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Diffusion of Electronic Stores: A Comparison Between Taiwan and the United States

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ABSTRACT

Electronic commerce that allows transactions to be conducted over the Internet has gained much attention. The number of electronic stores has experienced an unprecedented growth in recent years. In this paper, we examine the growth model of electronic stores offering different products in the United States and Taiwan. Empirical data were analyzed. The result indicates that information content of the product and information intensity of the value chain have significant effects on the growth potential of an industry. Bookstores and banks that have higher information intensity in their value chains are more likely to take advantage of the power of electronic commerce. The internal diffusion model can better describe their growth. Beverage and investment consulting, on the other hand, have a lower percentage of electronic stores. Their growth follows the external diffusion model. We also observed that the same industry might have different growth patterns in different countries.

JEL: L86, O31

Keywords: Technology diffusion; Electronic commerce; Comparative studies

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I. INTRODUCTION

The rapid growth of Internet users has resulted in an unprecedented increase of electronic stores on the web. The Amazon.com and CDNow.com are well-known examples. Although some web-based stores have been successful in generating sales, followers in other countries may not be as successful as in the United States. Different industries also seem to have different growth speeds and patterns. Therefore, it is interesting to study how electronic stores expand and diffuse in different industries and countries, and what are the factors that may affect the diffusion of electronic stores.

Technology diffusion is a phenomenon that more and more individuals or organizations adopt a certain technology over time. Research in the area focuses on investigating the process and affective factors of adopting a certain technology. In recent years, studies on the diffusion of computer networks have increased (e.g., Sibley, 1990; Goodman, 1994). However, no research has systematically studied the diffusion of electronic stores in a country or across the national border. Given the importance of electronic commerce in the coming century, it is time to have a better understanding of what has been the growing patterns and what are affecting the growth of these stores, which should help us predict their future. This is the objective of the research. More specifically, the objective of the study is three-fold:

(1) Investigate the growth and diffusion of on-line transaction functions in Internet stores,
(2) Analyze whether industrial specificity may affect the adoption of electronic transaction functions, and
(3) Compare whether the diffusion patterns may differ in different countries.

The remainder of the paper is organized as follows. In the next section, nature of on-line transactions and literature in technology diffusion are introduced. Based on the literature, a framework composed of product and market characteristics are proposed in Section 3 for empirical evaluation. The empirical results are discussed in Section 4. Section 5 is the conclusion.

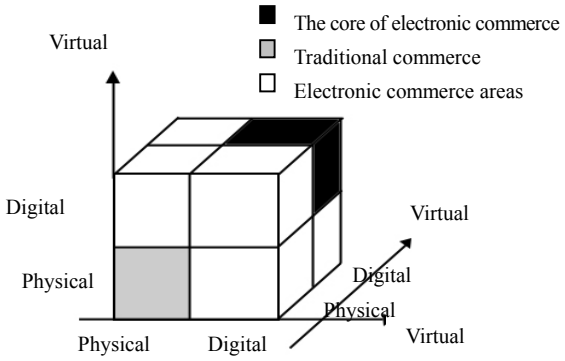
II. LITERATURE REVIEW

Electronic commerce is generally defined as using Internet to share information, maintain business relationships, or perform commercial activities (Zwass, 1996; Kalakota and Whinston, 1996). This section reviews literature related to factors that affects the adoption of electronic transactions and models of technology diffusion.

A. Factors Affecting on-line Transactions

Since electronic commerce involves business activities conducted over the Internet, the nature of electronic markets is different from that of traditional markets. Since Internet transmits digital signals, products or services that can be easily digitized seems to have an advantage to fit into the electronic market. The nature of digitizability can be defined in three dimensions: product, process, and channel (Whinston, et al., 1997), as illustrated in Figure 1. Electronic commerce allows virtual product, virtual process, or virtual players in the channel. If an industry that can accommodate all three dimensions, it falls into the black area and is considered to be the most suitable for electronic commerce. The white area is a mixture of electronic and traditional commerce, whereas the gray area is suitable for traditional commerce.

