Information Technology and Firm Profitability in Network Environments

Yucong Liu
Mansfield University of Pennsylvania
yliu@mansfield.edu

Younghwa Lee
University of Northern Iowa
gabe.lee@uni.edu

Andrew Chen
University of Kansas
andrewchen@ku.edu

ABSTRACT
Despite prolific research on IT business value, this stream of research still encounters considerable limitations such as inconsistent findings of the direct link between IT and firm profitability and the demonstration of the indirect relationship between IT and specific aspects of firm value without explicitly considering network environments. To overcome the limitations caused by utilizing the static and narrow definition of IT and investigating firm profitability in a secular business environment, this study adopts the dynamic capability theory to propose the concept of dynamic IT capability and tests its impact on firm profitability under networked environments. We tested research hypotheses by collecting secondary data of 26 companies across 19 industries during 1994-2008 and analyzing data using a multilevel modeling technique. The initial data analyses showed strong supports on dynamic IT capability’s direct and significant impact on firm profitability. It also was found that dynamic IT capability significantly interacted with network factors such as centrality and structural holes.

Keywords
Dynamic IT Capability, IT Business Value, Network Environments, Firm Profitability.

INTRODUCTION
The information systems research community has accumulated a rich literature of information technology (IT) business value studies (Shaft, Zmud and Dao, 2007). While these studies provide valuable insights on different aspects of IT business value, this stream of research still encounters considerable limitations. First, previous IT business value studies have not consistently demonstrated a clear, strong direct link between IT and firm profitability. The lack of such empirical evidence has made some researchers and practitioners believe that no such significant and direct link exists (Joshi, Chi, Datta and Han, 2010). Second, extant studies mostly focus on whether IT creates business value and demonstrate indirect relationships between IT and some aspects of firm value; however, the question of why and how IT can do so remains unanswered (Kohli and Grover, 2008) especially in today’s network environment. This study intends to address two plausible drawbacks of previous IT business value research: (1) the static and isolated definition of IT based on resource-based view (RBV) rather than the dynamic and holistic definition based on dynamic IT capability view, and (2) the investigation of firm profitability assuming a secular business environment rather than networked environment.

Based on resource-based view (Barney, 1991), past studies mostly considered IT resources (e.g., IT infrastructure, human IT resources, and IT-enabled intangibles (Bharadwaj, 2000)) as a measure of IT and examine their influence on firm profitability. Despite its significance, RBV might not adequately explain how and why firms own certain IT resources for competitive advantage. It also did not explain mechanisms through which IT resources actually contribute to firm profitability (Eisenhardt and Martin, 2000). Therefore, this study proposes the concept of dynamic IT capability based on the dynamic capability theory (Teece, Pisano and Shuen, 1997) and examines its impact on firm profitability. In essence, dynamic IT capability is the combination and integration of IT resources and business process. It focuses on the use of IT resources rather than the resources themselves or so-called IT-enabled resources owned by a firm. That is, dynamic IT capability is derived from the process of dynamically building, integrating, and upgrading IT resources to shape and reengineer business processes continuously. Therefore, dynamic IT capability explains the impact of IT resources as demonstrated in improved or enhanced business processes. With this definition of dynamic IT capability representing “IT”, we hypothesize that there exists a direct relationship between IT and firm profitability.
To be successful, an organization which operates in today’s networked economy relies on not only its own capability but also increasingly supports from its connected entities (e.g., suppliers and other companies with strategic alliance). However, previous research has mostly been conducted without explicitly considering the effects of networked business environment. In order to fully investigate IT business value, IS researchers need to incorporate network factors for examining the impact of IT in networked environment, primarily focused on interaction between IT and network structures. For example, Chi and her colleagues (2010a; 2010b) examined the influence of interactions between IT and network structures (e.g., network density and structural hole) on firm performance (e.g., competitive action and firm innovation) and found interesting results. In the same vein, we believe that the interaction between dynamic IT capability and network structures should be examined to capture IT business value in network environments.

