number of past financial and operational performance measures. The halo index includes individual measures of corporate earnings, returns, growth, size, and risk, and uses exactly the same set of variables described in Brown and Perry (1994). The halo index was created using five-year performance data prior to the period during which the firms were ranked as IT leaders. Since the sample used rankings data from 1991 through 1994, financial performance data from 1985 through 1990 were used to construct the halo index, the argument being that if these firms were consistent superior financial performers during the five years immediately preceding their selection as IT leaders, then a halo effect would influence their ranking as IT leaders. The halo index used five operating and financial performance variables and was computed as follows:

average return on assets (ROA_t) = $(\sum_{i=1}^{5} ROA_{t-i})/5$;

relative market to book value ($RELMV_t$) = (mkt/book $value_{firm}$)/ (mkt /book $value_{industry}$);

sales = logarithm of the average sales for past five years;

$growth_t$ = (%change in sales in $_{t-1}$ + ...+%change in $sales_{t-5}$)/5;

$risk_t$ = $debt_t/equity_t$.

The past financial performance measures were employed as independent variables in regression analyses on the IW rankings. The logistic regression procedure was used since the dependent variable was coded as a binary variable (Y = 1 for IT leader and Y = 0 for control firm). The regression equation took the form:

$$Y = B_0 + B_1ROA + B_2RELMV + B_3SALES + B_4GROWTH + B_5RISK + e$$

As shown in Table 2, the results of the logistic regression analysis using five-year past data indicated that the overall model was not significant. The model chi-square had non-significant p-values, indicating that, taken collectively, the past financial performance variables did not account for any significant difference between the two groups. The individual tests of significance for each of the variables also did not yield any significant values. The IT leaders sample, therefore, did not appear to be enjoying any special halo effects due to past financial performance.

Dependent Variables

Data related to firm performance measures were collected from *Compustat* for both the treatment and the control samples. The profit performance of the IT leaders and the control samples was compared using five profit-based measures focusing on net and operating income. The ratios were scaled by measures of firm size based on sales, assets, and number of employees. The first two ratios, return on assets (ROA) and return on sales (ROS), have been widely used in the IT business value literature as measures of firm profitability (Cron and Sobol 1983; Hitt and Brynjolfsson 1996; Strassman 1990; Weill 1992). The ROA measure, calculated as the ratio of net income to assets, indicates how profitably a firm employs its assets since it reflects how much profit a firm is able to generate for each dollar of

Table 2. Financial Performance Halo Effects

Variables	IT Leader Sample	Control Sample	T-value	Standardized Estimates
Average Growth	0.44	0.37	-1.0 (p = 0.31)	0.07 (p = 0.53)
Mean Log Sale	9.32	9.21	-0.53 (p = 0.59)	0.08 (p = 0.51)
Mean risk	118.70	156.08	0.71 (p = 0.48)	-0.09 (p = 0.48)
Mean ROA	5.22	4.59	-0.84 (p = 0.4)	0.00 (p = 0.99)
Mean Relative Market to Book Value	5.82	5.153	-0.14 (p = 0.8)	-0.02 (p = 0.85)
Number of firms (*N*)	*56*	*56*		
Model -2LOGLχ^2 1.53				
p value for model 0.91				
Model degrees of freedom 5				

asset invested. It is a broad measure that is correlated with several other profitability measures (Grinyer and Norburn 1975). The ROS measure, which is the ratio of net income to sales, serves as another indicator of a firm's net profit margin. The operating income to assets (OI/A) and operating income to sales (OI/S) ratios focus on operating returns only and exclude incomes earned by the firm from other sources such as interest income and income from other extraordinary sources. Operating income is, therefore, regarded as a more appropriate measure of the direct value of IT (McKeen and Smith 1993, 1996). Finally, the operating income to employees (OI/E) ratio was used as a measure of the relative profitability per employee of the effective IT users and the benchmark samples.

