IT capability, innovation capability, and long-term performance: A research approach

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ABSTRACT
The business value of IT is a central tenet of IS research. In this regard organizational IT capabilities are identified as a significant impact factor for performance and competitive advantage. Based on the dynamic capabilities view, this paper aims at extending existent research on IT capabilities and performance by incorporating innovation capability as a substantial driver of long-term performance. However, existing research falls short in investigating these relationships over time. To address these issues, several propositions are developed to link IT capability, innovation capability and long-term performance. This work aims at revealing the interdependencies among IT and innovation capability and to shed light on the temporal effects such as lag effects between investments into IT- and innovation capability and their effect on long-term performance.

Keywords  
IT capability, innovation capability, innovativeness, dynamic capabilities view.

INTRODUCTION
The business value of information technology (IT) is an important but challenging question that occupied researcher’s interest for decades. However, there exists broad consensus today that IT creates value, but in many fields questions remain unanswered (cf. Kohli and Grover 2008).

One of the research strands dealing with the business value of IT relates to IT capabilities and their effects on organizational outcomes such as competitive advantage (Bhatt and Grover 2005; Kohli and Grover 2008). Following the question of how IT capability and business performance is linked recent research in this area has investigated the impact of IT or in particular IT capabilities on performance (Bharadwaj 2000; Santhanam and Hartono 2003) and competitive advantage (Bhatt and Grover 2005; Dehning and Stratopoulos 2003). In this context, Bharadwaj (2000, p. 171) defines an IT capability as the “ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities”. This definition points to other capabilities than IT capability that may be involved to produce business value. Wade and Hulland (2004, p. 109) support this idea and thus state that “information systems exert their influence on the firm through complementary relationships with other firm assets and capabilities”.

According to Song et al. (2005) these other capabilities can basically be split into marketing-related and technology-related capabilities where the latter refers to developing and producing technology in response to changing environments. In this paper we focus on technology-related capabilities that may be complementary to IT capability or may be at least coevolving or copresent. More specifically, we focus on innovation capability, the ability to continuously generate and implement new ideas. For decades, literature has consistently shown that superior firm performance can only be achieved by continuous innovation (e.g. Schumpeter 1934). Thus, innovation capability is an important candidate to investigate when dealing with firm performance and potentially complementary effects between IT capability and innovation capability.
Besides asking for capabilities complementary to IT capability, research simultaneously strives for longitudinal studies to distinguish between successful and failed firms over time (Tushman and Romanelli 1985) and whether investment into IT- and non-IT capital leads to sustained advantages. Furthermore, long-term studies in this field fall behind. In the same context, Bharadwaj (2000, p. 188) demanded for “studies adopting a more longitudinal focus […] to understand why some firms are better at converting their IT investments into superior IT capability”. Similarly, Wade and Hulland (2004, p. 130) state that “some effort must be made to track the dependent variable of interest over time to avoid drawing invalid conclusions about the durability and sustainability of firm resources”. To overcome the limited point of time observations, longitudinal data need to be employed to better understand the time contingent effects. Investments in capabilities have to be developed and deployed over time to generate additional benefits and obviously cannot be measured immediately but rather with a time lag.

Following the call for longitudinal studies and the call for studies that simultaneously research into IT capability and organizational capability and their effects on firm performance (Bharadwaj 2000; Lee, Lim and Wei 2004) we posit the research question:

To which extent do IT- and innovation capability together influence long-term performance?

In accordance with this research question our paper therefore focuses on the effects of capabilities excluding their antecedents from investigation. To answer the research question we draw on existent research in the fields of IT capability (Bharadwaj 2000; Dehning and Stratopoulos 2003; Santhanam and Hartono 2003) and innovation capability (e.g. Bell 2005). Based on the dynamic capabilities view, we theoretically develop propositions linking these two concepts and long-term performance outcomes. Further on, we review the existing literature to identify key measures for the different capability constructs and derive measures for our ongoing research.

This paper is organized as follows. The next section offers a brief theoretical foundation of the main concepts, followed by the development of linking propositions. Subsequently, the methodological aspects of our research are outlined. The final section concludes with the expected contribution, limitations, and managerial implications.