In this study, we refer to dynamic capability theory and network concept as the bases to address the effects of dynamic IT capability and network structures on firm probability. In general, dynamic capability focuses on the internal capabilities that a firm integrates, builds and reconfigures internal and external resources to address rapidly changing environments (Teece et al., 1997) and claims itself as a necessary condition of competition in dynamic environments. Meanwhile, network structure represents an external environment consisting of stakeholders’ capabilities and a firm’s position in and interaction with the networks can influence firm profitability (Buytendijk, 2009). Occupying an advantaged position in networks and improving dynamic capabilities are two strategies that firms can adopt for achieving better performance in such environments.

Given this background, the research questions of this study are: (1) Can dynamic IT capability of a firm contribute directly to firm profitability? (2) What are the effects of network structures of a firm on the direct link between dynamic IT capability and firm profitability?

THEORETICAL BACKGROUND

Traditionally, IT business value research focuses on the economic value such as reducing costs or differentiating products or services that are derived from IT (Mata, Fuerst and Barney, 1995). The general conclusion is that IT can add value to firms in a wide variety of circumstances. However, past research either focused on the periphery of IT (such as business experience and relationship) or provided inconsistent findings, prompting us to further investigate the relationship in a different perspective.

Dynamic IT Capability

IT capability has become one of the most popular perspectives to explain IT business value since 2000 when Bharadwaj’s widely cited paper was published. In her pioneering work, Bharadwaj (2000) explicitly distinguished resources from capabilities. According to her, resources include tangible (e.g., financial capital, plant and equipment), intangible (e.g., reputation, brand image, and product quality), and personnel-based resources (e.g., technical know-how). On the other hand, capabilities refer to the ability to assemble, integrate and deploy resources. Capability is treated as the ability to use resources. Although it cannot contribute to competitive advantages alone (Eisenhardt and Martin, 2000), the ability to use resources should be treated as important, if not more, as owning resources. In addition, capability involves both using and generating resources and thus expects to play a critical role in firm profitability because companies should renew, combine, and integrate their resources in a dynamic process to adapt to changes in environment.

We believe that distinguishing IT capability from IT resource is important for meaningfully capturing IT business value in light of that numerous studies failed to demonstrate the direct effects of IT resources on firm profitability. While it is understandable that the ability to use IT could be included as a type of IT resources, which tend to focus on owning rather than using IT. Recent studies have started to emphasize the importance of using IT instead of merely owning IT on capturing IT business value and have provided significant findings. For example, Ravichandran and Lertwongsatien (2005) found that variation in firm performance is explained by the ability to use IT. Pavlou and Sawy (2006) revealed that the ability to effectively use IT is related to competitive advantage. Santhanam and Hartono (2003) disclosed that firms with distinguishing ability to use IT enjoy superior firm profitability. We think that distinguishing IT capability from IT resource is a solid step to focus on using, rather than owning IT.

Further, in the same vein with Bharadwaj’s definition of IT capability, dynamic IT capability, as a type of dynamic capability, emphasizes on the use of IT resources to support and improve business processes in a dynamic and continuous manner. The extension of IT capability to dynamic IT capability, just as the extension of RBV to dynamic capability theory, is intended to benefit IT business value research from two aspects. First, to create business value, IT resources should be in a continuous process of building, updating, and integrating. This aspect emphasizes that the ownership of IT resources is never an end goal; therefore, companies have to focus on using IT for creating business values. Second, IT resources should be
used to improve business processes. This aspect explains that IT resources contribute to firm profitability in routine business processes, rather by owning IT resources themselves. The two aspects emphasized in the definition of dynamic IT capability converge with recent IT business research.

For example, in their framework to explain IT business value, Sambamurthy and his colleagues (2003) argue that IT should be used to enable agility, which is defined as the ability to seize opportunities by assembling all kinds of resources in dynamic environments. Xiao and Dasgupta (2009) claim that dynamic IT capability is a valid and reliable measure of IT and believe that dynamic IT capability may explain firm performance. In addition, researchers have found that some catalysts through which IT resources affect business processes, such as top management support (Powell and Dent-Micallef, 1997) and the relationships between IT unit and other business departments (Ravichandran and Lertwongsatien, 2005), are positively related to firm performance. We believe that the essence under these phenomena is how IT is used to support business processes.