Three cost related ratios were used to compare the relative performance of the two groups: total operating expenses to sales (OEXP/S), cost of goods sold to sales (COGS/S), and selling and general administrative expenses to sales (SG&A/S). Total operating expenses (defined as the sum of COGS and SG&A) serve as a proxy for the firm's total cost of operations. Operating expense was selected because it is the most general and encompassing measure of a firm's total cost of operations (Mitra and Chaya 1996). Cost of goods sold and selling and general administrative expenses are the generally accepted accounting measures for the production and overhead costs of a firm. A dummy variable was used to code the firms in the treatment and control samples as "1" and "0" respectively.

Statistical Tests

The general hypothesis tested in this study is whether firms with high IT capability tend to enjoy better profit and cost performance when compared with a matched control sample of firms. One way to test this hypothesis is to compare the mean levels of operational performance variables for the treatment and control samples using a standard t-test. However, an examination of the underlying distribution of the variables suggested that a non-parametric test would be more appropriate. Specifically, the Kolmogorov-Smirnov test, which compares sample distributions to a normal distribution, rejected the hypothesis that the dependent variables (profit and cost performance ratios) are normally distributed in every case. Therefore, the Wilcoxon Rank Sum Test was used to evaluate the differences in the levels of the target variables for the two groups of firms. This test is more resistant to departures from normality and is considered more powerful than the pairwise t-test (Conover 1980).

Results

The results for all four years (1991 through 1994) are displayed in Table 3. Although both the mean and median of the performance measures are reported for both samples, the medians are considered to be better indicators. As the accounting data are not normally distributed, the medians are extremely robust to outliers and other

deviations from normality. The test results are reported as Wilcoxon Rank Sum Z-statistics, because the matched pair Wilcoxon test statistic has a normal distribution for sample sizes greater than 14. Although the statistic has no sign, it is included for interpretation only.[8]

As hypothesized, all of the profit ratios in each of the four years were significantly higher for the IT leaders when compared to the control sample of firms. In the case of the cost ratios, total operating expenses to sales (OEXP/S) was significantly lower for the IT leaders sample in all four years. The cost-of-goods to sales (COGS/S) ratios was also lower for the IT leaders sample in all four years with significance (at the 10% level) reported in two of the four years. However, contrary to expectations, the selling and administrative expenses to sales ratio (SGA/S) turned out to be higher for the IT leaders than for the control sample, although it did not attain significance in any of the years. Although contrary to the hypothesis, the results for selling and administrative expenses ratio is in line with the results reported in a recent study that examined the association between IT spending and cost ratios (Mitra and Chaya 1996). The study found that high IT spenders typically incurred higher overhead costs per unit of output and, therefore, had higher than average SGA expenses.

Qualitative Evidence of IT Capability

In an attempt to further validate the sample of IT leaders and to understand the nature of their IT capability, a search of the Dow Jones business database was conducted for articles describing the IT initiatives undertaken by the sample firms during the period 1991 through 1994. Several articles relating to various aspects of the target firms' IT policies, their introduction of new technologies, and other general assessments of their IT capability were found. Table 4 presents some exemplars from these articles, identifying the underlying IT resources that are indicated in the example. The evidence from these exemplars serves as additional indicators of the firms' strengths in the IT related resources identified in the paper. For example, Amoco's early initiatives in ATM technology, long before ATMs proved to be reliable or robust, is indicative of the firm's commitment to strengthen its IT infrastructure. Top management at Amoco realized that high-speed and high-capacity networks would be invaluable for a host of future applications such as seismologic modeling that would enable them to better analyze the voluminous data from oilfields and help predict the best locations for drilling. Amoco believed that these applications would help them lower the operating costs associated with surveying and drilling oil fields and thus have a tremendous impact on their bottom line. Furthermore, the experience they developed with ATM technology put Amoco's network managers way ahead on the learning curve as they learned to grapple with the new technology and integrate it with their legacy systems. Other firms that attempt to mimic Amoco would no doubt have to go through costly trial-and-error learning and face the time compression diseconomies indicated in the resource-based view.