THEORETICAL FOUNDATION

Dynamic capabilities view (DCV)

The Dynamic Capabilities View (DCV) builds on the resource-based view (Makado 2001) and emphasizes that resources of a firm such as IT assets or business skills do not create value on their own (Grant 1991) but have to be deployed effectively to achieve positive organizational outcomes. These capabilities can then implement competitive advantages (Barney 2001, p. 647).

According to Amit and Schoemaker (1993, p. 35) capabilities “refer to a firm’s capacity to deploy resources, usually in combination, using organizational processes, to effect a desired end”. This view was extended by Teece et al. (1997) and Eisenhardt and Martin (2000) by introducing the notion of dynamic capabilities as a means of a firm to respond to changes through integrating, reconfiguring, adding, and releasing resources. Capabilities as described above can be seen as “complex bundles of skills and accumulated knowledge, exercised through organizational processes that enable firms to coordinate activities and make use of their assets” (Day 1994, p. 38). Accordingly, “developing capabilities involves organizational learning: learning how to combine and use resources, and also the learning already embedded in the organizational routines employed” (Andreu and Ciborra 1996, p. 113). Thus, capabilities involve organizational learning as both an antecedent leading to a certain state of capabilities as well as an important coevolving process, i.e. employing such capabilities in turn leads to further learning. However, in this paper we focus on the state of capabilities in certain points of time excluding learning processes from analysis.

In the following, we concentrate on two concepts that are both uniformly interpreted through the theoretical lens of the DCV: IT capability and innovation capability.

IT-Capability

Several researchers studied organizational IT capabilities and proved the importance of this concept (Bharadwaj 2000; Santhanam and Hartono 2003). Early research conceptualized the IT capability rather unilateral; either in the sense of managerial capabilities (Sambamurthy and Zmud 1997) or technological capabilities (Sabherwal and Kirs 1994). However, more contemporary research integrated these two perspectives into a more comprehensive model (Bharadwaj 2000; Bhatt and Grover 2005). Based on previous work related to organizational capabilities, the IT capability has been defined as the “ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities” (Bharadwaj 2000, p. 171). Bharadwaj (2000) hypothesized and empirically verified the influence of the IT capability on firm performance.
(i.e. higher profit ratios and lower cost ratios). More recent studies provided further evidence for the importance of the IT capability and especially for this specific relationship (e.g. Santhanam and Hartono 2003). Other studies for example investigated the effects on process agility (Tallon 2008). Nevertheless, the majority of publications focused on performance (Bharadwaj 2000) or competitive advantage (Bhatt and Grover 2005; Dehning and Stratopoulos 2003) as the dependent variable.

Innovation capability

Research on innovation dates back to seminal contributions by Schumpeter (1931, 1934, 1939) and continued to be a challenging research stream up to today. Innovations “can be defined as the successful implementation of creative ideas, tasks, or procedures” (Cummings and Kiesler 2003, p. 297) or as “the development and implementation of new ideas to solve problems” (Bell 2005, p. 288). Contrary to innovation the more recent concept of innovativeness (at the organizational level) or innovation capability relates to the ability of a firm to continuously generate and implement innovations (Bell 2005; Subramanian and Nilakanta 1996, p. 633) and “reflects a firm's tendency to engage in and support new ideas, novelty, experimentation, and creative processes that may result in new products, services, or technological processes“ (Lumpkin and Dess 1996, p. 142). This concept accounts for research that identified highly innovative organizations to perform better than less innovative ones (Dosi 1988) and the importance of innovation to enhance firm’s chances for growth and survival (Kogut and Zander 1992). Similar to research on innovativeness, a variety of scholars examined its effects on performance (Cho and Pucik 2005; Hurley and Hult 1998) and competitive advantage (Alvarez and Barney 2000).

RESEARCH MODEL

Performance

“Competitive advantage grows fundamentally out of value a firm is able to create for its buyers that exceeds the firm’s cost of creating it” (Porter 1985, p. 3) and basically can be achieved by cost leadership or differentiation. A sustainable competitive advantage is achieved when the competitive advantage persists for a longer period despite competitive activities by other firms to diminish this advantage (Griffiths and Finlay 2004). Thus sustainability is an ongoing state; competitive advantage is an outcome (Peppard and Ward 2004).

