2D04

Competition and Innovation

- Diffusion Trajectory of Mobile Telecommunication in Japan and Taiwan -

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1. Introduction

According to the report of ITU (International Telecommunication Union) in October 1999, the number of mobile phone users kept increasing at the rate of 220,000 persons per day. Indeed, the market has grown rapidly during this decade. As illustrated in **Fig. 1.** and **Fig. 2.**, Taiwan and Japan are two good examples of this situation. There are similarities of them, such as success of adopting mobile telecommunication technology, slowing down diffusion rate, and privatization of the main telecommunication companies Chung-hwa Telecom and NTT.

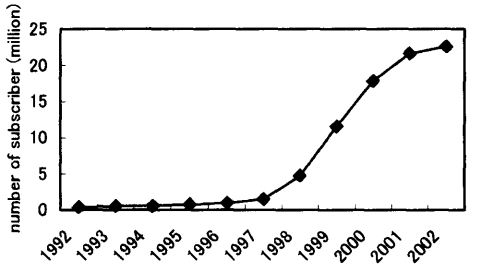

Fig. 1. Number of Subscribers in Taiwan (1992-2002).

Source : Taiwan's Ministry of Transportation and Communication

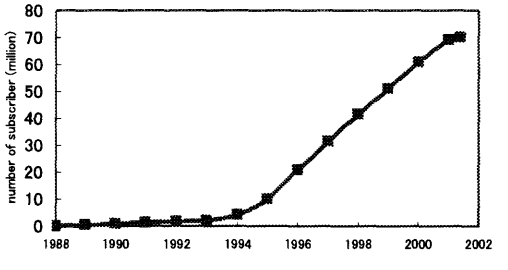

Fig. 2. Number of Subscribers in Japan (1988-2002).

Source : Japan's Ministry of Public Management, Posts and Communications

However, there are also some differences between these two markets, such as the structure of each market, the social environment of each country and the style of competition or cooperation among the telecommunication companies. This paper tries to reveal these differences and explain how these factors affect the diffusion of mobile phone technology.

2. Background

(1) Background of Taiwan market

In Taiwan, the mobile telecommunication system AMPS was first adopted in July 1989 by Chung-hwa Telecom, which was the only company of that time. However, due to the limit of AMPS technology, restricted functions and number of channels forced Chung-hwa Telecom to stop new subscribers' application. This situation was changed in July 1995 since another mobile system GSM900 was adopted. Several months later, Chung-hwa Telecom was privatized. Then, at the beginning of 1997, other private companies started to be allowed by legislation to enter the market. **Table 1** shows the basic profile of all the companies in Taiwan.

Table 1 Profile of Companies in Taiwan

Source : Taiwan's Ministry of Transportation and Communication

Company	Chunghwa	Taiwan	Fareast	Hoshin	Tongshin	Fanya
System	AMPS GSM900 GSM1800	GSM1800	GSM900 GSM1800	GSM1800	GSM900	GSM900
Foreign Partner		GTE (US)	AT&T	Bell (Canada)	Germany Telecom	Bell (US)
Market share	30.32%	25.00%	17.83%	17.83%	2.88%	6.14%

As illustrated in **Fig. 3.**, Chung-hwa Telecom had monopolized for several years. After five new companies joined the market, Chung-hwa Telecom led to lower the fee (about 40%) in 1999. As a result of price competition and eagerness to raise the market share, these companies followed Chung-hwa Telecom to bring down the fee. Therefore, for consumers, the cost to use a mobile phone suddenly dropped and kept going down.

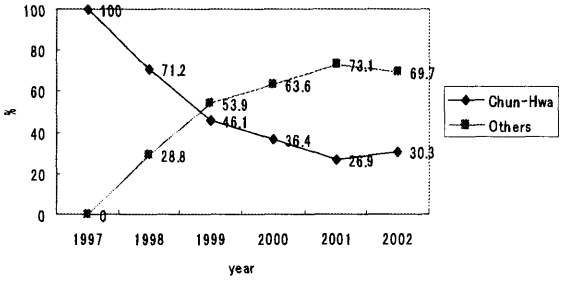

Fig. 3. Change of Market Share in Taiwan (1997-2002).

Source : Taiwan's Ministry of Transportation and Communication

(2) Background of Japan market

In July 1984, mobile phone technology started in Japan. Then, in November 1997, J-phone started the service of e-mail by mobile phone. A new page started in February 1999 when NTT adopted the technology innovation to provide Internet service by mobile phone in February 1999.

