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# Taiwan Internet Diffusion: An Empirical Study of Internet Interactive Effects

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## Abstract

The primary objects of this research were applying the innovation diffusion model to internet hosts and internet subscribers. The results of this study may be a useful reference to the further concept building of the relationship of innovative and adopters.

## 1. Introduction

During the last decade, there has been a lot of optimism regarding Internet Development. Reports and news showed that Internet growing at an exponential pace with no predictable upper bound or saturation limit. However, in March 2000, with NASDAQ Internet stocks falling, no one thought about it but rather than returned to the reality. [4][6]

Internet hosts' and Internet subscribers' growth at an exponential pace happened in early stage of Internet development. Common customer frustrations are concluded because of slow response time, inaccessible online service...etc. These problems can follow inadequate capacity planning caused by ignorance of the Internet growth pattern. [2]

After a six-year growth boom, Internet growth rate slow down. Analysts are claiming that Internet adoption by consumers has essentially saturated. Since Internet stock fell, stockholders are eager to see the real profit than gold in the heaven.

Thus for Internet companies accessing Internet subscribers and hosts accurately is a daunting but increasing important task. The purpose of this study is to understand Taiwan internet diffusion models of internet subscribers and internet hosts and the relation between internet subscribers and internet hosts.

## 2. Internet Diffusion

### 2.1. Internet Diffusion Model

The diffusion model is one classical model used to study the impact of a specific technology. The model is informed by the diffusion of innovation and various

economics theories and assumes that non-adopters of an innovation are increasingly likely to imitate adopters.

In other words, one person adopted because he or she observes the success of another person who has already adopted.

However, the number of adopters in a social system has its upper limit. Thus growth rates increases first and then decreases over time to achieve a finite saturation level. We call the point at the maximum growth rate of the growth models "the inflection point". Some growth curves are called "S-Curve" because of its shape.

Empirical studies shows the model have been used in many disparate fields such as social study, public health, management, sociology, marketing, communication networks to model diffusion through a population of adopters or subscribers.[7]

### 2.2. Mathematics form of growth model

There are three common growth models –the exponential model, the logistic model and the Gompertz model. [3]

#### 2.2.1. The exponential model

The exponential model assumes a constant rate of growth and thus does not involve either an inflection point in the growth rate or a definite saturation limit. Some studies shows in the early stages of its diffusion, the exponential model is suitable for understanding the growth. And the form of the exponential model

$$Y=A*\exp(B*T) \quad (1)$$

In equation (1), Y is the cumulative number of existing adopters. A、B are constants. T is the period.

#### 2.2.2. The Logistic model

Unlike the exponential model, the logistic model assume variable growth rate whereby the growth rate first increase and then decrease over time. The form of the Logistic model (also known as Pearl model)

$$Y=A/(1+B*\exp(-C*T)) \quad (2)$$

In equation (2) , Y is the cumulative number of existing adopters. B 、C are constants. T is the period. A is the upper limit of Y.

### 2.2.3. The Gompertz model

In this model, the rate of diffusion is a function of existing adopters and the difference between the logarithms of the number of adopters at the saturation level and the existing number of adopters. The form of the Gompertz model

$$Y=A*exp(B*exp(C*T)) \quad (3)$$

In equation (3),Y is the cumulative number of existing adopters. B 、C are constants. T is the period. A is the upper limit of Y.

## 2.3. Interactive Process of innovations and adopters

The Internet is a communication mesh of networked computers with their associated resources, including but not limited to email, ftp, gopher and the web. Organizations and individuals may adopt and use varying subsets of the Internet. [5]

In other words, Internet users could communicate with each other through “Internet” such as email, news groups...etc and interact with internet resources (webs, mail servers, ftp servers).

This interactive process first studied in the 1980s by diffusion researchers. Researchers found that interactive innovations (telephone, fax, email) possess different characteristics from innovations spread in the normal diffusion networks (mass media, interpersonal networks).

The main feature of the interactive process of innovations and adopters is its two-way communication process. In the case of non-interactive innovations, the earlier adopters have a sequential interdependence effect on later adopters. But in the case of interactive innovations, not only earlier adopters influence later adopters but later adopters also influence earlier adopters.[9]

Based on interactive innovations, one researcher showed internet client-server architecture may cause a new many-to-many communication model. .

