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Focusing On The High-End Or Low-End? Local Attacking With Network Externality

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Abstract

Network externality can encourage adoption when a network is growing in size. Network externality, however, can also encourage abandoning when a network is getting small. Therefore, the challenger's action focusing on persuading a part of the market can eventually affect the whole market when network externality is at work.

This paper discusses two local attacking strategies, namely, "focusing on the high-end" and "focusing on the low-end", and compares their effects. The conclusions show that the former strategy generally exhibits stronger eventual effects than the latter. Although direct effects are local, the eventual effects could be global when network externality is strong and/or consumers have small differences in their reservation prices.

Based on our results, the incumbent should set a price keeping all installed users away from being stranded. If any installed user gives up the incumbent's technology, he or she may be the fuse to trigger the chain reaction. Thus, a better approach is to "make the fuse wet". To the challenger, local attacking strategies work better when network externality is strong and/or reservation prices of installed users are nearly the same.

Keyword: Network Externality, Attacking Strategies, Targeting

1. Introduction

Network externality is the phenomenon that adopters' utility increases with the number of equivalent adopters [5] [6] [7] [14] [20]. Network externality has proven itself as a hot topic in the fields of economics and management. Moreover, it manifests undoubted relevance in information economies. Telephone, email [3] and computer operation systems are the most representative products characterized by network externality. It also exhibits the property of increasing return [2] [18], and various inefficiencies [8] [11] therefore shaping a new business model in information economies.

Applicable are conventional and classic strategic thinking: building alliance, taking first-mover advantages, and managing consumers' expectation [19]. However, various counter-intuitive but insightful strategies are proposed and analyzed in the context of network externality. For instance, allowing piracy in software markets [9], planned obsolescence [13], introducing "clones" [10], predatory pricing under some conditions [4], and providing an adapter [1]. Analyzing the characteristics and influences of network externality can help managers apply economic principles to improve on their decisions such as product line design, pricing strategies, property rights and taking advantage of lock-in effect [18].

We follow the research [21] that explained why challenger firm can win over incumbent firm in industries characterized by network externality. Theoretically, network externality stands on the incumbent's side and creates enormous switching costs for installed users, or namely, the installed base. Based on the work [12], challengers have little chance to successfully penetrate into industries characterized by network externality. However, it is interesting to note that in the history of industry this theoretical inference is not followed. The phenomenon that challengers win over incumbents takes place again and again. [21] successfully explained the phenomenon existed in *growing markets*. By contrast, attacking strategies in this paper can explain the same phenomenon even when *markets do not grow in sizes*.

One of the competitive strategies is seeking for sponsorship. Sponsorship can help one of the oligopolists to offer a lower price than marginal cost and thus gain competitive edge against the rival [15].

Another frequently cited research [17] showed that firms might race excessively and incompatibly in research and development. The *government* can take on the "force licensing" policy to slow down this race to improve social welfare. Our paper, on the other hand, proposes that *the challenger firm* can use local attacking strategies without interventions of governments.

Before we introduce this paper's purpose, we first come to the precise deinition of "local attacking strategies". Marketing activities can be utilized to target the whole market or to target at a specific segment. Marketing activities, such as advertising or promotional campaign, utilized to target the whole market can be very expensive and lost of focus. On the other hand, marketing activities can be utilized to target at a specific segment. We name these marketing activites "local attacking strategies" because they do not attempt to pursuade the whole market, by contrast, a particular part of the market. We will show that focusing on a rather small segment can affect the choice of the whole market in the context of network externality.

Briefly, the purpose of this paper is to illustrate that attacking strategies by the challenger can destruct the

incumbent's installed base. In this paper, the effects of two local attacking strategies are analyzed and compared. One strategy is "focusing on the high-end" and the other is "focusing on the low-end". This paper will show that local attacking strategies not only have local direct effect, but also have global eventual effect on the number of the incumbent's installed users.

The attempt of this paper is new in the fields of industrial organization and management science. Firstly, this paper shows that network externality can amplify the effect of a challenger's attracking strategies. Although the direct effect of attacking strategies is local, the strategic effect amplified by network externality could be enormous.

Explaining the similar phenomemon, this paper attempts to extend [21] to explain the challenger's victory even without a growing market. The increasing return property of network externality is well known but, however, network externality also makes a network more vulnerable when a network is under attack.