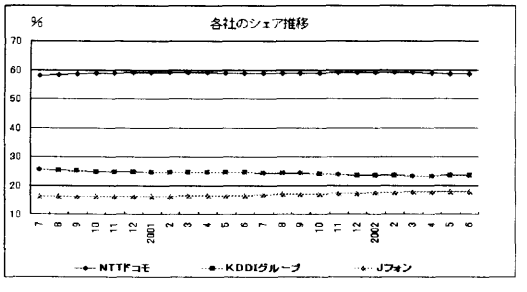

Fig. 4. Change of Market Share in Japan (2000-2002).

Source : Japan's Ministry of Public Management, Posts and Communications

At the beginning, NTT also monopolized the market. Then, the number of company increased and decreased. Now there are three companies offering the mobile phone service, which are NTT, KDDI and J-phone. However, unlike Taiwan, the market share remains almost the same in Japan. (see **Fig. 4.**)

3. Diffusion model

(1) Logistic diffusion model

Diffusion of technology innovation can be considered as diffusion of epidemic disease. The more the technology adopters are, the faster technology spreads out. Those who haven't adopted this technology would be "infected" by those "technology carriers" and then become carriers themselves. However, as technology spreads out, the number of people who haven't been infected decreases, i.e. the diffusion rate will slow down, until the penetration rate converges to the saturation point. The number of adopters at the saturation point is called the potential of epidemic model.

The Logistic function of diffusion is

$$\Delta N(t) = aN(t)(\tilde{N} - N(t)) \qquad \text{---(1)}$$

ΔN: increase of adopters N: number of adopters at time t

$\tilde{N}$: potential of adopters of this model (constant)

With method of solving differential equation, we have

$$N(t) = \frac{\tilde{N}}{1 + e^{-(at+b)}} \qquad \text{---(2)}$$

As t increases, $e^{-(at+b)}$ converges to zero. Therefore, as time goes by, N will converge to $\tilde{N}$.

(2) Dynamic carrying capacity model

In Logistic diffusion function, the potential $\tilde{N}$ of the model is constant. However, during the diffusion process, the potential of the model may also increase. For example, considering that the potential of mobile phone technology is related with the population, we should also take the growth of population into consideration. As a result, the potential $\tilde{N}$ would also grow as time passes by. Therefore, $\tilde{N}$ is also a function related with time t. Then the function of diffusion is

$$\Delta N(t) = aN(t)(\tilde{N}(t) - N(t)) \qquad \text{---(3)}$$

Setting $\tilde{N}(t)$ as a Logistic diffusion function, we have

$$N(t) = \frac{K}{1 + ae^{-bt} + \frac{b \cdot a_k}{b - b_k} e^{-b_k t}} \qquad \text{----(4)}$$

4. Analysis and discussion

(1) Empirical analysis

The result of empirical analysis of Taiwan is illustrated in **Fig. 5.** and **Table 2.**

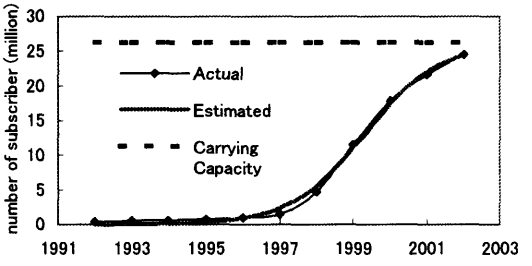

Fig. 5. Trends in the Diffusion Process in Taiwan (1992-2002).

Table 2 Potential/Coefficients of Diffusion Process in Taiwan

$\tilde{N}$	a	$B=e^{-b}$	*adj.*R^2	DW
2.62E+04	4112.30	1.00	1.000	1.34
(54.15)	(13.82)	(168.41)		

According to the census, in July 2002 the population in Taiwan is 22.4 million. However, the potential estimated by the model is 26.2 million, which is more than the population.

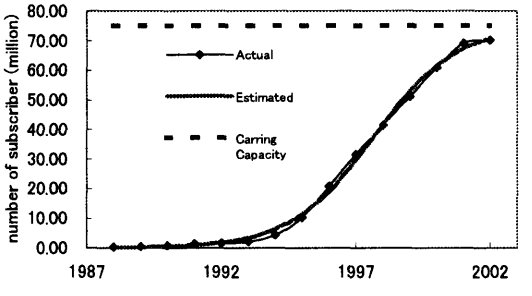

Fig. 6. Trends in the Diffusion Process in Japan (1988-2002).

Table 3 Potential/Coefficients of Diffusion Process in Japan

$\tilde{N}$	a	$B=e^{-b}$	*adj.*R^2	DW
7.50E+07	1017.40	0.65	1.000	1.45
(7.50E+07)	(4.83)	(33.03)		

The population of Japan is about 127.4 million in July 2002. As illustrated in **Fig. 6.** and **Table 3**, the potential $\tilde{N}$ is about 58.9%.

