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Network Externality and Necessary Software Statistics

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Abstract

In recent years, network externality is increasingly referred to as an important characteristic of the information society. When network externality exists, theoretically, there is a strong tendency for a monopoly of a single product, because increased numbers of users will always lead to enhanced benefits enjoyed by a user of the given product. When we endeavor to verify network externality empirically, however, we notice that statistics available for this analysis are very limited. This paper will try to show what kind of statistics are necessary to analyze network externality, through cases of video game machines and personal computer software. The conclusion is that sales value and quantity figures of individual products are necessary, as shown in the video game machine case. However, these figures are unavailable for personal computer software, especially for those which are pre-installed in personal computers. Another necessary piece of information is comprehensive records of all available software and functions of individual software. This information is not available for personal computer industry, whereas it is available for the videogame industry.

1. Introduction

Network externality is sometimes emphasized as an important characteristic of information revolution (For example, see Shapiro and Varian, 1998). When network externality exists, a product that has the highest share of the market tends to take 100% share because a user's utility is positively correlated with the number of other users of the product. This is one of the reasons why so-called "winner-takes-all" market structure is common in information technology industries such as software, computers, and telecommunications.[1] Many business guidebooks emphasize this externality and recommend enjoying the "first-mover-advantage."

Network externality is also an important factor in the recent Microsoft anti-trust case. The U.S. government and anti-Microsoft economists claim that Microsoft controls the operating system market for personal computers owing to network externality, and bundles applications such as Internet Explorer and Java to maintain its monopolistic power (Fisher, 1999). Microsoft and pro-Microsoft economists argue that the monopolistic power of network externality is limited in the environment of rapidly changing information technologies, and Microsoft's bundling behavior is beneficial to users (Davis and Murphy, 1999). The focusing point of this debate is how much strength network externality has in the operating system and the application software markets.

However, when we try to measure the impact of network externality empirically, we notice that data available for the analysis is limited. Winner-takes-all market structure is not sufficient as evidence because very excellent products also can dominate the market without network externality. In this paper I will show how network externality can be verified and what kind of statistics are necessary using two cases, video games and personal computer software.

2. How to verify network externality

Because network externality is not expressed in money terms in market transaction, we have to verify it by showing consequences caused by network externality. Listed here are five consequences caused by network externality:

(1) Winner-takes-all

When network externality exists, one product tends to drive away all other products. Thus if market

[1] Another reason is the increasing return to scale of software production.

share of a product increases steadily and reaches almost 100%, we can interpret it as a consequence of network externality.

(2) Lock-In

Once the monopoly is achieved by network externality, it is difficult for new products or firms to challenge this dominance. Therefore if market share continues to be overwhelmingly high, we can interpret it as a consequence of network externality.

(3) Inconsistency between function and share.

When network externality exists, a functionally inferior product can drive away superior products if it obtains sufficiently large market share. Thus there could be inconsistency between evaluation of the product and market share.[2] Liebowitz and Margolis (2001) applied this approach to Microsoft's Word and Excel in the US market.

(4) Positive feedback

In the case of indirect network externality, positive feedback works between the complimentary two goods; sales of PC's operating system and the number of software on it, sales of a video game machine and the number of game titles on it. Positive feedback can be verified by causality test of vector auto regression (VAR) model.

(5) Effect of the share to the utility: Demand function or Hedonic price model

When network externality exists, user's utility is positively correlated with the number of other users or number of complimentary products. Therefore if the demand function is affected by the share of the product or the number of complimentary products, we can interpret it as evidence of network externality. Hedonic price model also can be used to measure the effect of the share to the user's utility (Brynjolfsson and Kemerer(1996))

3. Case of videogame industry

(1) Winner-takes-all

Figure 1 shows the share of video game machines from 1983 to 1999. As easily seen, in each generation (8bit, 16 bit, and 32 bit respectively), one product takes almost all the share of the market. Therefore winner-takes-all occurs in every generation.

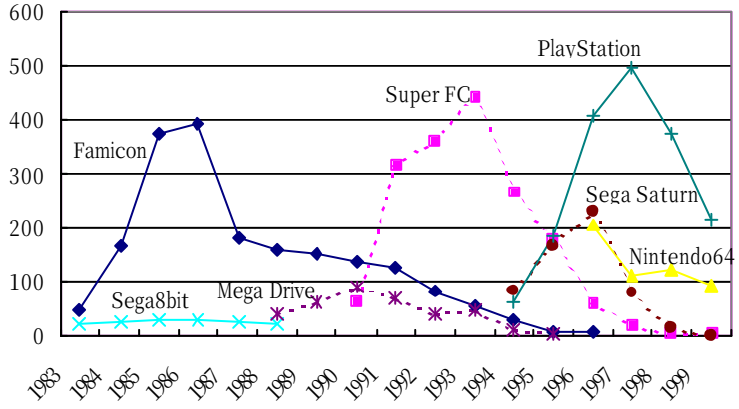
(2) Lock-in

As shown in figure 1, lock-in is not observed because winners change from 16bit to 32bit generation, that is, from Ninntendo's Super Famicon to SCE's Playstation. Thus lock-in does not occur.