Competition among firms can be understood as the aggregated effect of competition among sets of products or services a firm offers, because purchasing decisions refers to products or services rather than to firms (Klein 2002). Thus, based on “superior” products or services a firm can achieve a relative performance plus with respect to the competitors over some period of time that is called competitive advantage (Bhatt and Grover 2005).

In this paper, the term “competitive advantage” is understood as an outcome and refers to a firm’s ability to achieve a better position than its competitors in a relevant market such as a region, for example (see e.g. Klein 2002 for an elaborated discussion). In turn, “sustained competitive advantage” refers to a firm’s ability to achieve a better market position over time.

IT capability and performance

IT capability is not merely seen as a set of technologies but as an enterprise-wide capability to leverage technology (Bharadwaj, Sambamurthy and Zmud 1999) that comprises IT infrastructure, human IT resources, and IT-enabled intangibles. Organizations that have learned to deploy their IT resources adequately can reap the benefits and outperform poorly equipped competitors. The effect of IT capabilities was underpinned by a study presented by Bharadwaj (2000) who discovered that superior IT capability was associated with significantly higher profit ratios.

Expecting this relationship to be constant over time, we propose analog to previous research (Bharadwaj 2000; Santhanam and Hartono 2003) that a sustained superior IT results in higher long-term performance.

Proposition 1: IT capability is positively related to long-term superior performance outcomes.

Innovation capability and performance

Innovation capability – the ability of firms to continuously develop and implement new ideas – is a critical success factor to generate and leverage innovations, i.e. product/service and process innovations. Innovation capability leads to improved or even radically new products and services that foster differentiation and new market entry (Srinivasan, Lilien and Rangaswamy 2002). Product innovations are a necessity to get in the lead in competition and to increase market share. Process innovations on the other hand improve operational efficiency and help to reduce costs (Persaud 2005) to generate superior performance (e.g. Dosi 1988; Sher and Yang 2005), and market value (Cho and Pucik 2005). Thus, a continuously
maintained and stable innovation capability improves internal efficiency and enables organizations to position themselves well in the competitive environment.

Proposition 2: Innovation capability is positively related to long-term superior performance outcomes.

**IT capability and innovation capability**

IT affects the feasibility and cost of technology-based business innovations, and a firm’s ability to refine or reengineer business systems (Duncan 1995, p. 43). Accordingly, several studies identified the effect of IT capability on innovations. Barua et al. (1995) found that IT capital and IT applied to R&D positively influences new products. DeLone and McLean (1992) show how system quality and information quality ultimately produce organizational impacts such as innovations. Mooney et al. (1996, p. 73) considers IT to be an enabler of process innovation, on the one hand, while process innovation is considered to be a catalyst for the realization of the business value of IT. Innovations may also occur when “the uses of IT affect either business functions or core business processes of the organization” (Lyttinen and Rose 2003, p. 561). Furthermore, investing strategically in IT may reposition firms by “by supporting entry into a new market or the development of new products, services, or business processes” (Aral and Weill 2007, p. 766). Therefore, according to Bharadwaj et al. (1999, p. 384) firms should “focus on creating a firm-wide IT capability that provides a substantive basis for sustained IT innovation”:

We thus formulate:

Proposition 3: IT capability positively influences innovation capability.

**IT capability, innovation capability and performance**

It is widely recognized that IT does not provide benefits per se but must be employed together with other factors (Peppard and Ward 2004). This view is also supported by Powell and Dent-Micalef (1997) suggesting that IT only leads to competitive advantage when it leverages or exploits pre-existing, complementary human and business resources (Dewett and Jones 2001). This view is also reflected in the definition of Bharadwaj (2000) cited above or in the definition of Lee et al. (2004, p. 648) who define IT capabilities “as organizational functional capabilities to support organizational activities and work processes by deploying IT-based resources in combination or copresence with other resources and capabilities”. To consider the deployment of IT capability in copresence with other capabilities we formulate:

Proposition 4: Innovation capability mediates the relationship between a firm’s IT capability and long-term performance.

Figure 1 presents an overview of the proposed relationships.

