Customer-capturing strategies: The way to replace existing technology characterized by network effects

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Abstract

Network effects are the basis of competitive advantage in digital economies. Although some researchers have indicated that technologies characterized by network effects are difficult to replace, real-world situations have not confirmed this argument. Challengers still defeat market leaders in markets with network effects. The analytical results presented here include the following: (1) a proposed new concept, *resilience*, can describe the resistive strength of a network to challenger customer-capturing strategies, (2) three types of networks can be identified based on their resilience values, and (3) high-resilience networks possessing technology are difficult to replace. © 2005 Elsevier Ltd. All rights reserved.

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1. Introduction

Network effects refer to the manner in which the value of adopting a technology depends on the number of customers who have already adopted that technology. Consequently, a technology with more current adopters benefits adopters more than one with fewer adopters. New users thus tend to prefer technologies with a larger *network* of adopters, which makes the larger networks even larger. Technologies can be accompanied by physical objects (such as telephone networks or railway networks) or not (such as the MS Windows platform, MS Word software (Conner and Rumelt, 1991; Padmanabhan et al., 1997)), or can be accompanied by website membership.

Competitive issues in markets with network effects are worth exploring because the ‘larger becomes larger’ characteristic of network effects guarantees the benefits of natural monopoly and the associated high margins.

Research on this issue is extremely interesting to practitioners.

Previous studies have examined the benefits of network effects for market leaders and subsequent social welfare inefficiencies (Farrell and Saloner, 1986; Cabral et al., 1999; Katz and Shapiro, 1992; Church and Gandal, 1993; Kristiansen, 1998). Moreover, various market leader strategies have been discussed (Choi, 1994; Chou and Shy, 1990; Church and Gandal, 1992). However, several issues have not been addressed: (1) few studies have provided competitive strategies for challenger firms in markets with network effects, (2) although the advantages of network effects have been comprehensively studied, the literature has not discussed the unfavorable characteristics of network effects, and (3) challenger victories are not explained theoretically, creating a gap between theory and practice.

This study provides customer-capturing strategies designed to enable challenger firms to compete with market leaders in markets with network effects. These strategies suggest that the challengers should exploit network effects to compete with the market leader. Discussing the effects of these strategies helps explain why challengers can defeat market leaders in markets involving network effects.

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This study makes three contributions: (1) providing customer-capturing strategies that enable challenger firms to compete with market leaders, (2) discussing the characteristics of network effects that are unfavorable to market leaders, thus improving knowledge on this area, and (3) explaining why challenger firms can defeat incumbent firms in markets involving network effects. Explaining challenger firm victory bridges the gap between industry history and academic theory.

The following first reviews the theoretical development of network effects and then describes the proposed model. Next, customer-capturing strategies are proposed and analyzed. Finally, managerial implications and future research directions are presented following the conclusion.

2. Theoretical development of network effects

Abundant literature has existed on network effects since the pioneering works of Farrell and Saloner (1985) and Katz and Shapiro (1985). Researchers have proposed various strategies for the players to survive in markets with network effects. For example, the players can build alliances, obtain first-mover advantages, and manage customer expectations to increase profits (Shapiro and Varian, 1999). Other popular research issues include whether to make products compatible with those of competitors and the accessibility of complementary assets (Economides, 1989; Matutes and Regibeau, 1992; Brynjolfsson and Kemerer, 1996; Gupta et al., 1999). The most well-known strategy or business model involves initially setting a low price for penetrating the market and then to increase the price once the network exceeds a ‘critical mass’ (Bensaid and Lesne, 1996; Shapiro and Varian, 1998).

Some conventional business wisdoms have been challenged in markets with network effects. Conner and Rumelt (1991) showed that the profits of the incumbent (the market leader in markets with network effects) can be increased by permitting piracy if most pirates are low-end users. The logic to permit piracy is that pirates provide utility to legal users via using the same technology to communicate with each other. Conner (1995) further proposed that introducing ‘clones’ (different but compatible products) can increase profits, something not envisioned by traditional business tenets.

A market characterized by network effects eventually becomes a winner-takes-all market, which is not always an optimum in terms of social welfare. Kristiansen (1998) proved that the enforcement of licensing policy could overcome such inefficiencies. The related literature is summarized in Chiang and Teng (2005) and the classic book *Information Rules* (Shapiro and Varian, 1998).