Figure 1
Dimensions of digitization



Adapted from Whinston et al,1997

Schwartz (1997) used the information intensity matrix developed by Porter and Millar (1985) to predict the suitability of different products in the electronic market. The information intensity matrix has two dimensions: *information content of the product* and *information intensity of the value chain*. Products with higher information content or higher information intensity in their value chains are assumed to be more suitable for electronic transactions. In fact, this is a pretty popular model for assessing the value of information

technology in different industries. It's obvious that EC is less likely to be adopted if the value of information technology is low in an industry. In a recent research, Palmer and Griffith (1998) found that the information intensity of the value chain is more influential than the information content of the product.

Instead of relying on the characteristics of the product, Liang and Huang (1998) applied the transaction cost theory to explain what determines whether a product is suitable for marketing on the Internet. The result indicates that asset specificity and uncertainty are major concerns for consumers to purchase on-line. In other words, asset specificity and uncertainty of an industry determine the extent to which stores adopt EC.

B. Diffusion Models

Diffusion is defined as the process by which an innovation is communicated through certain channels over time among the numbers of a social system (Rogers, 1983). Innovation often means new thought or objects that have not been previously explored. Due to curious or other reasons for imitation, innovations can propagate to different interest groups very fast. Diffusion models are mathematical models that can be applied to depict the successive increase in the number of adopters or adopting units over time (Mahajan and peterson, 1985). Therefore, they can be used to predict future distribution of an innovative technology, illustrate possible effect of a policy, or marketing of a new product.

There are three general diffusion models: the internal influence model, the external influence, and the mixed influence model. The basic diffusion model can be expressed as in equation (1):

$$\frac{dN(t)}{dt} = g(t)[\overline{N} - N(t)] \tag{1}$$

Where: $N(t)$ is the cumulative number of adopters,
$n(t)$ is the number of adopters at a given time t,
$N(t) = \int_{t_0}^{t} n(t)dt$
$N(t = t_0) = N_0$
$\overline{N}$ = total number of potential adopters in a social system,
$\frac{dN(t)}{dt}$ = diffusion rate at time t
g(t) = diffusion coefficient, i.e., the probability that potential adopters will adopt the innovation at time t.

The equation indicates that diffusion rate is a function of the difference between total potential adopters and cumulative adopters. The more actual adopters therefore, will eventually resulted in a decreased diffusion rate. The term g(t) is the probability that potential adopters will actually adopt the innovation at time t. It is often affected by the nature of innovation, channel of diffusion, and the nature of the social system. It may be a function of time or a function of cumulative adopters. In previous research, g(t) has been defined into three forms (a, b are parameters):

(1) g(t) = a,
(2) g(t) =bN(t)
(3) g(t) = a+bN(t).

In (1), the diffusion rate is a constant. The basic diffusion model becomes the following:

$$\frac{dN(t)}{dt} = a[\overline{N} - N(t)] \tag{2}$$

The above model is called the external influence model. Because the diffusion rate is not affected by the existing diffusion within the system, the factor that causes further diffusion of the innovation is assumed to be outside the social system.

In (2), the diffusion rate is a function of the cumulative number of adopters. Since the existing adopters are assumed to have effect on future diffusion, the model is called the internal influence model. The internal influence model is as follows:

$$\frac{dN(t)}{dt} = nN(t)[\overline{N} - N(t)] \tag{3}$$

In (3), the diffusion rate is a combination of (1) and (2). Hence, it is called a mixed influence model. The equation is in the following:

$$\frac{dN(t)}{dt} = (a + bN(t))[\overline{N} - N(t)] \tag{4}$$

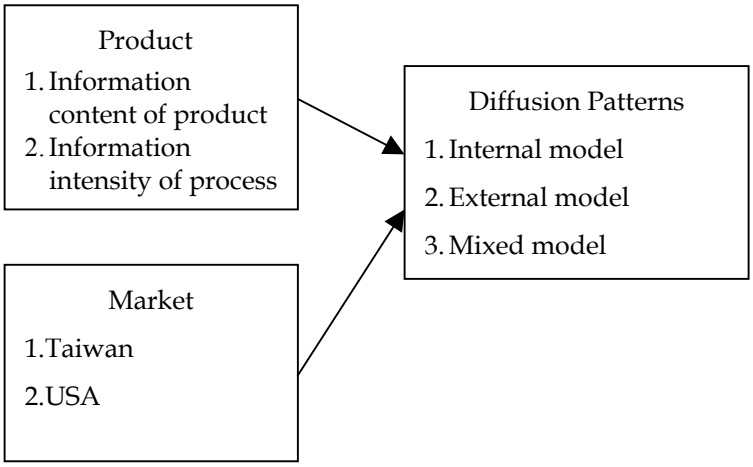
By assessing which model fits the growth pattern of an innovation, we may determine the primary factors affecting its diffusion.

III. RESEARCH FRAMEWORK AND METHODS

The above review of literature indicates that factors affecting the diffusion of

electronic stores may include the nature of products, market characteristics, diffusion channel, and innovation agents. In this research, we focus on the nature of industry and market characteristics. The information intensity matrix is used to classify different products. Stores in Taiwan and United States are chosen to illustrate markets of different characteristics. Figure 2 shows the major variables in our research framework.

Figure 2
Framework of the research



A. Research Design

To examine whether the factors have effects, five industries of different characteristics were chosen for observation in our research. The chosen industries were banking, stock brokers, beverage, investment consultant, and bookstores. Their classification is shown in Figure 3. We built diffusion models for banks, investment consultant, beverage, and bookstores and then used stock brokers to validate for consistency. The sample also covers physical, digital, and service products. Books and drinks are physical products that must be delivered in a traditional distribution channel. Stock brokers and banks offer digital products that can be transmitted over the Internet. Investment consultants offer services over the Internet. Theoretically, bookstores should have the highest adoption rate. The adoption rate of banks, investment consultant, and stock brokers should be lower than bookstores, but higher than beverage. The stores for selling drinks should have the lowest adoption rate because both the product and the process

have low information density.

Figure 3
Classification of sample industries

		Info Content of Product	
		L	H
Info. Intensity of Process	H	Banking Stock broker	Bookstore
	L	Beverage	Inv. Consultant

After choosing the industries, the number of electronic stores in each of the industries in Taiwan and USA were collected from www.yam.com.tw and www.yahoo.com every month starting from December 1997. The researcher entered related keywords to find web sites registered at the portal sites and analyze the found web sites to see how many of them offer electronic transaction functions. Since the number of web sites in Taiwan was not very large, all of them were analyzed. The found web sites in the United States were randomly sampled. Table 1 shows the number of sites observed in our research. The effective sample size is the sample size minus those who may be registered incorrectly or disappear in the research process. The selected web sites were analyzed once a month, usually in the period between 20 and 25 during the month.