A case study of Wal-Mart's IT initiatives provides another illustration of how the firm has honed its IT capability to the point that today IT is regarded as its core competency (Brown 1999). Wal-Mart's forays into satellite communication systems and real-time update of sales and inventory information led to a retailing revolution and entrenched them as the clear leader in the industry. Despite attempts by other retailers to copy Wal-Mart's IT systems, the firm continues its leadership position and remains solidly ahead in the learning curve on its leverage of IT. For example, while other retailers are currently experimenting with data mining technologies, Wal-Mart started doing so in the early 1990s and has already built an enormous database of purchasing information that enables them to understand what each customer buys and the relationship between the items in each customer basket. This has led to more efficient product placement in the aisles and to higher revenues per square footage in its stores (Wal-Mart Annual Report 1998).

[8]The analysis was also repeated using the non parametric sign-test, testing the null hypothesis that IT leaders do not show better financial performance when compared with the control group against the alternative that the financial performance of the IT leaders is better. The results from both tests were consistent.

Table 3. Results

	1991			1992			1993			1994		
	Mean	Median	Z Value	Mean	Median	Z Value	Mean	Median	Z Value	Mean	Median	Z Value
ROA-IT Leaders ROA-control	0.044 0.018	0.038 0.015	-2.35[a]	0.027 0.003	0.036 0.008	-2.19[b]	0.037 0.020	0.035 0.018	-1.87[b]	0.053 0.035	0.048 0.028	-2.38[a]
ROS-IT Leaders ROS-control	0.052 0.022	0.054 0.22	-2.76[a]	0.036 0.008	0.035 0.016	-2.10[b]	0.054 0.029	0.048 0.024	-2.11[b]	0.07 0.051	0.06 0.034	-2.54[a]
OI/A-IT Leaders OI/A-control	0.137 0.107	0.148 0.107	-2.20[b]	0.140 0.104	0.150 0.099	-2.47[a]	0.145 0.109	0.148 0.149	-2.79[a]	0.147 0.117	0.147 0.115	-2.53[a]
OI/S-IT Leaders OI/S-control	0.175 0.138	0.153 0.110	-2.21[b]	0.182 0.143	0.142 0.107	-2.21[b]	0.20 0.151	0.16 0.109	-2.81[a]	0.20 0.163	0.17 0.130	-2.09[b]
OI/E-IT Leaders OI/E-control	37.18 33.51	27.17 19.83	-1.31[c]	39.62 33.41	31.79 19.82	-1.32[c]	47.18 30.19	35.05 21.98	-1.41[c]	53.94 46.44	43.14 28.43	1.45[c]
COG/S-IT Leaders COG/S-control	0.67 0.70	0.67 0.72	1.37[c]	0.66 0.70	0.67 0.72	1.16	0.64 0.69	0.63 0.72	1.77[c]	0.64 0.67	0.66 0.71	1.14
SGA/S-IT Leaders SGA/S-control	0.22 0.21	0.22 0.21	-0.75	0.23 0.21	0.23 0.21	-0.85	0.22 0.211	0.23 0.19	-0.88[c]	0.22 0.44	0.22 0.21	0.60
OPEXP/S-IT Leaders OPEXP/S-control	0.84 0.874	0.85 0.89	2.16[b]	0.83 0.86	0.86 0.897	2.15[b]	0.814 0.865	0.840 0.897	2.73[a]	0.81 0.855	0.840 0.887	-2.49[a]

RO—return on assets; ROS—return on sales; OI/A—operating income to assets; OI/S—operating income to sales; OI/E—operating income to employees; COG/S—cost of goods sold to sales; SGA/S—selling and general administration expense; OPEXP/S—operating expense to sales.