Recent works on network effects have examined product-launch strategies (Sun et al., 2004; Lee and O'Connor, 2003), pricing (Chiang and Teng, 2001; Gallaugh and Wang, 2002), innovative and strategic activities (Ehrhardt, 2004; Ende and Wijnberg, 2003), competition on utility thresholds (Tseng et al., 2005), and

the degree of network externalities (Gowrisankaran and Starvins, 2004) in markets with network effects. Therefore, companies should incorporate network effects into demand estimation (Madden et al., 2004) and focus on improving network effects (Bonardi and Durand, 2003).

The two studies most closely related to this study discuss the competitive strategies used by challenger firms. Witt (1997) designed a model for explaining technology replacement in growing markets. Moreover, Chiang and Teng (2003) demonstrated the possibility of a challenger winning by luring away the customers who have either extremely high or low preferences for the offering of the market leader.

Three unique points distinguish the present study from past works. First, this study does not require the assumption of growing markets, unlike Witt (1997). Second, the strategies proposed in this study do not require the identification of customer preferences, thus preventing practitioners from applying the conclusions of Chiang and Teng (2003). Finally, the analysis of customer-capturing strategies not only provides challengers with competitive strategies but also offers market leaders insights that can help in preventing technology replacement.

3. Model

The model comprises one market leader, one challenger, and a market containing M prospective technology users. The market leader begins as a monopolist who has contracted with all M users at the model starting point. All customers (adopters) decide whether to pay the market leader to renew the technology-usage privilege. Meanwhile, the challenger begins without contracting with any user.

Notably, the network size is easy to obtain. The firms running technology networks compete to advertise a large subscriber base to attract more prospective customers, and third-party neutral organizations report the market shares of the network owners. Customers can easily estimate the sizes of the technology networks.

Varian (1992) defined the reservation price P_i as the price below which consumer i would buy one unit of the good. If the reservation price is not reached, consumer i will buy nothing. To represent the heterogeneity of user reservation price for the technology of the market leader, a subscript i is assigned to users in an ascending order based on the value they gained from adopting the technology. Customer who gains the i th low value is called C_i and his/her reservation price is P_i .

The reservation-price distribution among users is assumed to be $P_i = a^*i + b + r^*(n - 1)$, where a represents the reservation price difference between customers and b refers to the constant value obtained by solely adopting the market leader's technology, and r represents the strength of the network effect, i.e., every current user contributes a value r to every other user. Katz and Shapiro (1985) assumed that the reservation price of all users was uniformly distributed. Our setting on reservation price of

all users is a modification of their model in terms of reservation-price distribution. A discrete reservation-price distribution can more accurately reflect the fact that customers are discrete identities rather than being continuous.

The service-renewal price set by the market leader is fixed in this study to focus on the effects of customer-capturing strategies. Another reason for fixing the price is to reflect the short-run rigidity or inflexibility of the pricing strategy of the market leader. Incorporating strategic interactions between the market leader and the challenger complicates the model and destroys the advantages associated with its simplicity.

The price set by the market leader equals the reservation price of the user with the lowest reservation price, i.e., $P = a + b + (M - 1)r$. Setting the price at this level is reasonable because in the short term, a lower price generates only a lower profit, but a higher price drives some customers away from the network.

This study further assumes that all customers in the technology network of the market leader decide whether to pay the market leader in *ascending order* of their reservation prices; i.e., whenever a challenger offers marketing promotions, customer C_1 will be the first one to consider refusing to pay the market leader for service renewal. C_2 follows, and so on, through C_M . This sequence is reasonable because customers with a lower reservation price are more susceptible to the temptation of challengers than those with a high reservation price.

For easy reference, this study lists the model notations:

- r : the strength of network effect, namely, the value one user contributes to every user using the same technology,
- P : the service-renewal price set by the market leader for each technology adopter,
- M : the total number of all prospective technology users in the market,
- n : the current number of users adopting the technology of market leader,
- C_i : the user with the i th low reservation price among all of the M users, and
- P_i : the reservation price of user C_i and $P_i = ai + b + (n - 1)r$.

Among the above parameters, P_i , r , and a are positive constants, P and b are non-negative constants, and M is an integer exceeding two.

The model parameters can be estimated using qualitative or quantitative psychometric tools such as in-depth interviews or questionnaires. Taking a , for example, some target prospects can be sampled and asked how much they are willing to pay given a particular sized network. The value of a is estimated by ranking the answers in order and averaging the difference of adjacent pairs of answers. The value of r can also be estimated using questionnaires in which subjects are asked how much they wish to pay the

network owner for an increase in the network size. The answers are averaged and adopted as the point estimation of r .

4. Analysis

The method adopted by a challenger firm for penetrating a market with network effects and one dominant market leader is critical. When network effects significantly increase customer switching costs, it becomes increasingly difficult to attract a large number of customers. A more logical strategy is to first capture a small market share, which in the current model is a single customer.

