Effects of electronic commerce models and industrial characteristics on firm performance

Ting-Peng Liang
Cheng-Yi Lin and Deng-Neng Chen

The authors

Ting-Peng Liang is based at the Department of Information Management, National Sun Yat-sen University, Taiwan, Republic of China and also at Chinese University of Hong Kong, Hong Kong.
Cheng-Yi Lin is based at the Universal Scientific Industrial Co., Taiwan, Republic of China.
Deng-Neng Chen is based at the Department of Information Management, National Sun Yat-sen University, Taiwan, Republic of China.

Keywords

Electronic commerce, Modelling, Industrial design, Company performance

Abstract

The rapid proliferation of the Internet has allowed many firms to use this new technology to run Web-based electronic stores to expand their markets and to enhance the operational performance. Therefore, it is interesting to investigate why electronic commerce benefits some industries more than others, and what factors affect the impact of using e-Stores on performance in different industries. This paper reports findings on the effect of industrial characteristics, as portrayed by product information content and information intensity of the value chain, and e-commerce models on firm performance. The results indicate that both industrial characteristics and e-commerce models have significant effects on firm performance. Among the industrial characteristics, information content of the product and information intensity of the value chain have been found to have a significant impact on firm performances.

1. Introduction

The rapid growth of Internet users has made the Internet an increasingly important and attractive platform for business transactions. A survey by IDC predicts that the number of Internet users will reach 1 billion worldwide in 2005. Although many predictions have been optimistic, the reality has not been the case. Many companies are losing money from their Internet operations. Creative electronic stores, such as e-toys, cannot survive due to substantial loss and inadequate cash flow. According to webmergers.com, a San Francisco M&A research firm, 131 Internet stores have closed and more than 10,000 companies were taken over due to financial difficulties in the United States in 2000. Some 121 Web-related deals valued at $2.73 billion were announced during April 2002, which marked a 76 percent rise from $1.55 billion in M&A activity in the previous month. For those who are surviving, many have never made any profit in the past several years. Nonetheless, there are also good firms, such as eBay.com, that have benefited substantially from the Internet. Therefore, it is important to investigate why certain companies make money while others cannot, and what factors affect the financial performance of electronic stores.

There are several theories that can potentially explain the profit discrepancy in adopting e-commerce. One of them is the industry-technology fit theory, which argues that the nature of industry makes e-commerce to be more suitable for certain industries than for others. The industries whose characteristics better fit the e-commerce model are more likely to benefit, while those having a poor fit will perform worse.

The purpose of this paper is to investigate whether the industry-technology fit theory is true. In this study, industrial characteristics are represented by the information content of the product and the information density of the process.

The remainder of the paper is organized as follows. In Section 2 the background of the research is briefly reviewed, which is followed by a description of the research framework and hypotheses in Section 3. Section 4 presents the empirical design. Sections 5 and 6 report the major findings and discuss their implications.

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2. Literature review

2.1 Types of e-Business models
In the past several years, many companies have adopted e-commerce in one way or the other (Duffy and Dale, 2002; Wang, 2001). A typical approach is to build a Web site that contains the information or product for transaction. Based on the functions provided by the Web site, they can be differentiated into information-providing and product transaction. An information-providing Web site helps to promote a company to the general public, but does not allow the customer to order online; a product transaction Web site, however, goes further to allow customers to place orders or to download products online.

Based on the function provided on the Web site and whether the Web site has accompanying physical stores, e-commerce models can be differentiated into four categories, as shown in Figure 1. The first type is one which has no physical store, but has a Web site for providing information. Since no transaction occurs, it is omitted from our study. The other three models are as follows

(1) **Information provision.** Brick-and-mortar companies build Web sites that provide product information to their customers. Online order processing or real-time customer services are not provided;

(2) **Pure Web model.** Virtual stores offer online products/services. This has been the dominant form of dotcom companies, such as Amazon.com and eBay.com;

(3) **Hybrid model.** Brick-and-mortar companies offer virtual stores with online order processing and customer services functions, such as the Barnes and Nobles bookstore.

2.2 Effect of industrial characteristics
There are two general aspects for explaining the use of the Internet and e-commerce. One is to examine the nature of the product, called the product fitness theory, while the other is to examine the transaction costs, called the transaction cost theory. For example, Schwartz (1997) modified the information intensity matrix proposed by Porter and Millar (1985) to argue that products are more suitable for marketing online if they can be easily digitized, or if consumers need more information to use the product. Figure 2 shows the information intensity matrix that has product information content and information intensity of the process as two major dimensions for differentiating natures of different industries. In a study, Palmer and Griffith (1998b) found that information intensity of the value chain is more relevant to the adoption of the online transaction function.