[a]1% level
[b]5% level
[c]10% level

Table 4. Case Exemplars of IT Leaders

Case Exemplars	IT Infrastructure Resources	Human IT Resources	IT-Enabled Intangibles
In 1994 Amoco Corporation embarked on a trial of Asynchronous Transfer Mode (ATM) technology spanning the gamut from group LAN's to global WAN's (Wexler 1994).	• By investing in this technology long before ATMs were commercially deployable or robust technologies, Amoco put itself ahead of other firms in the learning curve and could move much faster on deploying applications such as seismologic modeling that generated gigabits of data.	• Network managers at Amoco learned to blend ATM technologies with their existing smart hubs, routers, and multiplexers, helping them unearth the ramifications of blending older equipment with next-generation products. • Rapid learning and experience with new technologies allowed Amoco to further build on their IT skills and launch innovative applications such as seismologic modeling. These applications help Amoco reduce the number of crews it deploys to drill and survey in the oil field, which are extremely costly operations in the oil business.	
In 1993 Banc One was the first bank to introduce a system for retail banking (Kindell 1993).	• Banc One's computer system became the genesis of a steady stream of portable new services.		• They introduced the first system for retail banking that links all of a customer's account information, so that its bankers can easily spot opportunities to sell additional products and services to its customers. • It is on the customer side that Banc One continues to innovate. Having pioneered the use of credit cards, the bank has gone on to design systems to make them more flexible.

Table 4. Continued

Case Exemplars	IT Infrastructure Resources	Human IT Resources	IT-Enabled Intangibles
In early 1992, Federal Express Corporation introduced a hand-held device that allowed its couriers to generate optically scanable zip code labels indicating the destination for packages (Hawkins 1992).	• Federal Express' IT infrastructure provided the integrated database and high speed network transmission capabilities required for the hand-held process innovation to succeed. Based on their infrastructure strength, they were able to be the pioneer in the introduction of the hand-held scanning technology.		• The process innovation manifested in better service quality (faster and more reliable service) by speeding up the sorting process at their hub locations and cutting down on the number of misrouted packages.
Since the late 1980s, Wal-Mart has been a pioneer in the introduction and aggressive use of IT for competitive advantage. Several unique IT resources have accrued over this time that allows Wal-Mart to continue as an IT leader, despite similar investments in technology by other retailers.	• The Wal-Mart satellite network supporting data, voice, and video paved the way for real-time update of sales and inventory information. • The Wal-Mart EDI systems resulted in electronic issuance of purchase orders and invoices with all of the chain's vendors. • The Wal-Mart retail-link network allows vendors to access POS, forecasting, and inventory management data realtime.		• "For some time now, Wal-Mart has been at the vanguard of an industry trend toward tracking products in finer detail for purposes of market analysis" (as quoted in Horwitt 1993). • "Wal-Mart is four to five years ahead of competition in implementing continuous replenishment systems, in which stores send orders for new merchandise as soon as customers take it out of the door" (quoted in Horwitt 1993).

Discussion

The purpose of this study was to draw on the resource-based view of the firm to explicate the nature of a firm's IT capability and its relationship to firm performance. This study contributes to the growing body of literature linking IT and the resource-based view and provides a framework for understanding how IT may be appropriately viewed as an organizational capability. More importantly, it is one of the first studies to provide an empirical test of the resource-based view of IT. The study provides a three-fold identification of IT resources in terms of IT infrastructure, human IT skills, and IT-enabled intangibles and develops the notion of IT as an organizational capability created by the synergistic combination of IT resources copresent with other organizational resources and capabilities. The empirical analysis examines the association between superior IT capability and superior firm performance and finds the relationship to be positive and significant.

Viewed from a resource-based perspective, the empirical findings indicate that IT capability is rent generating resource that is not easily imitated or substituted. Isolating mechanisms such as time compression diseconomies, connectedness of resources, and social complexity allow firms with high IT capability to achieve and sustain superior performance. The analysis suggests that IT-resources not only take time to acquire and build, but also highlights the difficulties raised by complementary resources and resource-embeddedness. As Wal-Mart's CIO points out,

> [C]ombine these [Wal-Mart's] information systems with our logistics, our hub-and-spoke system in which distribution centers are placed within a day's truck run of the stores, and all the pieces fall into place for the ability to respond to the needs of our customer, even before they are in the store. (Wal-Mart Annual Report 1998)

Thus, the firm's IT, logistics, and distribution systems, combined with a strong customer orientation, creates a set of complementary resources that are not easily matched by rival firms.