This paper is organized as follows. The current section describes this paper's purpose, importance and status in the literature. The next section describes the model. The third section solves the problem and discusses the results. Finally, the conclusion is drawn.

2. Model

The model consists of one incumbent firm, one challenger firm and a number (M) of users. The incumbent possesses a technology and set a price for usage right in a specific time period, for instance a year. Every user in the market is assumed to have paid for the technology in the previous time period but needs to decide whether to pay the incumbent again for the coming year's usage. That is, the incumbent firm occupies the market in the beginning of the model.

This paper does not analyze the dynamic and competitive issues between the incumbent and the challenger. The focus is put on the one-shot effect of the challenger's attacking strategies and network externality between technology adopters. The analysis is limited to the scope in which the challenger takes one strategy and the incumbent is not ready to notice or react to the challenger's attack. Thus, the game theoretical view is not applied on the interactions of the incumbent and the challenger, but applied on the interactions between technology adopters.

Since the challenger is new in the market, he/she may concentrate his/her marketing resources to attract some (locally), but not all (globally), of the consumers in the market. Intuitively, "focusing on the high-end" and "focusing on the low-end" are two candidate strategies. The only decision to be made in this model is challenger's strategy.

Let us first elaborate these strategies. The term "high-end" refers to consumers, who may have higher income or wealth, possessing higher reservation prices. By contrast, the other term "low-end" refers to consumers possessing lower reservation prices. Moreover, "focusing on the high-end" strategy is concentrating marketing resources to target consumers with higher reservation prices. On the other hand, "focusing on the low-end" strategy is concentrating marketing resources to target consumers with lower reservation prices for the incumbent's technology.

It is hard to judge which of these two strategies is better. The former, "focusing on the high-end", may lead the challenger to seize a higher-margin segment as a niche. On the other hand, "focusing on the low-end" may help the challenger expand its market share in a higher speed.

To reflect the direct effects of these two strategies, we model the former strategy, "focusing on the high-end", in a way that a challenger moves the consumer with the *highest* reservation price out of the incumbent's installed base. Similarily, we model the latter strategy, "focusing on the low-end", in a way that a challenger moves the consumer with the *lowest* reservation price out of the incumbent's installed base. The consumer, who is "targeted" by a challenger, "uninstall" the incumbent's system and stops using the incumbent's technology, and consequently leave no value to other consumers and the incumbent.

The incumbent charges a price at the end of the model to every consumer who decides to renew the contract with the incumbent. One must notice that in this paper the incumbent is assumed to set a price maximizing his/her short-term profit without considering the competition. Thus, the incumbent's price is fixed when consumer reservation prices and the strength of network externality are given. In other words, the incumbent does not expect the emergence of the challenger. Accordingly, this paper does not attempt to provide any equilibrium but the optimal move (the optimal local attacking strategy) for the challenger.

To clearly identify every consumer and his or her reservation price, we next sort and give subscript *" i "* to consumers by their reservation prices. Moreover, consumer C_i's reservation price is called P_i. Accordingly, The consumer with the lowest reservation price, P_1, is called C_1 in this paper and correspondingly the consumer with the highest reservation price, P_M, is indexed as C_M.

Consumers decide in a sequence of C_1, C_2, …, C_M. Therefore, we set that there are M periods and M consumers. In the first period, the consumer (C_1 or C_M) who is targeted by the challenger refuses to pay the incumbent again. In the following $M - 1$ periods, consumers decide in a sequence (C_2, C_3…, C_M or C_1, C_2, …, C_{M-1}) and just one consumer decides in each period, respectively. The sequence may reflect the reality well because the consumer with a lower reservation price is more sensitive to market change such as the challenger's strategic actions. On the contrary, the consumer with a higher reservation price is more satisfied with the incumbent's system thus less willing to search for alternatives.

The distribution of consumers' reservation prices indeed matters. We assume that distribution follows a

linear pattern of $P_i = a*i+b + r*(n - 1)$, where "n" represents the number of consumers who still are installed users of the incumbent's technology. That is, P_1 equals $a + b + r*(n - 1)$ and P_M equals $a*M + b + r*(n - 1)$. The parameter "a" thus represents the reservation price difference between consumers. On the other hand, the parameter "r" therefore represents the strength of network externality.

The linear pattern of reservation prices of consumers is a approximity of uniform distribution setting [14]. On the other hand, the linearity of network utility on the number of adopters is following the model of [21] and similar to the setting [16].