Network Environments

The roles of network in economic activities attract much attention from both researchers and practitioners over the past two decades (Smith-Doerr and Powell, 2003). In practice, “networking among companies is now in fashion all over the world” (Harrison 1994). Correspondingly, there is an exponential increase in network research (Borgatti and Foster, 2003). Researchers have pointed out three major reasons for the increased interest in the concept of network: the emergence of the “New Competition”, the emergence of new information technologies, and the maturing of network analysis as an academic discipline and a legitimate mainstream perspective (Piore, 1992). The “New Competition” refers to the competitive rise of small entrepreneurial firms, of regional districts, of new industries such as computers and biotechnology, and of Asian economies such as Japan, Korea, and Taiwan, and is supposed to use a lateral and horizontal network as a model of organizations (Nohria, 1992). Information technology provides a platform and makes it possible for firms to achieve disaggregated, distributed, and flexible production arrangements, as well as organize their internal operations in efficient ways (Piore, 1992).

Recent network research often focuses on structural characteristics, such as network centrality (Tsai, 2001) and structural holes (Shipilov, 2009). Along the same vein, IS studies recently investigated influence of network structures including how the use of inter-organizational systems influences the structuring network position of companies (e.g., centrality) (Chi, Holsapple and Srinivasan, 2008); how IT-enabled knowledge capabilities interact with alliance network structure to influence firm innovation (Joshi et al., 2010); and how IT-enabled capability interacts with alliance network structures (e.g., structural holes) to influence firm competitive actions (Chi et al., 2010b). Believing the significance of network structure of a firm, this study investigates its impact on the relationship between dynamic IT capability and firm profitability.

RESEARCH MODEL AND HYPOTHESES

Figure 1 presents the research model for this study. By adopting the concept of dynamic IT capability, this study proposes the direct influence of dynamic IT capability on firm profitability in network environments. In addition, this study argues that the interaction between dynamic IT capability and network structures will influence firm profitability.

![Figure 1. Research Model](image-url)

Dynamic capabilities theory posits that a firm has to continuously integrate, build, and reconfigure internal and external resources to address rapidly changing environments. This is especially true for IT resources. As IT continuously advances,
companies are seeing the emergence of all kinds of new technologies, such as Web 3.0, virtualization, and cloud computing and obtaining more and more powerful computing capability. It is hard to imagine that a firm can continually perform well without making use of new IT now and in the future as innovative IT emerges. Owning a technology, however, is not the purpose, no matter it is new or old. Technology should be used for creating values to companies. On the other hand, a firm not only can adopt new IT to improve business processes, but also need to upgrade or integrate existing IT resources, such as developing middleware to connect old mainframe-based applications with new web-based applications to deliver new services. If the consequences of using technologies are not associated with improvements on business processes, a firm cannot possess superior dynamic IT capability, resulting in poor value creation and firm profitability.

This study expands this concept of IT capability into dynamic IT capability by emphasizing that IT resources are in a dynamic process of building, integrating, and upgrading and must be used to improve business processes and create business value. This argument is supported by the findings of recent studies. For example, Bharadwaj (2000) and Santhanam and Hartono (2003) found that IT capability, which is defined as use of IT resources, is directly associated with superior firm profitability. Bhatt and Grover (2005) demonstrates that IT business expertise and the relationship with other business units are related to competitive advantages and stresses the importance of using IT to serve business needs. Ravichandran and Lertwongsatien (2005) also indicates that firm performance depends on the ability to use IT to support and enhance firm competencies. Given this, we predict that dynamic IT capability contributes to firm profitability with improved or enhanced business processes. Therefore, we hypothesize that:

H1. Dynamic IT capability is positively related to firm profitability.

The relationship between network structures and IT is still vague in existing studies. There are early tempt trying to establish causality between them. But it is clear that each can exist independently. It is also straight that they can facilitate each other as we have seen that IT makes people and companies connected more easily than ever. Thereby, previous studies suggest that the linkages between IT capabilities and firm performance should be considered in a dynamic environment (Lee, 2006). However, they have demonstrated that the interaction between IT and network environments is complicated and even contradictory (Chi et al., 2010a).