In dual acceptance theory, diffusion of internet adopters depends upon internet servers whereas the diffusion of the web server depends upon internet users.

Chen’s study indicated that if there are only a few web servers, using the web is of the little value to users. Similarly, if there are only a few web users on the internet,

creating a web server is of little value to organizations or business. That is the rate of adoption of web servers depends upon the number of users, not the number of web servers.[1]

## 3. Research Method

This study attempts to use diffusion model to access diffusion models of Taiwan internet users and internet hosts ,but also to fit the dual acceptance model.

The data of Taiwan internet hosts comes from Internet Software Consortium. The number of Taiwan Internet hosts equals to the sum of the number of .tw domain name and the number of hinet.net domain name. Hinet is the largest ISP in Taiwan and other ISP domain name is including in .tw domain name. The data of Taiwan internet users comes from Taiwan Directorate of Telecommunications.[8]

At the beginning this study, we use the data of internet users and hosts in Taiwan to fit the diffusion model . Secondly, we apply Taiwan Internet diffusion model for dual acceptance model.

**Table 1 Taiwan Internet hosts**

Time	Taiwan Internet Hosts
Jan-95	14618
Jul-95	16166
Jan-96	25273
Jul-96	30645
Jan-97	34650
Jul-97	40533
Jan-98	176836
Jul-98	353523
Jan-99	519597
Jul-99	676623
Jan-00	849652
Jul-00	1156573
Jan-01	1349261
Jul-01	2293024
Jan-02	3433129
Jul-02	3544102

Source: Internet Software Consortium

**Table 2 Taiwan Internet Users**

Time	Taiwan Internet Users (thousands)
Jul-96	440
Jan-97	600
Jul-97	1260
Jan-98	1660
Jul-98	2170
Jan-99	3010
Jul-99	4020
Jan-00	4800

Jul-00	5600
Jan-01	6273
Jul-01	7214
Jan-02	7824
Jul-02	8080

Source : Taiwan Directorate of Telecommunications

## 4. Analysis and Discussions

### 4.1. Analysis of Taiwan Internet Hosts

We use the data regarding the number of Taiwan Internet hosts from Jan-95-Jul-00 at half-year intervals, based on reports publish by Internet Software Consortium to fit three growth models. Which model is the best? For  $R^2$ , these three growth models are acceptable. ( Table3 )

**Table.3 Regression Models of Taiwan Internet hosts**

Model	R <sup>2</sup>	Model
Logistic	0.9813	$Y=6794521/(1+844.38*\exp(-0.4339*t))$
Gompertz	0.9760	$Y=65693134*\exp(-10.70*\exp(-0.0826*t))$
Exponentia	0.9731	$Y=33328*\exp(0.2976*t)$

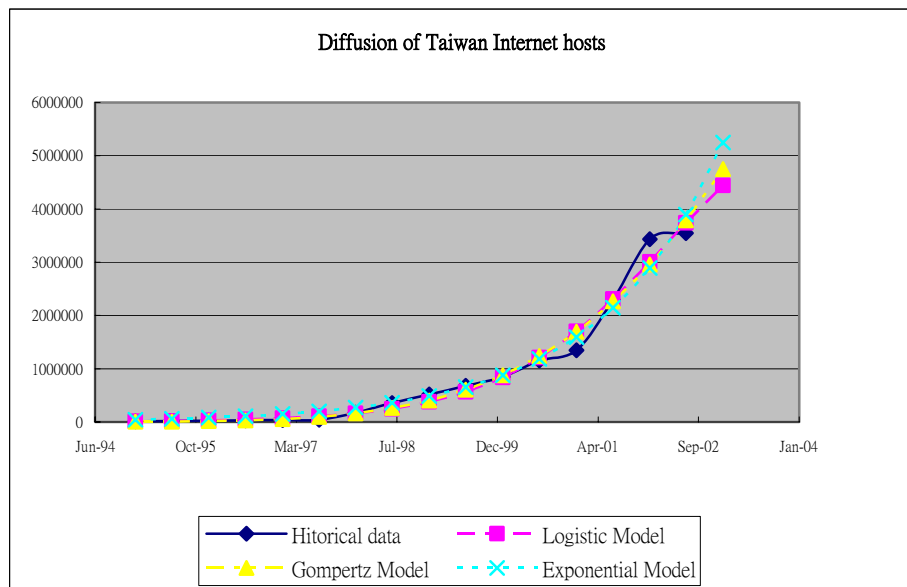
### 4.2. Analysis of Taiwan Internet Users