The transaction cost perspective, on the other hand, focuses on the effect of the Internet on the efficiency of the transaction process. E-commerce will be adopted if the use of the Internet can lower the cost, speed up activities in the value chain, or reduce the overall transaction cost (Rotondaro, 2002). Hence, if the use of the Internet can reduce the transaction cost of the process, it is more likely to generate benefits (Lightfoot and Harris, 2003). In an experiment that used five different types of products, Liang and Huang (1998) found that consumers were more willing to buy goods through online if the transaction cost is lower. In both perspectives, the characteristics of product and value chain are considered as major factors that may affect the outcomes of adopting e-commerce.

3. Research framework and hypotheses

From the above review of literature, two variables affect the performance of using e-commerce: industrial characteristics and e-commerce models. Industrial characteristics can be represented by product information content and information intensity of the value chain; the research framework as shown in Figure 3 was therefore, developed. The framework includes industrial characteristics and e-commerce models as independent variables and firm performance as the dependent variable. The industrial characteristics are further defined by product information content and information intensity of the value chain.

The following alternative hypotheses (against null hypotheses of no effect) can be derived.
H1. Performance of adopting e-commerce is affected by industrial characteristics.
H1a. Product information content has a significant effect on the performance of e-commerce.
H1b. Information intensity of the value chain has a significant effect on the performance of e-commerce.
H2. Different e-business models affect firm performance.
H3. Different industries need to adopt different e-commerce models in order to achieve better performance.
H3a. Product information content affects the performance of different e-commerce models.
H3b. Information intensity of the value chain of an industry affects the performance of different e-commerce models.

4. Research design

4.1 Sample
In order to test the research model, an empirical study was performed. A total of 60 companies in six industries were chosen for investigation. Their relative positions in the information intensity matrix were assessed and financial data were collected from electronic databases for analysis.

Six industries commonly found on the Internet were chosen for analysis. They are as follows.
(1) Information content provider (ICP). Web sites that provide digital information content, such as yahoo.com. Major value chain activities include information collection, organization, compilation and presentation.
(2) Internet Advertising. Web sites that provide Web-based advertising and marketing services, such as DoubleClick.com. Major value chain activities include R&D of database marketing, Internet advertising and sales techniques, and helping clients to search for suitable Web site for ads posting.
(3) Security broker. Web sites that allow investors to buy and sell in the stock market, such as etrade.com. Major value chain activities include providing financial information, placing buy/sell orders on the security markets, and transfer of funds.
(4) Banking. Web sites that offer banking services over the Internet, such as Netbank. Major activities include online deposit/withdrawal, loan arrangements and other transaction activities, as well as R&D activities on Internet security and internal control.
(5) Retailing. Web sites that provide Internet shopping functions, such as Amazon.com and other similar Web sites. Major value activities include outbound logistics, marketing and sales, inventory management and customer services.
(6) Software vendors. Web sites that provide software development services, such as BMS Software, Inc. Major value activities include R&D, product packaging, and online/physical product delivery.

Firms traded in the New York Stock Exchange and Nasdaq were chosen for the study. This was primarily because their data were easier to obtain. Samples are primarily selected from the companies included in the USA TODAY’s Internet 100 Index (USAToday.com). A small portion of the sample companies was randomly selected from Quote888.com to broaden the coverage. All sample companies were listed on NYSE, AMEX or Nasdaq. The final sample composition is shown in Table I. A few cells in the table do not have value (e.g. information provision for ICP) because no firm falls in the category.

4.2 Variable measurements and data collection
Three kinds of variables needed to be measured: industrial characteristics, e-commerce models, and firm performance. They are described as follows.
(1) Industrial characteristics. Since industrial types are characterized by information content of
the product and information density of the value chain, an instrument for measuring the relative position of an industry was developed. The questionnaire was adapted from Liang and Ku (2001). It was developed based on the transaction cost theory and consists of two major parts. The first part assesses product information intensity. The second part accesses information intensity of value chain with respect to five major activities: procurement/inbound logistics, operation, storage/outbound logistics, marketing and sales/customer services and R&D. The criteria are listed in Table II. A five-point Likert-scale was used to measure the magnitude of each criterion.