Comparing the coefficients of the models of Taiwan and Japan, both a and b of the model of Taiwan are larger than those of Japan. It shows that mobile phone has diffused more rapidly in Taiwan than in Japan.

(2) Interpretation

The potential of the model is usually considered related with the population of the country (denoted by P). Moreover, it will not exceed the population. If we suppose that people ranging from 13 to 65 years old are possible users of mobile phone, it would be obvious that the structure of population affects the potential $\tilde{N}$ of the diffusion model. Then, the penetration rate $\tilde{N}$ /P will be affected. In Japan, the proportion of the old population is higher, so the penetration rate would be bounded by this factor. To minimize the effect of the bound of population structure, it is important for companies to design more user-friendly products, especially products easier to use for the old. If this kind of simplified and specialized product exists, the potential $\tilde{N}$ may increase since it can include people of wider range of age.

Next, the potential $\tilde{N}$ of Taiwan exceeds the total population. Although the model sets up the upper bound that number of adopter will not exceed the population, it is possible that some users have more than one mobile phone. If the "number of user" is actually counted by the number of people using mobile phones, this model will fit well. However, if the "number of user" is counted by the quantity of mobile phone numbers, the model may not explain or predict the market well. For example, when only 60% among the population have become users of mobile phone and 10% of the population have not only one mobile phone, then the number of subscriber will be at least 70%. The actual

penetration rate is less than the computed penetration rate since some users have more than one mobile phone. After the market reaches the saturation point, the computed number of user may exceed the actual potential of the diffusion model, and even exceed the population P.

In Taiwan, it is not rare that people own two or more mobile phones. According to the ITU World Telecommunication Indicator Database, the proportion of mobile phone subscribers has reached 96.6% in 2001. Obviously it doesn't mean that 96.6% of the population use the mobile phone. When estimating demand, we seldom set the potential up to this level. Therefore, consumers' behavior to use more than one mobile phone will definitely affect the quantity of potential.

To understand the reason why people in Taiwan have this unusual mode of using mobile phone, we have to focus on the strategies and competition of the companies. Since there are 6 companies in Taiwan, each company cuts down the monthly fee to attract consumers. Besides, they design campaigns to attract consumers to have one more mobile phone number. For example, a customer can get a NOKIA phone device for free, which originally costs ¥14,000, by signing a contract to have one more new number. What he needs to do is paying the monthly fee (¥400-700) for two years. Compared with the lowest monthly fee in Japan (¥2000), the cost for users in Taiwan to have one more mobile phone is far less than the cost for consumers in Japan. People buy one more mobile phone number when needing a new device, and then give it to their friends or family who haven't got a mobile phone. Thus, mobile phone "spread out" to those who wouldn't adopt a mobile phone by themselves.

The keen competition in Taiwan caused the price to drop rapidly and hence caused the number of subscriber to increase rapidly. Judging from the change of market share, even if Chung-hwa Telecom once monopolized the whole telecommunication market, as long as other companies are competitive enough, users in Taiwan are willing to use mobile phones of those companies.

5. Conclusion

Stableness allows the companies to exploit longer/more. On the one hand, only if the minor companies can offer better service with lower prices to raise competitiveness, the consumers will select the products of them. As long as the minor companies can occupy more market share, the major company will definitely improve itself. This competition will help the diffusion of mobile phone technology. On the other hand, subscribers' willingness to adopt new product and new suppliers will also force the suppliers to work more.

This paper only discusses some factors that resulted in the differences of the diffusion of mobile phone technology in Taiwan and Japan. In the future, it is important to apply more diffusion models and analyze other factors.

References

[1] Dai S. C., "Time Series Research of Diffusion of Mobile Phone Users of OECD and Taiwan," Department of Economics, Taiwan University (2002).

[2] Chi S. C., "Demand Predict and Penetration Rate of Mobile Phone in Taiwan," Department of Business Management, Chen-kong University, Taiwan (2001).

[3] Gruber, H., Verboven, F., "The Diffusion of Mobile Telecommunications Services in the European Union," European Economic Review (2000).

[4] Gruber, H., Verboven, F., "Competition and Innovation: The Diffusion of Mobile Telecommunications in Central and Eastern Europe," Information Economics and Policy 13, No. 1(2001).

[5] Ahn, H., "A Nonparametric Method of Estimating the Demand for Mobile Telephone Networks: An Application to the Korean Mobile Telephone Market," Information Economics and Policy 13, 95-106(2001).

[6] Valletti, T. M., "A Model of Competition in Mobile Communications," Information Economics and Policy 11, 61-72(2001).