Results from this study also serve to inform the debate about the business value of IT. It suggests that the inconsistent statistical findings about the relationship between IT and firm performance may be attributed to our incomplete understanding of the nature of a firm's IT resources and skills and to the fact that IT investment dollars serves as a poor surrogate for assessing a firm's IT intensiveness. For example, the finding that IT investments and firm profitability are uncorrelated, or even negatively correlated, may be due to the fact that despite high investments in IT, not all firms are successful in creating an effective IT capability. Given the complexity associated with creating a firm wide IT capability, in any sample of IT spenders, only a small subset of the sample is likely to have the right IT resources in place for achieving competitive advantage. Other firms are more likely to have incurred the expenses of IT without comparative parity in IT capability. Mean returns to IT spending for the total sample may therefore be non-significant or even slightly negative as reported in Hitt and Brynjolfsson (1996). Even studies that have employed other measures of IT intensiveness such as the total number of systems and number of specific hardware systems such as point-of-sale systems, etc. (c.f. Powell and Dent-Micallef 1996) typically use extent of automation as an indicator of a firm's IT resources. In contrast, this paper argues that IT capability is a socially complex organizational capability that can only be imperfectly imitated by competitors due to isolation mechanisms such as time compression diseconomies, causal ambiguity, and path dependencies. As noted by Henderson and Venkatraman (1993), IT capability is not so much a specific set of sophisticated technological functionalities as it is an enterprise-wide capability to leverage technology to differentiate from competition. A firm's IT capability derives from underlying strengths in IT infrastructure, human IT resources, and IT-enabled intangibles. The IT infrastructure provides the platform to launch innovative IT applications faster than the competition; the human IT resources enable firms to conceive of and implement such applications faster than competition; and a focus on IT-enabled intangibles enables firms to leverage or exploit pre-existing organizational intangibles such as customer orientation and synergy in the firm via copresence and complimentarity.

This study thus contributes to the IT business value literature by providing empirical support for the relationship between superior IT capability and firm performance. In particular, the finding that IT leaders have significantly higher income ratios when compared to a well-matched control portfolio of firms indicates that IT leader firms do not necessarily have a cost focus, but tend to exploit IT for generating superior revenues. Related to this, the finding that the SGA/S ratio is higher for the leader sample provides further evidence that an IT capability may be developed and sustained even at higher costs, if the additional costs are more than offset by increased revenues.

Managerial Implications

By establishing the link between IT capability and superior firm performance, the study serves to inform business managers that firms should do much more than merely invest in IT. They should identify ways to create a firm-wide IT capability. Through theoretical arguments and practical examples, this study shows why building such a capability is complex and requires time and effort. For business managers, however, there is little by way of guidance for developing IT capability, although more recently, an increasing number of studies have begun to address this issue. For example, Rockart et al. (1996) present eight imperatives representing a combination of organizational arrangements and target achievements for IS organizations desirous of building an overall IT capability. Similarly Ross et al. (1996) identify a strong IT staff, a reusable technology base, and a flourishing partnership between IT and business management as prerequisites for strong IT capability. Feeny and Willcocks (1998) identify nine core IS capabilities—*leadership, business systems thinking, relationship building, architecture planning, making technology work, informed buying, contract facilitation, contract monitoring*, and *vendor development*—as the primary core activities that need to be effectively managed for overall IT capability.

The first step toward building any strong organizational capability is self-assessment, which requires firms to assess their own strengths and weaknesses. To identify and appraise a firm's IT capability, managers must look broadly and deeply. This study has relied on external peer evaluations of IT capability and used the IW ranking as a measure of an organization's IT capability. Perhaps managers would do well to compare themselves to other firms in their industry that get ranked as IT leaders and understand the nature and scope of their IT resources. It is also critical to develop quantifiable measures of performance that permit inter-firm comparisons. For example, Keen's (1991) *reach* and *range* framework can be used to develop quantifiable measures of a firm's IT infrastructure. Likewise, Sambamurthy and Zmud (1992), in a study of IT management competencies, provide measures for assessing the managerial IT competencies of firms.