The incumbent's price, P, also plays an important role in the effectiveness of a challenger's attacking strategies. Intuitively, a higher price without losing any consumer can generate the maximal short-term profit. How much can the incumbent charge? In order to retain all of consumers in the system, the price cannot exceed the lowest reservation price P_1 with $n = M$. Moreover, any price beneath P_1, statically, does not attract more consumers but only directly reduce the profit. To focus on the effect of a challenger's attacking strategies, the price set by the incumbent is modeled to be $P = a + b + r*(n - 1)$. The price set by the incumbent is modeled as a constant in this paper. The only decision is made by the challenger to choose one of the two attacking strategies.

The model operates as follows. The incumbent sets a price equal to $P = a + b + r*(n - 1)$, equivalently $a + b + r*(M - 1)$. Next, the challenger decides to target at C_M, the consumer with the highest reservation price, or C_1, the consumer with the lowest reservation price. These two approaches are named "focusing on the high-end" and "focusing on the low-end", respectively. In the mean time, the consumer targeted by a challenger does not pay the incumbent again. Finally, the remaining consumers decide whether to renew the contract with the incumbent and pay the price in a sequence specified above. The number of consumers who do not pay the incumbent again measures the effectiveness of attacking strategies.

For easy reference, we list notations used throughout this paper in the following.

C_i: the consumer with the i^{th} low reservation price

P_i: the reservation price of C_i consumer

a: the reservation price difference between consumers C_k and C_{k+1}, where k is an integer between 1 and $M - 1$

r: the strength of two-way network externality between any pair of consumers

n: the number of consumers who still use the incumbent's technology in the current period

M: the total number of consumers in the market

P: the price set by the incumbent which is equal to P_1 with $n = M$, that is, $P = a + b + r*(n - 1)$

3. Analysis

Now we start to analyze the first targeting strategy: "focusing on the high-end". A challenger concentrates his or her marketing resources to target the consumer with the *highest* reservation price. The effects of such attacking strategy are shown as Figure 1.

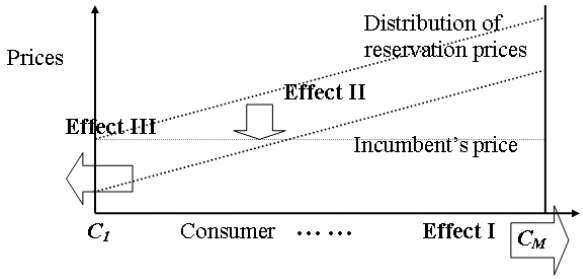

Figure 1: Effects of "focusing on the high-end" strategy

Firstly, the targeted consumer does not pay for the incumbent's technology (Effect I), that is the direct effect. Since consumers' reservation prices are constructed upon other consumers' equivalent adoptions, the reservation prices of remaining consumers all drop an amount of r (Effect II). Consequently, the reservation prices of some consumers may fall beneath the incumbent's price and refuse to pay it (Effect III). Moreover, some other consumers abandon the incumbent's technology and the reservation prices drop more. Those effects (Effects II and III) form a self-reinforcing loop, which is triggered by the "focusing on the high-end" strategy (Effect I). Although only one consumer is affected initially by the challenger's strategy, more than one consumer is eventually affected. The argument is proved more rigorously in the following.

Proposition 1 :

When the challenger uses the "focusing on the high-end" strategy and $\frac{a}{r} \geq 2$, *eventually 2 consumers will not pay for the incumbent's technology.*

Proof:

When consumer C_M is targeted and does not pay the incumbent again, all consumers' reservation prices drop an amount of r. Consumer C_1's reservation price now becomes $a + b + (M - 2)*r$, which is below the price, $a + b + (M - 1)*r$, set by the incumbent. Consumer C_1 refuses to pay the incumbent again. Next, consumer C_2's reservation price thereafter becomes $2a + b + (M - 3)*r$, which is above the price, $a + b + (M - 1)*r$, set by the incumbent when $\frac{a}{r} \geq 2$. Consumer C_2 pays the price and stays as an installed user and the stop-point of the chain reaction of abandoning. The consumers $(C_3 \sim C_{M-1})$ with a higher reservation price than C_2 deservedly pay the

price for the incumbent's technology. Only C_1 and C_M are affected by the challenger's strategy. Proposition 1 is proved.

