The Impact of Information Technology Innovation on Firm Performance

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Does IT Create Value?

• Much existing research on IT performance impact has focused on IT investment.
  – Simply putting money into IT does not automatically create economic value.
  – Creating value with IT is a complex process.
    • depends largely on how IT is used in organizations.

• This research focuses on IT innovation.
  – Examines empirically the relationship between IT innovation and firm performance by using the Information Week’s annual data set of innovative IT users and the Compustat database.
What is Innovation?

• Innovation is an idea, practice, or object that is perceived as new (Rogers 1995).

• Organizational innovation theory
  – The adoption of a new idea or behavior (Daft 1978)
  – The first or early use of a new idea (Becker and Whisler 1967)
  – An innovator is considered as the first or early adopter of an innovation (Swanson 1994).
IT Innovation

• IT innovation is an integrative concept that includes not only IT investment but also organizational changes in business processes and structures, which are complementary to IT investment.

• Based on the definition of innovation, we define IT innovation as the early adoption and use of new information technologies and business processes (technological and organizational innovation).
  – Information technologies can be re-invented to adapt to existing organizational arrangements, but they can also transform organizational structures and practices.
IT Innovation and Firm Performance

- Swanson’s Tri-Core model of IS innovation (1994)
  - Type I innovation
    - Process innovation restricted to IS functional tasks, e.g., relational database and CASE.
  - Type II innovation
    - The use of IS to support administrative tasks, e.g., finance, accounting, and payroll.
  - Type III innovation
    - Integrates IS with core business processes, e.g., ERP, SCM, and CRM systems.

- Type III innovations affect the whole business and have strategic relevance by offering competitive advantage to the firms that are early adopters.
IT Innovation and Firm Performance

• Innovation is the source of value creation (Schumpeter 1934).
  – Schumpeterian innovation theory emphasizes the importance of technology and considers innovative use of technology as the foundation of new products and production methods (Zhuang 2005).

• Innovation can help firms alter the rules of competition, affect industry structure, and develop new ways of outperforming rivals, thus creating competitive advantage (Porter and Millar 1985).

• Accordingly, we propose that IT innovation has a positive impact on firm performance.
Data Sources and Measures

• The Information Week’s annual data set of innovative IT users for two years: 2000 and 2001 and the Compustat database.
  – Information week has rated companies by the quality of IT innovations (defined as technological, procedural, and organizational innovations), not by the amount of IT spending.
  – The data set includes four IT innovation categories such as technology strategy, e-business strategy, business practices, and customer knowledge, scored at three levels (gold, silver, and bronze) for each firm based on “its early adoption and creative use of technologies and business practices” (Weston 2000).
  – This specification is consistent with the IT innovation literature.
Data Sources and Measures

• We treat the four IT innovation categories as first-order factors of IT innovation.
  – Since they were developed by Information Week, we do not directly use them in our analysis.

• The second-order construct of IT innovation is developed from exploratory factor analysis (principal component analysis with equimax rotation).
  – More rigorous than simply adding up the factors (Zhu 2004).

• Multiple measures of firm performance
  – Tobin’s q, revenue per employee, and return on assets (ROA)
Estimation of the Second-Order Construct of IT Innovation

Table 1. Estimation of the Second-Order Construct

<table>
<thead>
<tr>
<th>Second-order construct</th>
<th>First-order construct</th>
<th>Component loadings</th>
<th>Average variance extracted</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT innovation</td>
<td>Technology strategy</td>
<td>.720</td>
<td>.54</td>
<td>.71</td>
</tr>
<tr>
<td></td>
<td>E-business strategy</td>
<td>.746</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Business practice</td>
<td>.712</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Customer knowledge</td>
<td>.746</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Extraction method – principal component analysis with equimax rotation
Estimation of the Second-Order Construct of IT Innovation

- The component loadings to the four first-order factors are of high magnitude, greater than .7, the cutoff suggested by Chin (1998).
- Cronbach’s \( \alpha \) is greater than .7, providing satisfactory reliability (Nunnally 1978).
- The average variance extracted is greater than .5 (Bagozzi and Yi 1988; Fornell and Larcker 1981).
Methodology and Model

• A regression analysis of the combined data set for two years.

\[ \text{Performance}_{i,t} = \beta_0 + \beta_1 \text{IT}_{i,t} + \beta_2 \text{DIV}_{i,t} + \beta_3 \text{CAP}_{i,t} + \beta_4 \text{ROA}_{i,t-1} + \beta_5 \text{INDUSTRY}_{i,t} + \beta_6 \text{YEAR}_{i,t} + \varepsilon \]

• The model measures the relationship between IT innovation and firm performance as measured by Tobin’s q, revenue per employee, and ROA while controlling for:
  – Diversification (entropy index of total diversification)
  – Capital intensity (capital investment/total assets)
  – One-year lagged variable of ROA: control for past performance
    • When ROA is employed as a dependent variable, the one-year lagged variable of Tobin’s q is employed as a past performance variable.
  – Industry and year (control for differences in industry characteristics and market trends respectively)
# Regression Results

Table 3. Regression Results

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Tobin’s $q_t$</th>
<th>Revenue per Employee$_t$</th>
<th>ROA$_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Innovation$_t$</td>
<td>.109***¹ (2.644)²</td>
<td>.085** (1.950)</td>
<td>-.006 (-.129)</td>
</tr>
<tr>
<td>Diversification$_t$</td>
<td>-.155*** (-3.697)</td>
<td>-.015 (-.327)</td>
<td>.095** (2.146)</td>
</tr>
<tr>
<td>Capital Intensity$_t$</td>
<td>-.052 (-1.123)</td>
<td>-.095* (-1.587)</td>
<td>.250*** (5.876)</td>
</tr>
<tr>
<td>ROA$_{t-1}$</td>
<td>.458*** (9.733)</td>
<td>.015 (.301)</td>
<td></td>
</tr>
<tr>
<td>Tobin’s $q_{t-1}$</td>
<td>Industry and Year</td>
<td>Industry and Year</td>
<td>Industry and Year</td>
</tr>
<tr>
<td>Other Controls</td>
<td>27.1%</td>
<td>7.4%</td>
<td>22.0%</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>17.81***</td>
<td>5.02***</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>454</td>
<td>508</td>
<td>453</td>
</tr>
</tbody>
</table>

** (p<.01), ** (p<.05), * (p<.10)

¹ Standardized coefficients are reported.

² The values in parentheses are t-statistics.
Case Examples of IT Innovation

• The operational CRM of Harrah Entertainment
  – By analyzing not only historical customer data but also customer behavior in real-time, the company has been able to provide better customer service and find ways to add value to customer experience, such as surprising them with special gifts and offers at the moment they hit a new royalty status.

• Motorola’s global SCM system
  – By integrating foreign suppliers into its global supply chain, the company designs, builds, and distributes products globally to meet growing customer demand,
  – The company goes beyond offshore outsourcing to pursue global opportunities.
Case Examples of IT Innovation

• Sun Microsystems’ One Touch Program
  – The company operates a single global instance of its ERP applications, supply chain management software, and demand planning applications.
  – Using the One Touch System, the company could configure products for each order, rather than filling orders using predetermined products, thereby being able to close distribution centers in Asia, Europe, and the US and cut inventory-handling costs.
Conclusions

• There is a strong positive relationship between IT innovation and firm performance as measured by Tobin’s q and revenue per employee.

• This research views generating value from IT as a complex process of innovation associated with IT.

• By using the IT innovation data that entails both technological and organizational innovation, our work demonstrates that innovative use of IT is an important link to IT value, which seems to be missing in the literature.