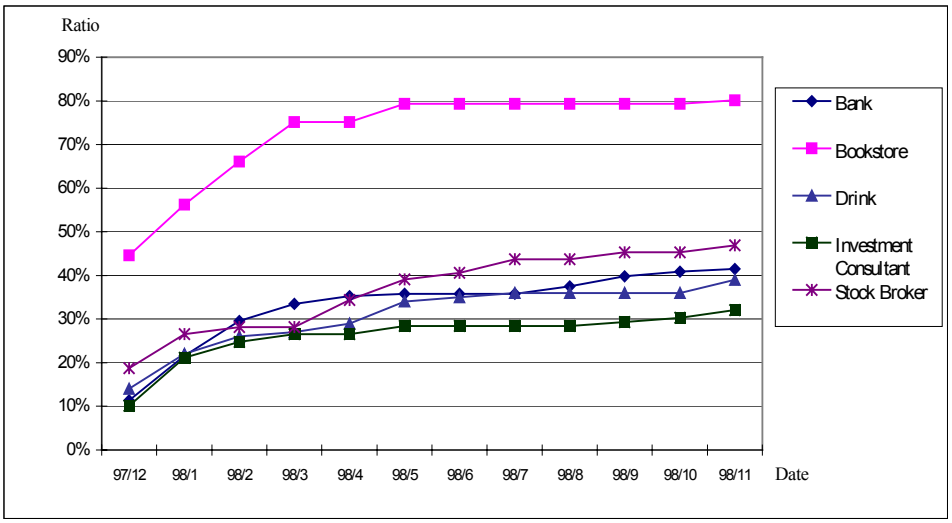
Table 1
Sample of the research

Area	Taiwan	USA		Total
Industry	Effective sample	Total sample	Effective sample	
Bank	41	191	176	217
Bookstore	41	166	121	162
Beverage	23	166	104	127
Inv. Consultant	64	127	109	173
Stock broker	26	148	64	190

IV. RESEARCH FINDINGS

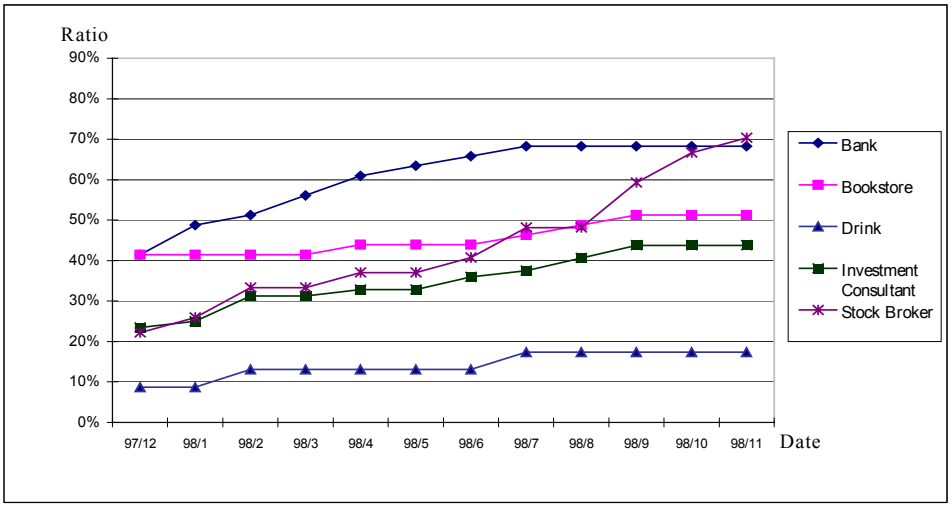
We analyze the content of their web pages to determine whether the stores offer EC functions, and then calculate the increase of the percentage of firms that offers EC functions. The growth data of EC stores in different industries from December 1997 to November 1998 in the United States and Taiwan are shown in Figures 4 and 5, respectively.

Figure 4
Growth of different industries in the United States



We can see from the figures that different industries have quite different growth patterns. The same industry in different countries also differs in their growth. In December 1997 for example, banks and bookstores in Taiwan had 41% of their web sites with EC functions, but banks kept growing to 68% in November 1998, which is much higher than the 51% for bookstores in November 1998. The investment consultant had 23% in December 1997, but its growth rate was pretty good. Drinks had the lowest adoption rate and growth rate. The electronic stores in the United States are a little different from those in Taiwan. The adoption rate of bookstores was near 80% by November 1998, which is much higher than the 51% in Taiwan. The adoption rates of banks and drinks in the United States were higher than that of investment consultant, which is different from the case in Taiwan.