Despite the limited empirical findings from existing studies, the relationship between IT and network structures can construe from a perspective of dynamic IT capability. As defined earlier, dynamic IT capability is a kind of dynamic capability, which is favorable in dynamic environments. On the other side, networks emerge as a weapon to compete in dynamic environments (Gulati, 1998). Thus, the existence of some relationships between them seems to be intuitive. To explore such relationships, we argue that dynamic IT capability represents the ability of a firm to use IT resources for competition in dynamic environments. Meanwhile, network structures present the opportunities of a firm in network environments to access resources. The relationship between dynamic IT capability and network structures is demonstrated in the picture where both internal capabilities and external opportunities are needed to improve firm profitability in dynamic environments.

As a continual effort to enrich our understanding of the network effect on firm profitability, this study adopts two key network structure properties, network centrality and structural holes, and investigates how they interact with Dynamic IT capability in regards to firm profitability. Network centrality indicates the position a firm occupies in a network. A straightforward measure of network centrality is the number of strategic alliances that a firm has in a network (i.e., degree centrality). Strategic alliances are voluntary agreements for exchange, sharing or co-development of capital, technology, or firm-specific assets (Gulati, 1995). It can be understood as the efforts of a firm to occupy a competitive position or obtain market power (Kogut, 1988). A position with higher centrality in a network makes the firm more visible for other members and provides more opportunities for access to partner’s resources. Past studies provide empirical evidences for the benefits of network centrality. For example, Powell, Koput and Smith-Doerr (1996) found that network centrality increases the growth rate of biotechnology start-ups. Baum, Calabrese and Silverman (2000) reported that biotechnology start-ups with high network centrality obtains access to diverse information and achieves high revenue growth. Thus, we propose that:

H2a: The interaction between dynamic IT capability and network centrality is positively related to firm profitability.

Unlike network centrality, structural holes, defined as bridging ties that link network actors otherwise not connected to one another (Burt, 1992), do not rely much on the number of direct connected partners in a network, but focus on nonredundant connections. According to Burt, nonredundant connections create benefits of nonredundant information and control over unconnected partners. In the context of strategic alliances, nonredundant connections provide opportunities for access to diverse resources and control over the flow of resources. In other words, resources flow not only between dyads but also over a network. Firms who occupy a position with rich structural holes can obtain access to diverse resources and also control over the flow of these resources to other members who do not have direct access to those resources. Empirical studies also provide
evidences that firms are able to extract profitability improvements from network positions rich in structural holes (Shipilov, 2009).

While structural holes provide opportunities to access and control resources, how to take use of these opportunities can depend on dynamic IT capability. Dynamic IT capability can facilitate integration and reconfiguration of internal and external resources (Xiao and Dasgupta, 2009) because it facilitates information processes and helps companies handle heterogeneous information derived from nonredundant connections (Shipilov, 2009) for necessary improvement on business processes. Thus, we propose that:

H2b: The interaction between dynamic IT capability and structural holes is positively related to firm profitability.

RESEARCH METHODOLOGY

For investigating the effect of dynamic IT capability on IT business value in network environments, this study initially identified a sample of 26 companies across 19 industries during the period of 1994-2008 (where actual data were collected through 2011 because we took the three-year moving-window of network measures). As a result, our sample size is bigger or comparable with similar studies (Chi et al., 2010a; Chi et al., 2010b). We selected public companies that (1) have been actively involved in network environments, such as having at least five strategic alliances in most recent years in the targeted study timeframe, (2) have been either leaders in their industry or included in Fortune 500 or S&P 500, (3) did not lose their identity through acquisition or merger during the targeted study timeframe, and (4) are from different industries (in order to comprise a balanced representation for our cross-industry study). We collected secondary data for dynamic IT capability from multiple data sources including InformationWeek, ComputerWorld, and eWeek.