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**Figure 1: Research model**
DATA AND METHODOLOGY

Data
To study the proposed organizational effects we concentrate on companies listed in the Standard and Poor’s (S&P) 500 Index. We chose the S&P 500 because it represents the American economy with its various industries and second, because of the high standards for disclosure as stipulated by the U.S. Securities and Exchange Commission (SEC) for U.S. companies. In particular the latter guarantees a rich base of corporate data.

The data will be retrieved from Thomson ONE Banker, a database provided by Thomson Reuters, one of the world’s largest information companies. The data accessible date back to 1997 and thus offers a unique possibility to investigate the proposed temporal effects within a 13 year time window. This allows avoiding bias involved with primary measures and provides standardized data comparable across firms.

Measures
Secondary measures are used by comparably fewer researchers compared to the use of primary measures. An overview of publications and secondary measures related to IT capability at the organizational level are listed in Table 1, respectively in Table 2 for the innovation capability. As mentioned before, the measures for the innovation capability are further divided into input- and output-oriented measures.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Publication</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>InformationWeek ranking</em></td>
<td></td>
</tr>
<tr>
<td>- IT budgets</td>
<td>(Bharadwaj 2000; Santhanam and Hartono 2003)</td>
</tr>
<tr>
<td>- Size of IT staff</td>
<td></td>
</tr>
<tr>
<td>- Percentages of IT budget devoted to various</td>
<td></td>
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<tr>
<td>technologies</td>
<td></td>
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<tr>
<td><em>ComputerWorld’s Premier 100 list</em></td>
<td></td>
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<tr>
<td>- Total spending on IS as a percentage of</td>
<td>(Dehning and Stratopoulos 2003)</td>
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<tr>
<td>revenue</td>
<td></td>
</tr>
<tr>
<td>- Total spending on IS staff as a percentage</td>
<td></td>
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<tr>
<td>of total IS spending</td>
<td></td>
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<tr>
<td>- Total spending on IS staff training as a</td>
<td></td>
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<tr>
<td>percentage of total IS spending</td>
<td></td>
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<td>- Total market value of the company’s</td>
<td></td>
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<tr>
<td>processors as a percentage of revenue</td>
<td></td>
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<tr>
<td>- Percentage of employees with a personal</td>
<td></td>
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<tr>
<td>computer (PC)</td>
<td></td>
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<tr>
<td>- Peer rating of the most successful users of</td>
<td></td>
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<td>IS within their industry</td>
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<tr>
<td>- A rating of how well IS management has</td>
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<tr>
<td>positioned the IS to service business</td>
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<td>needs (developed by ComputerWorld in</td>
<td></td>
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<td>conjunction with IT consultants)</td>
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<tr>
<td>- How well top management believes the</td>
<td></td>
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<td>organization is using IT</td>
<td></td>
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<tr>
<td>- 5 year growth rate in profits</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Secondary measures for IT capability
Measure | Publication
---|---
Ratio of R&D expenditure to a firm’s total number of employees (R&D intensity) *(input-oriented)* | (Sher and Yang 2005)
Ratio of full-time R&D employees to a firm’s total number of employees (R&D manpower) *(input-oriented)* | (Sher and Yang 2005)
Number of products/services introduced *(output-oriented)* | (Zaheer and Bell 2005)
Number of patents *(output-oriented)* | (Ahuja and Katila 2004; Baum, Calabrese and Silverman 2000; Rothaermel and Hess 2007; Sher and Yang 2005)
Innovativeness as determined by the Fortune Reputation Survey (FRS) | (Cho and Pucik 2005)

Table 2: Secondary measures for innovation capability

We adopt the financial items of recent research, namely IT expenditure (Bharadwaj 2000; Santhanam and Hartono 2003) and IT expenditure to revenue (Dehning and Stratopoulos 2003). In accordance with these measures and research on financial key figures we add the IT expenditure to sales and IT expenditure to employee ratios. Additionally we compute IT expenditure growth. This data will be retrieved from annual reports provided through the Thomson database. As previous research showed the high correlation between the two applied magazine rankings (Lichtenberg 1995), we will apply one of them to additionally validate our measures.