Under another condition, $\frac{k}{k-1} \le \frac{a}{r} < \frac{k-1}{k-2}$, the effect of "focusing on the high-end" strategy would be stronger.

Proposition 2 :

When the challenger uses the "focusing on the high-end" strategy and $\frac{k}{k-1} \le \frac{a}{r} < \frac{k-1}{k-2}$, *eventually k consumers will not pay for the incumbent's technology, where k is a positive integer between 3 and M - 1.*

Proposition 3 :

When the challenger uses the "focusing on the high-end" strategy and $\frac{a}{r} < \frac{M-1}{M-2}$, *eventually all (M of) consumers will not pay for the incumbent's technology.*

Proposition 4 :

When the challenger uses the "focusing on the high-end" strategy and $\frac{a}{r} < 1$, *eventually all (M of) consumers will not pay for the incumbent's technology.*

When the four propositions are proved, we observe that the incumbent's installed base is more "fragile" when reservation price difference between consumers (*a*) is smaller and/or network externality (*r*) is stronger. The more "fragile" the incumbent's installed base is, the higher the incentive for the challenger to launch an attacking action.

To the incumbent, what are the ways to make the installed base more "solid"? The reservation price difference between consumers (*a*) is a characteristic of the market and may be hard to change. On the other hand, network externality (*r*) can be strengthened by technical functions facilitating consumers' interactions or providing convenience to interact with friends by the incumbent's technology.

Intuitively, the incumbent shall enhance consumers' value (*r*) from interactions. The installed base, however, becomes more fragile when network externality (*r*) gets stronger. Therefore, the incremental value from interactions is double-edged to the incumbent. Its advantage is that it helps the incumbent to achieve higher performance in terms of consumer satisfaction or profits. On the other side, it makes the incumbent's installed base more vulnerable. The double edge traps the incumbent into a dilemma whether to add consumer's value from interactions.

To the challenger, the values of "*a*" and "*r*" can help to estimate the effect of "focusing on the high-end" strategy. When "*a*" is relatively small and "*r*" is relatively large, the "focusing on the high-end" strategy can be expected to have a larger effect on the incumbent's installed base.

For instance, players in online games interact frequently and closely, that represents a stronger network externality, namely larger "*r*". Players in online game industry mainly consist of students. They can be considered to have similar reservation prices. A challenger may concentrate his or her marketing resources to offer attractive deals such as free usage or cash rebate. According to the propositions above, the challenger uses the "focusing on the high-end" strategy and the remaining players lose contact to players who refuse to pay the incumbent again and lose value from communication with them. Some of remaining players may feel dissatified and do not repurchase the incumbent's service. As more players swtich their choice, the remaining players will tend to swtich also. Those may form a self-reinforcing loop and make the "focusing on the high-end" strategy very powerful to destruct the incumbent's installed base.

Now let us analyze the second targeting strategy: "focusing on the low-end". A challenger concentrates his or her marketing resources to attract the consumer with the lowest reservation price. The effect of such attacking strategy is shown as Figure 2.

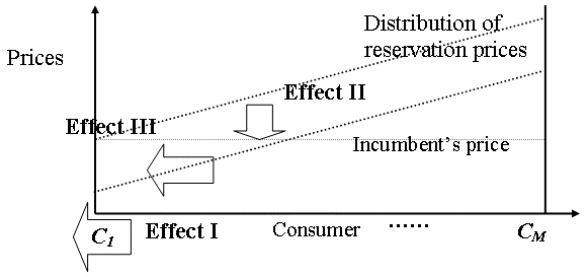

Figure 2: Effects of "focusing on the low-end" strategy

First, the targeted consumer (C_1) refuse to pay the incumbent again (Effect I), that is the direct effect. Other remaining consumers' reservation prices drop an amount of "*r*" (Effect II). Consequently, the reservation prices of some consumers may fall beneath the incumbent's price and refuse to pay it (Effect III). Accordingly, more consumers leave and the reservation prices drop more. Those (Effects II and III) form a self-reinforcing loop, which is triggered by the "focusing on the low-end" strategy (Effect I). Although only one consumer is affected, more than one consumers will eventually be affected. The argument is proved more rigorously in the following.