The measure of dynamic IT capability was carefully operationalized. Traditionally, IT resources are measured by IT spending. As we discussed early, however, the focus of dynamic IT capability is using IT resources for improving business processes rather than owning IT resources. In several recent studies (Chi et al., 2010a; Joshi et al., 2010), IT capabilities are measured by IT initiatives (Table 1), which is argued as a better indicator of using IT resources. Using secondary data to assess firm IT capabilities also has been suggested as a feasible approach in a number of prior studies (Joshi et al., 2010). Another possible measure of dynamic IT capability is using survey. Such self-reported measure, however, has been criticized as biased and cannot be used for longitudinal study (Chi et al., 2010b). Thus, we adopted IT initiatives to measure dynamic IT capability with two adjustments. First, we did not accumulate IT initiatives for all years as prior IT capability studies did because we focus on a dynamic and current capability. We also excluded IT initiatives that were announced but canceled or discontinued later. Second, we mapped IT initiatives into business processes using the categories suggested by Porter (1985). This adjustment is derived from the focus on business processes defined in dynamic capability theory (Eisenhardt and Martin, 2000) and allows us to further explore the differences of IT contributions to firm profitability through different business processes.

<table>
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<th>Studies</th>
<th>Operationalization</th>
<th>Key findings</th>
<th>Contrast to current study</th>
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<tr>
<td>Bharadwaj, A. S. (2000)</td>
<td>Measured IT capability using a special category of “IT leader”</td>
<td>Firms with high IT capability tend to outperform a control sample of firms on a variety of profit and cost-based performance measures</td>
<td>Using of “IT leader” as the indicator of super IT capability is limited for practice. Enhancing dynamic IT capability with business process focus can provide better practical guidelines.</td>
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<td>Bhatt, G.D., and Grover, V. (2005)</td>
<td>Measured IT variables from the opinions of IT executives</td>
<td>1. While IT infrastructure did not have any significant effects on competitive advantage, the quality of IT business expertise and the relationship infrastructure did. 2. The intensity of organizational learning was significantly related to IT infrastructure quality, IT business expertise, and relationship infrastructure</td>
<td>This study indicates how to use IT is more important than owning IT itself. In turn, the current study intends to shows how exactly IT (i.e., dynamic IT capability) can be used with the focus of business processes.</td>
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<td>Reference</td>
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<td>Liu et al. (2010)</td>
<td>Measured IT capabilities using IT initiatives</td>
<td>Three types of IT enabled knowledge capabilities (IT-potential, IT-realized, and IT-socializing) differentially interact with structural holes to affect firms’ patent innovations.</td>
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<tr>
<td>Joshi, K.D., Chi, L., Datta, A., and Han, S. (2010)</td>
<td>Measured IT capability using IT initiatives</td>
<td>1. Knowledge capabilities enhanced through the use of IT contribute to firm innovation. 2. Different types of IT-enabled knowledge capabilities have differential effects on firm innovation.</td>
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<td>Ravichandran, T., and Lertwongsatien, C. (2005)</td>
<td>Measured IT from the opinions of IT executives</td>
<td>1. Variation in firm performance is explained by the extent to which IT is used to support and enhance a firm’s core competencies. 2. An organization’s ability to use IT to support its core competencies is dependent on IS functional capabilities, which, in turn, are dependent on the nature of human, technology, and relationship resources of the IS department.</td>
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<tr>
<td>Xiao, L., and Dasgupta, S. (2009)</td>
<td>Measured Dynamic IT capability from the opinions of IT executives</td>
<td>1. Dynamic IT capability is a valid and reliable measure of IT that may explain firm performance within the selected samples.</td>
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This study suggests that dynamic IT capability is a good measure to explain firm performance. The operationalization of dynamic IT capability, however, is mostly based on resources-based review.
Table 1. Research Stream Followed by this Study

Also, empirical evidence has indicated that the impacts of IT initiatives were observed to be characterized mostly by a one-year lag (Shaft et al., 2007); so, we used one-year lag firm profitability data in for our analysis. Another benefit of using one-year lag data is to ensure that changes in dynamic IT capability precede those in firm profitability and avoid potential endogeneity problems. To derive network structures, data about strategic alliance were collected from the SDC Platinum dataset, which is regarded as one of the most comprehensive sources of data on alliances and widely used for strategic alliance network studies (Lavie, 2007). Following prior IT business value studies on firm profitability operationalization (Santhanam and Hartono, 2003), we identified a set of firm profitability measurements as dependent variables including return on sales (ROS), return on assets (ROA), operating income to employees (OI/E), and operating expenses to sales (OPEXP/S). Data of firm profitability are collected from COMPUSTAT North America, which is a database of U.S. and Canadian financial and market information on publicly held companies. Table 2 summarizes our construct operationalizations.