Benchmarking can also play an important role in upgrading organizational capabilities. Firms should identify activities or functions that need improving and then identify companies that are world leaders in those activities. For example, the Norwegian firm, Compass Analysis, has built comparative models to measure effectiveness for a range of IT functions, such as data center networks, application development, and outsourcing. It collects measurements based on actual results and uses it to generate qualitative information that can be compared with data from other companies (Manchester 1998).

Finally, the leverage of IT capability for competitive advantage is contingent on the sustenance and enhancement investments that firms have to make. Realistically, competing firms are likely to strive to bridge the resource and skill gaps that place them at a disadvantage relative to competition (Bharadwaj et al. 1993). In practice, however, firms fall into "rigidity traps" and face enormous organizational barriers in their efforts to change. For example, in his study of large financial service companies in the U.K. Watkins (1998) found that the established firms felt encumbered by their massive and rigid technological infrastructures of the previous decades, but could not quickly convert to new systems due to cost pressures. Additionally, the IT staff in these organizations had a vested interest in preserving the legacy systems and resisted organizational change. IT resources that were once valuable to these firms had been rendered obsolete and created a competitive disadvantage.

Limitations and Future Research

The study uses external rankings of IT leaders as an indicator of superior IT capability. An earlier section of the paper discusses some of the limitations of such rankings and the steps taken to alleviate some of the inherent potential biases. However, a more critical concern is that the rankings are not based on objective evaluations of a firm's underlying IT resources. As noted earlier, future research should focus on developing better metrics for evaluating IT resources. Some of the published IS literature provides a good starting point. For example, Sethi and King's (1994) CAPITA scale captures the extent to which an individual IT application confers competitive advantage. Likewise scales such as the SERVQUAL (Parasuraman et al. 1988, 1991) help in determining the quality of information systems services, an important determinant of overall IT effectiveness (Pitt et al. 1995). Further research in the development and use of such measures will aid in inventorying and measuring an organization's IT resources and capabilities.

Another limitation that warrants mention is the selection of the control sample. Despite attempts to match the control sample to the treatment sample based on industry type and firm size (level of sales), for some of the firms in the leader sample, an appropriate control firm of similar size could not be found at the 4-digit SIC level. Consequently a corresponding two digit or three digit match had to be made for these firms. However, separate analyses with the subset of four digit matches did not yield any significant difference in results. Finally, our lack of knowledge about the IT capability of the control sample precludes any direct comparison of the two groups on the nature and quality of their IT resources.

The limitations listed above suggest avenues for additional research. Although the analysis indicates that superior IT capability leads to improved firm performance, the underlying mechanisms through which this is achieved are by no means clear. Additional research is needed to identify the full chain of variables connecting IT capability to firm performance. The notion of IT as an organizational capability itself needs more attention and a model for examining and classifying the IT capability of firms based on the quality of their IT resources and skills must be developed. Such a model can then be related to measures of firm performance and the specific IT resources and skills most strongly associated with superior performance can be identified.

Studies adopting a more longitudinal focus are also essential to understand why some firms are better at converting their IT investments into superior IT- capability. A search to identify the most important IT resources and skills is essentially a search to understand the nature of superior IT performance. Such studies will yield insights into the exact nature of IT resources, how they develop and evolve in a firm, and how they can be leveraged for superior profit performance.