We use the data regarding the number of Taiwan Internet hosts from Jan-95-Jul-00 at half-year intervals, based on reports publish by Internet Software Consortium to fit three growth models. Which model is the best?

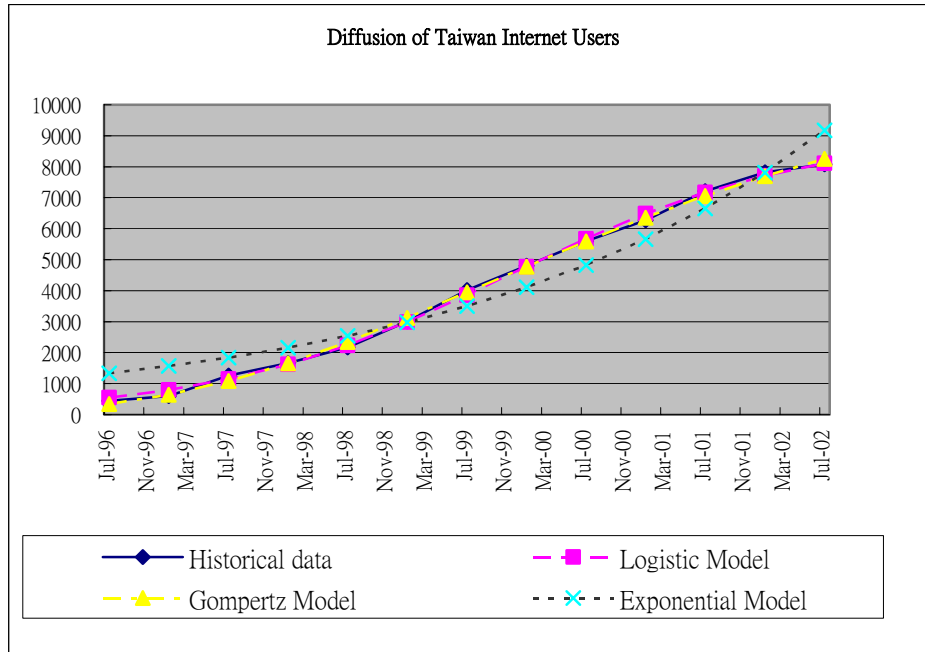
For  $R^2$ , these three growth models are acceptable. ( Table 4 ) But if we look at the trend of the three model, the exponential model seems not unacceptable.