(3) Inconsistency between function and share

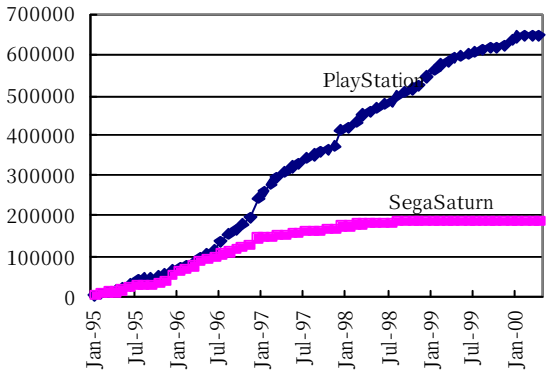
Inconsistency between function and share is clear in the case of Playstation and SegaSaturn. Although the functions and prices of these two machines are nearly the same, the cumulative sales differed dramatically after spring of 1996 as seen in figure 2.

Figure 1 Anual Sales of Console game hardware, unit=10thoudsand



Souce:Toy Journal, White paper of Information Media

Figure 2 Cumulative sales of PS and SS
unit=number of sales of sample retail shops



Source Dengeki(Game Magazine)

[2] Implicitly we assume that the prices of these products are almost the same. If the prices are different, we should adjust it by the hedonic price model.

(4) Positive feedback

H(t): hardware sales at t month, season adjusted

S(t): number of game software titles released at t-1, t, and t+1 month, season adjusted

Estimated VAR model is as follows.

Playstation $H(t)=1426 +0.44H(t-1) +112S(t-1) +200t -5.4t^2$ $R^2=0.66(0.63)$, n=63

(1.1) (3.9) (2.0) (1.4) (-2.9)

SegaSaturn $H(t)=2757 +0.48H(t-1) + 38S(t-1) –51t -0.67t^2$ $R^2=0.57(0.53)$, n=63

(2.6) (3.3) (0.7) (-0.3) (-0.2) (t values in parentheses)

Source H(t): same to figure 2.

S(t): "Kougien"(comprehensive list of all game titles) Ambit

Since the coefficient of S(t-1) is significant for Playstation, the positive feedback works. On the other hand, the coefficient of S(t-1) is not significant for SegaSaturn. So Sega could not enjoy the positive feedback.

(5) Effect of the share to the utility: Demand function

Estimated demand function is shown in Table 1. Since the demand grows logistically as is often the case with durable consumer goods, time and time-squared are added as exogenous (or instrumental) valuables in the demand function. Cumulative production is introduced as an exogenous variable in the supply function because the learning effect is common in microchip production. The effect of network externality is measured by the number of game titles S(t) in the demand function.

For Playstation, coefficient of S(t), 261, is significant at 5% level, so network externality is verified. On the other hand, for SegaSaturn, the coefficient, -83, is not significant. This result is consistent with the positive feedback analysis of (4). Whereas Playstation enjoyed the network externality, SegaSaturn did not. This is one of the reasons why Playstation won the competition with SegaSaturn.[3]

Adding up all these five results, we conclude that network externality works for video game hardware in each generation. However, the effect of externality is limited within the one generation. As generation changes, the winner can change. Therefore competition for winning in the next generation continues at every generation.

Table 1

	PlayStation		SegaSaturn	
	Demand	Supply	Demand	Supply
constant	-94603	36649	25.1	32303
	-(1.31)	(5.85)	(0.01)	(6.17)
Hardware Price P(t)	2.58	-0.964***	0.104	-0.727***
	(1.32)	-(4.48)	(0.14)	-(4.98)
Number of game	261**		-83	
soft titles S(t)	(2.56)		-(1.19)	
time	2128		898	
	(1.27)		(0.57)	
time*time	-42.4		-19.1	
	-(1.61)		-(0.76)	
Cumulative Production		-0.019***		-0.113***
of Hardware CH(t)		-(2.63)		-(6.24)
R-square	0.21	0.42	0.44	0.62
Adusted R-square	0.13	0.40	0.39	0.60
number of dat	44	44	44	44

Data Source P(t):Dengeki, Nikkei newspaper Sunday edition,
S(t):Kougien, Ambit, CH(t):Dengeki

4. Case of PC software

For PC software, Microsoft's Windows and Word/Excel seemingly have dominant share in the market. But it is not easy to verify network externality owing to lack of available data.