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Appendix A

List of IT Leaders and Control Sample of Firms

LEADER SAMPLE			CONTROL SAMPLE		
COMPANY	SIC	INDUSTRY DESCRIPTION	COMPANY	SIC	INDUSTRY DESCRIPTION
MINNESOTA MINING & MFG	2670	CONVRT PAPR	INTL PAPER CO	2600	PAPER AND ALLIED PRODUCTS
GANNETT CO	2711	NEWSPAPER PUBG	TIMES MIRROR COMPANY	2711	NEWSPAPER PUBG
MONSANTO CO	2800	CHEMICALS & ALLIED PRODUCTS	BAYER A G -SPON ADR	2800	CHEMICALS & ALLIED PRODUCTS
DU PONT (E I) DE NEMOU	2820	PLASTICS	AKZO NOBEL NV -ADR	2800	CHEMICALS & ALLIED PRODUCTS
DOW CHEMICAL	2821	PLASTICS	RHONE-POULENC SA -ADR	2800	CHEMICALS & ALLIED PRODUCTS
LILLY (ELI) & CO	2834	PHARMACEUTICAL PREPARATIONS	IMPERIAL CHEM INDS PLC	2800	CHEMICALS & ALLIED PRODUCTS
ABBOTT LABORATORIES	2834	PHARMACEUTICAL PREPARATIONS	ROCHE HOLDINGS LTD -S	2834	PHARMACEUTICAL PREPARATIONS
MERCK & CO	2834	PHARMACEUTICAL PREPARATIONS	WARNER-LAMBERT CO	2834	PHARMACEUTICAL PREPARATIONS
PROCTER & GAMBLE CO	2840	SOAP	AMERICAN HOME PRODUCTS	2834	PHARMACEUTICAL PREPARATIONS
USX CORP-CONSOLIDATED	2911	PETROLEUM REFINING	ATLANTIC RICHFIELD CO	2911	PETROLEUM REFINING
AMOCO CO	2911	PETROLEUM REFINING	SHELL OIL CO	2911	PETROLEUM REFINING
CHEVRON CORP	2911	PETROLEUM REFINING	TEXACO INC	2911	PETROLEUM REFINING
CORNING INC	3220	GLASS	OWENS-ILLINOIS INC	3221	GLASS CONTAINERS
DEERE & CO	3523	FARM MACHINERY AND EQUIPMENT	DRESSER INDUSTRIES INC	3510	ENGINES AND TURBINES

Appendix A. Continued

LEADER SAMPLE			CONTROL SAMPLE		
CATERPILLAR INC	3531	CONSTRUCTION MACHINERY & EQ	DEERE & CO-PRE FASB	3523	FARM MACHINERY AND EQUIPMENT
BLACK & DECKER CORP	3540	METALWORKING MACHINERY & EQ	KOMATSU LTD -ADR	3531	CONSTRUCTION MACHINERY & EQ
HEWLETT-PACKARD CO	3570	COMPUTER & OFFICE EQUIPMENT	INGERSOLL-RAND CO	3560	GENERAL INDUSTRIAL MACH & EQ
INTL BUSINESS MACHINES	3570	COMPUTER & OFFICE EQUIPMENT	DIGITAL EQUIPMENT	3570	COMPUTER & OFFICE EQUIPMENT
SUN MICROSYSTEMS INC	3571	ELECTRONIC COMPUTERS	HITACHI LTD -ADR	3570	COMPUTER & OFFICE EQUIPMENT
GENERAL ELECTRIC CO	3600	ELECTRICAL	SIEMENS A G -ADR	3600	ELECTRICAL
TEXAS INSTRUMENTS INC	3674	SEMICONDUCTOR	NORTHERN TELECOM LTD	3661	TELE & TELEGRAPH APPARATUS
FORD MOTOR CO	3711	MOTOR VEHICLES & CAR BODIES	GENERAL MOTORS CORP-PR	3711	MOTOR VEHICLES & CAR BODIES
ALLIEDSIGNAL INC	3724	AIRCRAFT ENGINE	UNITED TECHNOLOGIES CO	3724	AIRCRAFT ENGINE
LOCKHEED MARTIN CORP	3760	GUIDED MISSILES & SPACE VEHC	THOMSON CSF -ADR	3812	NAVIGATION EQUIPMENT
NORTHROP GRUMMAN CORP	3812	NAVIGATION EQUIPMENT	RAYTHEON CO	3812	NAVIGATION EQUIPMENT
UNION PACIFIC CORP	4011	RAILROADS	BURLINGTON NORTHERN RR	4011	RAILROADS
CSX CORP	4011	RAILROADS	CANADIAN PACIFIC LTD	4011	RAILROADS
UNITED PARCEL SERVICE	4210	TRUCKING	CALIBER SYSTEMS INC	4210	TRUCKING
ROADWAY EXPRESS INC/DE	4213	TRUCKING	YELLOW CORP	4213	TRUCKING
FEDERAL EXPRESS CORP	4513	AIR COURIER SERVICES	NORTHWEST AIRLINES COR	4512	AIR TRANSPORT
SPRINT CORP	4813	PHONE COMM EX RADIOTELEPHONE	U S WEST -CONSOLIDATE	4813	PHONE COMM EX RADIOTELEPHONE
MCI COMMUNICATIONS	4813	PHONE COMM EX RADIOTELEPHONE	AMERITECH CORP	4813	PHONE COMM EX RADIOTELEPHONE