To operationalize the innovation capability construct, we use information on R&D expenditure, in particular related ratios such as R&D expenditure to sales and R&D expenditure to the number of employees (Sher and Yang 2005). Adopted from IT capability research we will employ R&D expenditure to revenue (Dehning and Stratopoulos 2003). Additionally we compute R&D expenditure growth (Baum et al. 2000). Data on R&D expenditure and already calculated ratios are available through the Thomson database.

Equal to Bharadwaj (2000) me measure performance with several key figures: return on assets (ROA), return on sales (ROS), operating income to assets, operating income to sales, and operating income to employees. These measures are widely adapted in strategic management research and proved to be reliable (Santhanam and Hartono 2003). Venkatraman and Ramanujam (1986) provided a profound review on the benefits and limitations of different performance measures.

**Method**

To evaluate the long term performance implications of organizational capabilities we consider a vector-autoregressive-model (VAR). This approach allows us to model dynamic relationships (e.g. Johansen 1995) and model time series with different length (e.g. Patton 2006).

The corresponding VAR model incorporating these dynamic aspects is outlined below whereas performance (PERF), IT capability (ITCAP), and innovation capability (INCAP) are included as endogenous variables to test for the proposed direct and indirect influences (cf. Greene 2003). The number of considered lagged periods is determined by J. To account for longer lasting historical and short-living contemporary development cycles as well as industry specifics, the maximum lag effect will be set to 4 years.

\[
\begin{bmatrix}
\text{PERF} \\
\text{ITCAP} \\
\text{INCAP}
\end{bmatrix}
= \begin{bmatrix}
\text{ITCAP} \\
\text{INCAP}
\end{bmatrix}
+ \sum_{j=1}^{J} \begin{bmatrix}
\pi_{11} & \pi_{12} \\
\pi_{21} & \pi_{22}
\end{bmatrix}
\begin{bmatrix}
\text{PERF}_{t-j} \\
\text{ITCAP}_{t-j} \\
\text{INCAP}_{t-j}
\end{bmatrix}
+ \begin{bmatrix}
\epsilon_{1t} \\
\epsilon_{2t} \\
\epsilon_{3t}
\end{bmatrix}
\]

For example, a performance increase due to an investment in innovation capability two years earlier is represented by the value \(\pi_{12}\).
DISCUSSION

Limitation
At this point two limitations of our approach should be mentioned. First, we use highly aggregated constructs, i.e. IT capability and innovation capability, which does not allow digging deeper into the relationship among these constructs. For example, we are not able to distinguish between different types of IT capability such as relationship capability or IT infrastructure capability. Second, employing data from a database implies the use of proxies for IT and innovation capability. These proxies are commonly defined for all firms but do not allow looking into details and thus may comprise aspects which are not accounted for by the use of our theoretical concepts.

Contribution
Addressing the call of prior research for “additional research […] to identify the full chain of variables connecting IT capability to firm performance” Bharadwaj (2000, p. 188) and regarding complementary relationships of IT capability with other capabilities we expect to reveal a mediating effect of innovation capability. That is, innovation capability mediates the effect of IT capability on performance.

Furthermore, addressing the call of prior literature for longitudinal studies, we expect to detect lag effects (and their sizes) between investments into IT and innovation capability and the effect on long-term performance. Moreover we expect to observe in which relation a firm must invest into IT and innovation capability to render a maximum effect on long-term performance. This will contribute to our understanding of sustainability and co-evolvement of capabilities.

Thus we expect to extend Bharadwaj’s research by adding another organizational capability and employing a longitudinal approach and therefore contribute to uncovering the chain between IT capability and performance and by demonstrating that IT capability is important (1) for developing an innovation capability and (2) for driving long-term performance.

Managerial implication
Our research addresses the prevailing question if and how IT creates business value and especially leverages the organizational innovation capability and thus promotes process and/or product innovations. Furthermore differences among different profiles of IT spending (e.g. above or below average and sawtooth-shaped) will be compared and analyzed for specific outcomes. Intuitively, results could reveal a curvilinear graph for the spending to benefit relation suggesting industry specific thresholds for IT spending. We therefore expect to demonstrate the strategic value of IT that allow CIOs and CEOs to better coordinate the development of IT and non-IT capabilities to produce superior outcomes.

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