Proposition 5 :

When the challenger uses the "focusing on the low-end" strategy and $\frac{a}{r} \geq 1$*, eventually only 1 consumer will not pay for the incumbent's technology.*

Proposition 6 :

When the challenger uses the "focusing on the low-end" and $\frac{a}{r} < 1$*, eventually all (M of) consumers will not pay for the incumbent's technology.*

Similar to propositions 1 to 4, propositions 5 and 6 also indicate that the incumbent's installed base is more "fragile" when reservation difference between consumers (a) is smaller or network externality (r) is stronger. The incumbent faces the same dilemma whether to facilitate consumers' interactions and add some value to consumers via more convenient communication.

One may notice that the incumbent in this model set a price that makes one consumer (C_1) on the threshold of paying for the incumbent's technology or not. The pricing rationale is most profitable in the short run or without competitors. The single on-the-threshold consumer, however, can be a fuse triggering the chain reaction of abandoning due to network externality. One intelligent way is to lower the price to take all consumers away from the threshold point, that is, "make the fuse wet". Once the incumbent adopts such defensive strategy, the challenger may face difficulties to trigger the chain reaction by local attacking strategies.

Again we turn back to the challenger. The values of "a" and "r" can help to estimate the effect of "focusing on the low-end" strategy. When "a" is relatively small and "r" is relatively large, the "focusing on the low-end" strategy can be expected to have a larger effect on the incumbent's installed base.

For instance, word processing software (such as MS Word) may be one of the markets consisting of diversifying consumers. Students, professionals and administrators may have different reservation prices. In the model, the difference of consumer reservation prices may be large. On the other hand, network externality may be low to medium, that is, the value of "r" may be small. Based on propositions 5 and 6, we have the theoretical result that the challenger's "focusing on the low-end" strategy only has a limited effect.

When two local attacking strategies are analyzed, we are on the position to compare their effects.

Proposition 7 :

The "focusing on the high-end" strategy is more effctive than the "focusing on the low-end" strategy when $\frac{a}{r} \geq 1$.

Proposition 8 :

The "focusing on the high-end" and "focusing on the low-end" strategies are the same effective when $\frac{a}{r} < 1$.

To be clear, proposition 1 to 8 are summarized in Table 1.

Table 1: Comparison of two local attacking strategies

Number of consumers switch / Strategy / Scenario	Focusing on the high-end	Focusing on the low-end
$2 \leq \frac{a}{N_p}$	*2*	*1*
$\frac{k}{k-1} \leq \frac{a}{N_p} < \frac{k-1}{k-2}$	*k (3≦k≦M-1)*	*1*
$1 \leqq \frac{a}{N_p} < \frac{M-1}{M-2}$	*M*	*1*
$\frac{a}{N_p} < 1$	*M*	*M*

According to Table 1, we find that "focusing on the high-end" strategy is superior to the "focusing on the low-end" strategy in some cases however only the same effective in other cases. To sum up, "focusing on the high-end" strategy weakly dominates "focusing on the low-end" strategy in the context of network externality.

4. Conclusion

This paper analyzes the effects of two local attacking strategies by a challenger. The "focusing on the high-end" strategy is found superior to "focusing on the low-end" strategy in some industry scenarios.

Two local attacking strategies are shown to have larger eventual effects than the direct effects in the context of network externality. That is, local attacking strategies although only have limited direct effects but can trigger the chain reaction, which results in larger eventual effects.

By analysis of this paper, a challenger can estimate the effect of his or her local attacking strategies. When consumers have same similar reservation prices, the chain reaction is easier to be triggered and local attacking strategies have significant effects. On the contrary, local attacking strategies only have limited or local effects when consumers are very distinct in their reservation prices. The reason is that chain reaction is harder to be triggered.

In addition to consummers' heterogeneity in reservation price, the strength of network externality should be considered when estimating effects of local attacking strategies. Strong network externality represents larger value via communication between the consumers. The power to strengthen and facilitate chain reaction is stronger when network externality is stronger. Accordingly, effects of local attacking strategies arise with network externality.

On the contrary, weak network externality hardly pushes the chain reaction to go on. Therefore, the effects of local attacking strategies become weaker in the context

of weaker network externality.

From the incumbent's point of view, it is unwise to take over as much as consumers' surplus in the industries characterized by network externality. One consumer, who is stranded or stand on the threshold of abandoning or not, can be the fuse to trigger a scale of chain reaction. A better approach is to adequately lower the price to leave more surplus to consumers, that can be regarded as "make the fuse wet" approach. Alghouth that approach reduces the short-run profit, it can effectively retain the installed base stable and subsequently the seat of incumbent.