Appendix A. Continued

LEADER SAMPLE			CONTROL SAMPLE		
BELL ATLANTIC CORP	4813	PHONE COMM EX RADIOTELEPHONE	NYNEX CORP	4813	PHONE COMM EX RADIOTELEPHONE
AT&T CORP	4813	PHONE COMM EX RADIOTELEPHONE	NIPPON TELEGRPH & TELE	4813	PHONE COMM EX RADIOTELEPHONE
ENTERGY CORP	4911	ELECTRIC SERVICES	POWERGEN PLC -SPON AD	4911	ELECTRIC SERVICES
SOUTHERN CO	4911	ELECTRIC SERVICES	EDISON INTERNATIONAL	4911	ELECTRIC SERVICES
PG&E CORP	4931	ELECTRIC & OTHER SERV COMB	COASTAL CORP	4922	NATURAL GAS TRANSMISSION
HOME DEPOT INC	5211	LUMBER & OTH BLDG MATL-RETL	LOWES COS	5211	LUMBER & OTH BLDG MATL-RETL
DILLARDS INC -CL A	5311	DEPARTMENT STORES	MONTGOMERY WARD HLDG	5311	DEPARTMENT STORES
DAYTON HUDSON CORP	5331	VARIETY STORES	PENNEY (J C) CO	5311	DEPARTMENT STORES
K MART CORP	5331	VARIETY STORES	ITO YOKADO CO LTD -AD	5311	DEPARTMENT STORES
WAL-MART STORES	5331	VARIETY STORES	SEARS ROEBUCK & CO	5311	DEPARTMENT STORES
WALGREEN CO	5912	DRUG & PROPRIETARY STORES	RITE AID CORP	5912	DRUG & PROPRIETARY STORES
TOYS R US INC	5945	HOBBY	CVS CORP	5912	DRUG & PROPRIETARY STORES
WACHOVIA CORP	6021	NATIONAL COMMERCIAL BANKS	FIRST CHICAGO NBD CORP	6021	NATIONAL COMMERCIAL BANKS
BANC ONE CORP	6021	NATIONAL COMMERCIAL BANKS	BANKBOSTON CORP	6021	NATIONAL COMMERCIAL BANKS
NORWEST CORP	6021	NATIONAL COMMERCIAL BANKS	WELLS FARGO & CO	6021	NATIONAL COMMERCIAL BANKS
BANKAMERICA CORP	6021	NATIONAL COMMERCIAL BANKS	NATIONSBANK CORP	6021	NATIONAL COMMERCIAL BANKS
CITICORP	6021	NATIONAL COMMERCIAL BANKS	BANK TOKYO-MITSUBISHI	6029	COMMERCIAL BANKS
MERRILL LYNCH & CO	6211	SECURITY BROKERS & DEALERS	SHEARSON LEHMAN BROS H	6211	SECURITY BROKERS & DEALERS
AETNA INC	6321	ACCIDENT & HEALTH INSURANCE	BAT INDS PLC -SPON AD	6311	LIFE INSURANCE
TRAVELERS CORP	6331	FIRE,MARINE&CASUALTY INS.	CNA FINANCIAL CORP	6331	FIRE,MARINE&CASUALTY INS.
CIGNA CORP	6331	FIRE,MARINE&CASUALTY INS.	AMERICAN INTERNATIONAL	6331	FIRE,MARINE&CASUALTY INS.