Expert interviews were conducted to find out the product information content and information intensity of the value chain for each industry. They were asked to consult with experts in the area, discuss, and then fill out the questionnaire for each of the six industries. The results are shown in Table III. The relatively low product information content of the retail industry may be due to the lower degree of product digitizability.

(2) E-commerce models. The researcher visited the Web sites of the sample firms to identify available functions. Their e-commerce models were classified based on the availability of online ordering and delivery on their Web sites.

(3) Firm performance. In the study, earnings per share (EPS) is used as a proxy to assess the financial performance of these firms. This was chosen because of its availability, as data for calculating return on investment (ROI) were not available for some sample companies. The EPS data were from the year 2000, and were obtained from Marketwatch.com. The mean and standard deviation of the sample firms are given in Table IV.

5. Analysis of the result

5.1 Effect of industrial characteristics and e-commerce models

An ANOVA is performed on the business performance data. The result is shown in Table V. The effect of industrial characteristics \((p < 0.01)\) and the interaction effect between industrial characteristics and e-commerce models \((p < 0.05)\) are found to be statistically significant. Since the main effect cannot be interpreted if the interaction effect is significant, we need to focus on the interaction between industry and EC models. The result indicates that the interaction of industrial characteristics and e-commerce models has an impact on firm performance. Data in Table IV show that advertising is more suitable for purely online sales, while security broker and retailing are more suitable for a hybrid model of online and physical sales.

(1) Effect of industrial types. Table VI shows the average EPS of e-Stores for each industry. The Post Hoc test result (Table VII) shows that the significant order of these industries are security broker > banking > software > ICP and security broker > retailing > advertising > ICP.

(2) Interaction between industrial characteristics and e-commerce models. From Table V, we see that industrial characteristics and EC models have an interaction effect on performance \((F = 2.484, p = 0.040 < 0.05)\). A further analysis of the data (shown in Table VIII) indicates that the impacts of e-commerce
Results from the Post Hoc test show that, for these two industries, using a combined model will generate EPS that is significantly higher than the pure online model.

5.2 Effect of product information content, value chain information intensity and e-commerce models

To simplify analysis, the results shown in Table III are further divided into four groups, as low and high on each dimension. Table IX shows the results. The hurdle value for separation is 4.0, which was chosen because it can divide the six industries evenly based on their information intensity of value chain. Industries with value more than or equal to 4 are defined as high in product information content or information intensity of the value chain.

A three-way ANOVA was performed to test the effect of product information content, value chain information intensity, and e-commerce models. The results are shown in Table X. The effect of value chain information intensity \( (p < 0.01) \), EC models on business performance of two industries are statistically significant. They are the security broker industry \( (F = 4.088, p = 0.044 < 0.05) \) and retail industry \( (F = 5.336, p = 0.036 < 0.05) \). Results from the Post Hoc test show that, for these two industries, using a combined model will generate EPS that is significantly higher than the pure online model.
models \((p < 0.05)\), and the interaction effect between product information content and EC models \((p < 0.05)\) are found to be statistically significant. Hence, \(H5\) and \(H6\) are supported, while \(H4\) and \(H7\) are not. This means that value chain information intensity and the interaction between product information content and e-commerce models have significant impacts on firm performance. On the other hand, product information content and the interaction between value chain information intensity and e-commerce models do not have a significant effect.

1. **Value chain information intensity.** In Table X, we see that the effect of value chain information intensity is statistically significant. A Post Hoc test indicates that higher information intensity in the value chain \((\mu = 0.5406, \sigma = 1.1385)\) leads to a higher EPS (Table XI). This could be because the process can be fully automated over the Internet and hence results in a higher operational efficiency (such as eBay.com and online traders).

2. **Interaction effect of product information content and e-commerce models.** In Table X, we also find that the interaction effect between product information content and e-commerce models is significant \((\text{ANOVA } F = 4.995, p = 0.029 < 0.05)\). A further analysis shown in Table XII indicates that business performance of the combined model is better than the pure online transaction, but the advantage declines when the information content increases.

### 5.3 Effect of different factors

In order to explore the relative influence of different factors, a multiple regression analysis was performed and the results are shown in Table XIII. A t-test shows that all coefficients – such as product information content \((b_1)\), value chain information intensity \((b_2)\) and existence of physical stores \((b_3)\) – are all statistically significant, except the presence of Internet transaction \((b_4)\), which is not significant. The regression model is statistically significant \((F = 5.613, p = 0.001)\). \(R^2\) is 0.358 and adjusted \(R^2\) is 0.324.