**Table.4 Regression Models of Taiwan Internet Users**

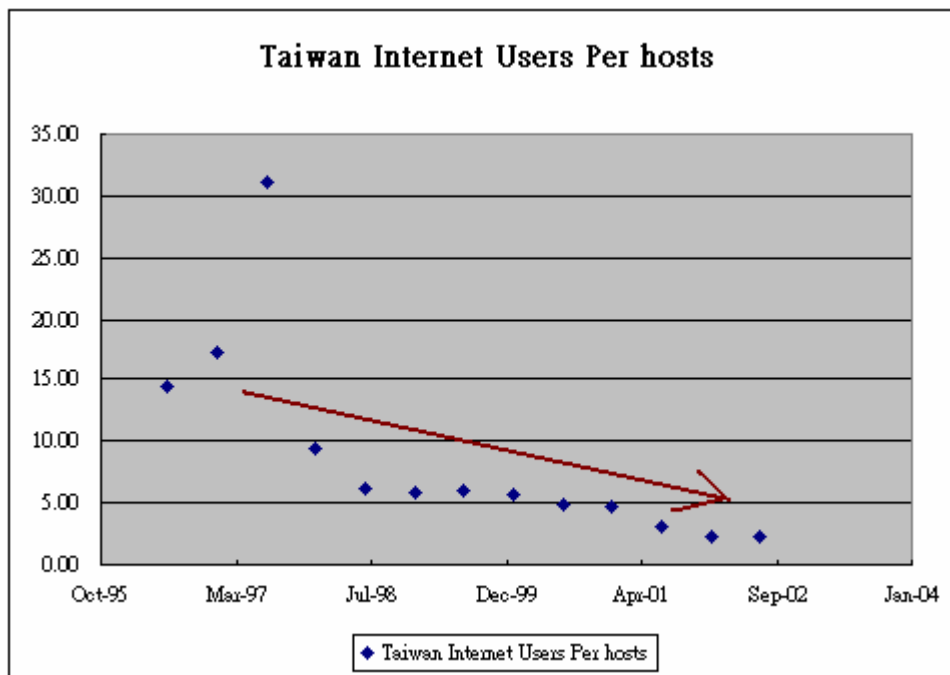
Model	R <sup>2</sup>	Model
Logistic	0.9982	$Y=9044.2858/(1+80.38*\exp(-0.4089*t))$
Gompertz	0.9982	$Y=11366.30*\exp(-7.7977*\exp(-0.1997*t))$
Exponentia	0.9371	$Y=701.3346*\exp(0.1607*t)$



**Figure 1 .Diffusion of Taiwan Internet hosts**



**Figure 2 .Diffusion of Taiwan Internet Users**



**Figure 3.Taiwan Internet Users Per hosts**

#### 4.3. Analysis of Dual Acceptance Model

Dual acceptance model implied that internet hosts is related to internet users and the relation of internet hosts and internet users follows a linear relationship.

Though the Correlation coefficient of Taiwan internet users and Taiwan Internet hosts appears to be a high relationship (  $r=0.9193$ ), the total number of internet hosts doesn't follow a stable linear relationship with the

total number of internet users , but follows a decreasing relationship.(Table 5, Figure 3).

Dual acceptance theory indicated the rate of adoption of web servers depends upon the number of users, not the number of internet hosts, which means more internet users, more internet hosts. But the growth rates of Taiwan internet hosts and internet users changes every period and don't follow the dual acceptance theory.

In short ,the data of Taiwan Internet users and hosts doesn't support. dual acceptance theory.

**Table 5.Taiwan Internet Users per host**

Time	Internet Users Per host
Jul-96	14.36
Jan-97	17.32
Jul-97	31.09
Jan-98	9.39
Jul-98	6.14
Jan-99	5.79
Jul-99	5.94
Jan-00	5.65
Jul-00	4.84
Jan-01	4.65
Jul-01	3.15
Jan-02	2.28
Jul-02	2.28

## 5. Conclusion

Although the Internet is still developing now, we couldn't get the whole picture how Taiwan internet users interact with Taiwan internet hosts. However the results of this study still prove some useful finding to the concept of the diffusion process of innovative and adopters. They are summarized as following:

### 5.1. Models of diffusion of innovations

Developing models that explain the growth process is critical for policy formulation, capacity planning and introduction new network hardware and software. Growth projection informs providers of Internet products and service of the potential consumer base.

This paper has presented that Gompertz and Logistic models could be used for forecasting regional Internet diffusion. The exponential model is only useful at early stage of diffusion of innovations. For a long-term planning, the general S curve regression model could be better fitting models.

### 5.2. Dual acceptance theory in Taiwan

In dual acceptance theory, diffusion of internet adopters depends upon internet servers whereas the diffusion of the web server depends upon internet users. The rate of adoption of web servers depends upon the number of users, not the number of internet hosts.

The Correlation coefficient of Taiwan internet users and Taiwan Internet hosts supports the relationship of Internet hosts and Internet Users.

However , the total number of internet hosts follows a decreasing relationship with the total number of internet users. The data indicated the rate of adoption of internet hosts increased faster than the rate of adoption of internet users. And this doesn't follow the study of Chen's research.

This finding implied that dual acceptance model should be modified. The dual acceptance model is a new concept which has not been sufficiently explored. Further research on the dual acceptance model is needed to expand the knowledge about on the relationship of innovative and adopters and the consequence of innovative.

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