The strategic implication to the challenger is to find the "fuse", the consumer(s) who are least satisfied with the incumbent's current offering. "To light the fuse" can effectively take advantage of network externality. The better fuse is the high-end consumer(s) because of stronger eventual effects theoretically guaranteed by network externality. Practical targeting strategies are offering "rebate when old exchanged for new" or "special deal", or concentrating advertising and channel efforts to target at the better fuse.

Future researches extending or improving this paper can: (1) analyze the value of the timeliness of incumbent to stop the chain reaction, (2) provide defensive strategies and analyze their effects, (3) form a sequential attacking-defending game for an incumbent and challenger, and (4) consider the cost factors and subsequently provide a decision support model.

In addition, network externality between consumers may not always be *anonymous*, but *local* with identities. That is, a research may extend this paper by considering local network externality and find differences in results. Another natural extension of this paper is to consider different distributions of consumers' reservation prices. The form of distribution can indeed affect the effects of attacking strategies.

Reference

[1] Baake, P., & Boom, A. "Vertical product differentiation, network externalities, and compatibility decisions," *International Journal of Inudustrial Organization*, 2001,19(1,2), pp.267-284.

[2] Belleflamme, P. "Adoption of network technologies in oligopolies," *International Journal of Industrial Organization*, 1998,16(4), pp.415-444.

[3] Brynjolfsson, E., & Kemerer, C.F. "Network externalities in microcomputer software: An economic analysis of the spreadsheet market," *Management Science*, 1996,42(12), pp.1627-1647.

[4] Cabral, L.M.B., Salant, D.J., & Woroch, G.A. "Monopoly pricing with network externalities," *International Journal of Industrial Organization*, 1999,17(2), pp.199-214.

[5] Chiang, D.M., & Teng, D.C. "Pricing strategies with network externalities between two groups of customers," *NTU Management Review*, 2001,12(1), pp.1~36.

[6] Chiang, D.M., & Teng, D.C. "The installed-base-collapsing strategies with network externality," *Journal of Management*, 2003, forthcoming.

[7] Chou, C.-F., & Shy, O. "Network effects without network externalities," *International Journal of Industrial Organization*, 1990,8(2), pp.259.

[8] Church, J., & Gandal, N. "Complementary network externalities and technological adoption," *International Journal of Industrial Organization*, 1993,11(2), pp.239.

[9] Conner, K.R., & Rumelt, R.P. "Software piracy: An analysis of protection strategies," *Management Science*, 1991,37(2), pp.125-139.

[10] Conner, K.R. "Obtaining strategic advantage from being imitated: When can encouraging "clones" pay?" *Management Science*, 1995,41(2), pp.209-225.

[11] De Bijl, P.W.J., & Goyal, S. "Technological change in markets with network externalities," *International Journal of Industrial Organization*, 1995,13(3), pp.307-325.

[12] Farrell, J., & Saloner, G. "Installed base and compatibility: Innovation, product pre-announcements, and predation," *American Economic Review*, 1986,76(5), pp.940-955.

[13] Fishman, A., Gandal, N., & Shy, O. "Planned obsolescence as an engine of technological progress," *Journal of Industrial Economics*, 1993,41(4), pp.361.

[14] Katz, M.L., & Shapiro, C. "Network externalities, competition, and compatibility," *American Economic Review*, 1985,75(3), pp.424-440.

[15] Katz, M.L., & Shapiro, C. "Technology adoption in the presence of network externalities," *Journal of Political Economy*,1986,94, pp.822.

[16] Katz, M.L., & Shapiro, C. "Product introduction with network externalities," *Journal of Industrial Economics*, 1992,40(1), pp.55.

[17] Kristiansen, E.G. "R&D in the presence of network externalities: Timing and compatibility," *Rand Journal of Economics*, 1998,29(3), pp.531-547.

[18] Shapiro, C., & Varian, H.R. *Information Rules*. HBS Press, 1998.

[19] Shapiro, C., & Varian, H.R. "The art of standard wars," *California Management Review*, 1999,41(2), pp.8-32.

[20] Shy, O. "Technology revolutions in the presence of network externalities," *International Journal of Industrial Organization*, 1996,14(6), pp.785.

[21] Witt, U. ""Lock-in" vs. "critical masses" -- industrial change under network externalities," *International Journal of Industrial Organization*, 1997,15(6), pp.753.

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