The coefficients indicate that higher product information content would result in a lower EPS. This seems to contradict some earlier arguments that digitizable products are more suitable for online sales. In fact, the low entry barrier of digitizable products (such as news) over the Internet makes it difficult to charge for the services. This is probably a reason why most ICPs and other information-rich companies are having a hard time maintaining their financial balances. The information intensity of the value chain has the highest impact on firm performance. This supports previous arguments that intensity of the business process is more important than product information content. The presence of physical stores is also a plus to profits.

### 6. Conclusion and managerial implications

Our analysis on firms that adopted e-commerce has indicated that industrial characteristics (including value chain information intensity and product information content) and e-commerce
models affect their financial performance. Major findings include the following.

(1) Industrial characteristic can affect e-store performance. Specifically, performance of e-stores are in the following descending order: security broker > banking > software > ICP and security broker > advertising > retailing industries.

(2) High information intensity in the value chain results in higher EPS if e-commerce model is adopted.

(3) The hybrid model that combines physical and online stores works better for industries whose products are not digitizable (such as retailing).

A further examination of the firms that have survived the dotcom bubble, their performance in 2001 and 2002 has shown a similar effect. Table XIV shows the average performance in different settings. A significant interaction effect of industrial characteristics and e-commerce models exists (p < 0.05). The hybrid model performs well in the retailing industry and poorly in the advertising industry. The result confirms the generalizability of the findings in the paper. A major implication of the findings is that managers must take industrial characteristics into consideration when they intend to adopt e-commerce. Information provision and hybrid models are in general better than pure online model. The pure online model is effective only when the product and process are both information intensive (such as banking).

Although extensive effort has been spent in the study, several limitations may exist. First, due to time constraint and the fact that many e-commerce and performance data are not readily available, we were unable to obtain firms that adopted all kinds of models in our sample. For example, 5 of the 24 categories do not have any observation. This may reduce the reliability of the result. Second, the study only covers six different industries and three e-commerce models. Different relationships may exist in other industries and business models. Therefore, one must be careful when the result is generalized and applied to other industries. Finally, EPS was used as the only indicator of firm performance. It may be necessary to investigate whether similar results can be observed if ROI or other performance indicators are used. Nonetheless, the findings in the study do provide good guidelines for those who intend to adopt e-commerce models.

Table XI Business performance of e-Stores with different value chain information intensity

<table>
<thead>
<tr>
<th>Value chain information intensity</th>
<th>Number of samples</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>46</td>
<td>−2.2350</td>
<td>2.0503</td>
</tr>
<tr>
<td>High</td>
<td>34</td>
<td>0.5406</td>
<td>1.1385</td>
</tr>
</tbody>
</table>

Table XII Post Hoc test results on E-Store types

<table>
<thead>
<tr>
<th>Product information content</th>
<th>E-Store types (I-J)</th>
<th>Mean difference (I-J)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Hybrid – pure online</td>
<td>2.605</td>
<td>0.036</td>
</tr>
<tr>
<td>High</td>
<td>Hybrid – pure online</td>
<td>1.6644</td>
<td>0.029</td>
</tr>
</tbody>
</table>

Table XIII Results of the regression analysis

<table>
<thead>
<tr>
<th>Model</th>
<th>Non-standardized regression coefficient</th>
<th>Standardized regression coefficient</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept (a)</td>
<td>−20.391</td>
<td>−4.368</td>
<td>0.000***</td>
<td></td>
</tr>
<tr>
<td>Product information content (b₁)</td>
<td>−1.349</td>
<td>−0.508</td>
<td>−2.430</td>
<td>0.017**</td>
</tr>
<tr>
<td>Value chain information intensity (b₂)</td>
<td>6.552</td>
<td>0.872</td>
<td>3.912</td>
<td>0.000***</td>
</tr>
<tr>
<td>Physical store (b₃)</td>
<td>1.280</td>
<td>0.292</td>
<td>2.578</td>
<td>0.012**</td>
</tr>
<tr>
<td>Internet transaction (b₄)</td>
<td>0.796</td>
<td>0.152</td>
<td>1.370</td>
<td>0.175</td>
</tr>
</tbody>
</table>

Notes: *p < 0.1; **p < 0.05; and ***p < 0.01
References


Further reading