Figure 5
Growth of different industries in Taiwan



In order to further understand the pattern of diffusion, we applied both internal and external models to fit the data. In a previous work, Rai, et al, (1998) found that the exponential model had the best predictive capability. Therefore, we use the exponential and logistic models and estimate parameters a, b, and M using the nonlinear least square method. Tables 2 and 3 show the resulting models. Since each industry is estimated using two models. The one with the higher R^2 is assume to be the better model for explaining the diffusion in the industry. In the tables, a and b are the parameters of g(t) in the model. M is the estimated ceiling of the diffusion. The higher the M value is, the more likely companies are expected to adopt EC.

The data in the tables indicate that diffusion of electronic stores in banks and bookstores in Taiwan can be explained by the internal model, which implies that the growth was primarily driven by the forces within the adopters. Growth of electronic stores in drink and investment consulting is better explained by the external model. This implies that they were primarily driven by forces other than the interaction of adopters (possible factors may be media promotion or other non-technological factors). The result in the US is similar except that the banks in the US fit the external model, instead of fitting the internal model in Taiwan. This difference shows that even the same industry may have different concerns when they adopt electronic commerce.

Table 2
Diffusion models of different industries in Taiwan

Industry / Model	Bank			Bookstore		
	Parameter	M	R^2	Parameter	M	R^2
Internal (b)	0.5271	0.70	0.9947	0.0338	1	0.9522
External (a)	0.2507	0.72	0.9923	0.0151	1	0.9467
Industry / Model	**Drink**			**Inv. Consultant**		
	Parameter	M	R^2	Parameter	M	R^2
Internal (b)	0.99	0.2	0.9317	0.3371	0.52	0.9805
External (a)	0.1071	0.22	0.9339	0.0574	0.69	0.9812

Table 3
Diffusion models of different industries in US

Industry / Model	Bank			Bookstore		
	Parameter	M	R^2	Parameter	M	R^2
Internal (b)	1	0.45	0.921	0.879	0.8	0.9963
External (a)	0.476	0.42	0.9858	0.498	0.81	0.9931
Industry / Model	**Drink**			**Investment consultant**		
	Parameter	M	R^2	Parameter	M	R^2
Internal (b)	0.9849	0.4	0.9747	0.8	0.4	0.8306
External (a)	0.2866	0.39	0.9843	0.7047	0.33	0.946

Since M is an estimated percentage of web sites that will provide EC functions in a given predicted time period, a higher M value means that the industry is more suitable for adopting EC. The ranking of M values in Taiwan is bookstore > bank > investment consultant > drink, whereas the ranking in the US is bookstore > bank > drink > investment consultant.

A few interesting findings can be derived. First, the ranking shows that the information intensity matrix can predict the suitability of an industry for offering electronic stores. Those with higher information content in the product or information intensity in the value chain are likely to adopt EC functions. The only exception is that the drink industry has a higher adoption rate than investment consultant. After examining the drink web site in more detail, we found that a

significant portion of the sites in the US sold bottled water as their major items, which is not found in the web sites in Taiwan. If we exclude these sites, the rankings of drink and investment consultant become reversed. Second, differences in market characteristics do have effect on the adoption of EC functions. For instance, the banks in Taiwan may have a higher percentage of adoption rate than those in the US (0.7 vs. 0.42). This is due to the geographical difference between Taiwan and the US. Many US banks are local banks, which may not need to offer web-based EC support, while Taiwanese banks are often national banks.

Since the industry of stock brokers is similar to banks in their information properties, their growth patterns are supposed to be similar. In fact, the portion of web sites providing EC functions increased from 23% in December 1997 to 73% in November 1998 in Taiwan, and from 19% in December 1997 to 47% in November 1998 in the US. This is consistent to our prediction.

V. CONCLUSIONS

In this paper, we have investigated the growth of electronic stores in bookstores, banks, investment consultants, drink, and stock brokers in the U.S. and in Taiwan. The information intensity matrix and diffusion models have been applied to analyze the data collected from December 1997 to November 1998. The industry with higher information content in their products and with higher information intensity in their value chains has a higher adoption ratio. Difference between the US and Taiwan is also found significant.

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