Table 2. Construct Operationalization

We compared firm profitability among companies across different industries. To make these companies comparable, we used two control variables: firm size and industry dynamism. We used the number of employees to measure firm size and use the average industry R&D spending to measure industry dynamics (Joshi et al., 2010). Firm size is widely used as an important control variable in firm innovation and performance studies (Bharadwaj, 2000) as large firms can enjoy advantages such as economies of scale and scope that might not be available for smaller firms (Bhatt and Grover, 2005).

Industry dynamism describes a basic characteristic of industries. Firms located in highly dynamic industries are facing constant changes and forced to compete in different ways such as continuously innovating (Joshi et al., 2010). These control variable data were obtained from COMPUSTAT North America. We used multilevel modeling (MLM) for initial data
analysis in this study. Compared with other approaches, MLM treats clusters as if they are sampled from a larger population of clusters to enhance the generalizability of results. In other words, cluster–level effects are not estimated separately for each cluster and regression weights area assumed to have a particular distribution across clusters. Considering we collected data of companies cross multiple years, we believe that the use of MLM is appropriate to help reduce cluster effects. The statistical models used in this study are listed below.

Main effect model:
\[ y_{ij} = \beta_0 + \beta_1 \text{Year}_{ij} + \beta_2 \text{FirmSize}_i + \beta_3 \text{IndustryDynamism}_i + \beta_4 \text{DynamicITCapability}_i + e_{ij} \]

Interaction effect models:
\[ y_{ij} = \beta_0 + \beta_1 \text{Year}_{ij} + \beta_2 \text{FirmSize}_i + \beta_3 \text{IndustryDynamism}_i + \beta_4 \text{DynamicITCapability}_i + \beta_5 \text{StructureHole}_i + \beta_6 \text{DynamicITCapability}_i * \text{StructureHole}_i + e_{ij} \]
\[ y_{ij} = \beta_0 + \beta_1 \text{Year}_{ij} + \beta_2 \text{FirmSize}_i + \beta_3 \text{IndustryDynamism}_i + \beta_4 \text{DynamicITCapability}_i + \beta_5 \text{Centrality}_i + \beta_6 \text{DynamicITCapability}_i * \text{Centrality}_i + e_{ij} \]

The initial data analyses were conducted and found strong supports for Hypothesis 1 that dynamic IT capability has a direct and significant impact on firm profitability (for all four indicators – ROA, ROS, OI/E, and OPEXP/S). The initial results also indicate that dynamic IT capability significantly interacted with network centrality to influence two indicators of firm profitability (i.e., ROA and OPEXP/S) and that dynamic IT capability significantly interacted with structural holes to influence all four indicators (ROA, ROS, OI/E, and OPEXP/S).

CONCLUSIONS
The quest of IT business value has been a big concern in both IS and organizational research. Despite the common belief on the crucial role of IT on firm profitability, some scholars have argued that either there is no direct link between IT and firm profitability or even IT does not matter. The consequences of such opinions are troublesome because they can significantly discourage the enthusiasm of practitioners to embrace and justify investing in IT resources for pursuing competitive advantages. Our study aims to provide appropriate and meaningful definition of IT as dynamic IT capability and provides empirical results to clearly indicate that IT can directly contribute to firm profitability. With the reference of dynamic IT capability, we demonstrate how and where to use IT resources for business processes in order to obtain business value. We also discover that dynamic IT capability can complement network structures, such as network centrality and structural holes, to improve firm profitability. We believe that our findings can contribute to current IT business value research and provide support for practitioners to effectively use IT and achieve competitive advantages.

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