(1) Winner-takes-all and (2) Lock-in

Share of PC software cannot be obtained by retail data because most Microsoft products are pre-installed in tPCs. For example, though Ichi-taro's sales fell by 2/3 during 1997, Ichi-taro still had the highest share in the word processor "retail" market. This is because MS Word is usually provided to users pre-installed. Although some research companies provide estimation of software sales including preinstalled sales, they are expensive and cover only a few recent years.

(3) Inconsistency between functions and share

Unlike the game hardware, the functions of PC software are complicated and difficult to compare with each other. Review articles of various PC magazines can be used as evaluations of software to some extent. Figure 3 shows the evaluations of review articles of Nikkei Byte about word processor software from 1990 to 1998. As is easily seen, MS Word always ranked above Ichi-taro. Since Ichi-taro took

[3] It is interesting question why network externality didnot work for SegaSaturn. One possible answer is that characteristics of game/users are different between SegaSaturn and PlayStation. It is said that Saturn's games are mania-oriented and purchased only by heavy users.

the highest share before 1996 (that is, before the pre-installed software became common), there was inconsistency between the evaluation and the share before 1996. This suggests that network externality exists.

The review articles of PC magazines are not always available for most software, however. Reviews of the spreadsheet on Nikkei Byte disappeared after 1995, and reviews of operating systems are rarely seen in any PC magazines. Therefore the inconsistency cannot be tested for the spreadsheet and OS.

(4) Positive feedback

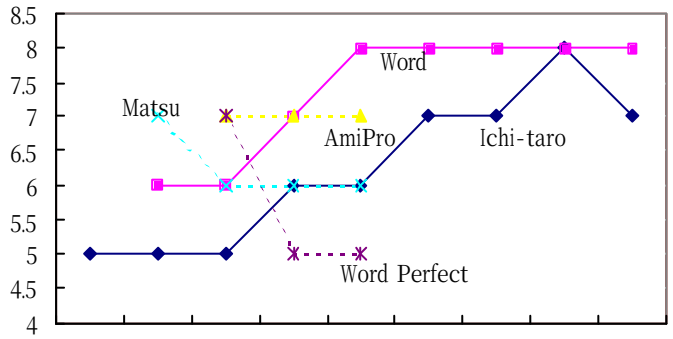
To test positive feedback, we need the number of existing software products by operating systems. Number of software products by OS, however, is difficult to obtain since there is not a comprehensive list of software products. As very rough approximation, I counted the software products on the educational software catalogue of the University Coop (Figure 4). It shows that the number of Windows' software products increased and reached beyond those of Macintosh in 1997. If PC sales share in the educational market is available, we can see whether or not the number of software products affects the PC's share.

But figure 4 is a very rough estimation of the number of available software products. It is far more difficult to count business and entertainment PC software products.

(5) Effect of the share to the utility: Demand function

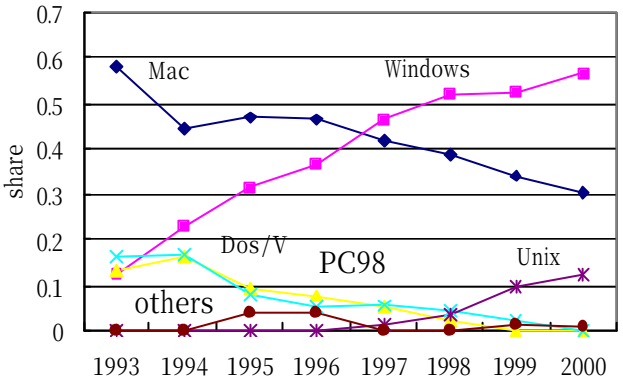
Price data of software is necessary to estimate the demand function. However, price data of the pre-installed software are not available since they are not publicly announced.

Figure 3 Evaluation of Word Processor Based on Review Articles of Nikkei Byte



Source Nikkei Byte

Figure 4 Educational Software Share by Operating Systems



Source: Educational Software Catalog (Univ. Coop)

5.Conclusion

The Microsoft case is more important than the video game industry case from the view of economic welfare because the total market size of PC's software is far larger. However, data on PC's market is less available. Software statistics should be enhanced. To test network externality, following data are useful: value and quantity including preinstalled software, function and evaluation of the software, and a comprehensive list of software products.

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