When the customer C_k is captured by the challenger, the remaining customers lose the value obtained from contact with customer C_k . Thus, the reservation prices of all the other customers decrease by amount r . C_1 now becomes dissatisfied with the offering of the market leader and refuses to pay the renewal fee. Customer C_2 then has the reservation price $2a + b + (M - 3)r$, which is not below the price set by the market leader, $P = a + b + (M - 1)r$, when $a/r \geq 2$. If the condition $a/r \geq 2$ is satisfied, customer C_2 agrees to pay the market leader for service renewal. The value of a/r is found to be crucial in determining the effect of customer-capturing strategies. Hence, this value is termed *resilience* to represent the 'solidness' of the technology network or 'immunity' of the network from ambush by challengers. For brevity, in the subsequent analysis, resilience (or the value of a/r) is denoted by R .

To analyze the effect of customer-capturing strategies on competition, this study first classifies technology networks into three types based on the value of R . First, networks with the resilience R of two or greater are termed *high-resilience networks*. Second, networks with the resilience R of below one are named *low-resilience networks*. Third, networks with the resilience R between one and two are termed *medium-resilience networks*. The decision regarding which customer should be captured and the effects of customer-capturing strategies are discussed by using the following three cases, respectively.

Case I: High-resilience networks: The high-resilience networks are defined as having resilience of not less than two ($R \geq 2$, i.e., $a/r \geq 2$). Therefore, the value that every technology adopter contributes to other adopters is less than half of the reservation price difference between adopters (i.e., $a/2 \geq r$). In such networks, the value of technology adoption comes primarily from using the technology itself, not from interactions with other adopters via the technology. Restated, such networks comprise users offering each other little interaction value and appearing to be vulnerable but, in reality, are not.

Challengers facing a high-resilience network can focus their resources on capturing an adopter (or customer) C_k , where $k \neq 1$. Once customer C_k is captured, the customer C_1 who was originally about to abandon the technology of the market leader refuses to pay the renewal fee; i.e., $P_1 < P$ holds true.

The chain reaction of customer refusal and network value reduction may stop. The reservation price of customer C_i is $P_i = ia + b + (M - i - 1)r$, which always exceeds $ia + b + (M - i - 1)r - (i - 1)a + ir$, i.e. P , when $R \geq 2$; i.e., $P_i \geq P$ always holds true. Every customer agrees to pay the market leader for service renewal. Meanwhile, the customer-capturing strategies generate only a tiny effect. In fact, the high-resilience network is ‘compact’ or immune to the ambush of the challengers.

Proposition 1. (High-resilience networks). *Customer-capturing strategy leads to exactly two customers refusing to pay the market leader when $R \geq 2$.*

Case II: Low-resilience networks: Low-resilience networks are defined as having a resilience below one ($R < 1$). Therefore, the value that individual technology adopters contribute to other adopters exceeds the reservation price difference between adopters. In such networks, the value obtained from technology adoption comes mainly from the interactions with other adopters via the technology. The adopters offering one another considerable value form a network that appears compact but in reality is not.

Challengers facing a low-resilience network can focus their resources on capturing one adopter (or customer) C_k . When customer C_k is captured, the customer C_1 also refuses to pay the renewal fee, i.e., $P_1 < P$ holds true.

The chain reaction of customer refusal and network value reduction may continue. The reservation price of an arbitrary customer C_i is $P_i = ia + b + (M - i - 1)r$, which is always below $ia + b + (M - i - 1)r - (i - 1)a + ir$, i.e. P , when $R < 1$; i.e., $P_i < P$ always holds true. Thus, every customer following C_1 refuses to pay the market leader. The customer-capturing strategies have an overwhelming effect. The low-resilience network is extremely vulnerable and sensitive to challenger attack.

Proposition 2. (Low-resilience networks). *Customer-capturing strategy lead to all M customers refusing to pay the market leader when $R < 1$.*

Case III: Medium-resilience networks: The third type of networks with resilience within an interval between one and two ($1 \leq R < 2$) are medium-resilience networks. Challengers facing medium-resilience networks can capture customer C_k . Following C_k , the customer C_1 also refuses to pay. This study first explores the strategic effects when the chain reaction of customer refusal and network value reduction stops before the customer C_{k+1} . The customer at which the chain reaction stops is denoted as C_s , where $s \leq k$, C_s 's reservation price P_s , which decreases by sr since customers $C_1 - C_{s-1}$ and C_k refused to pay the renewal fee to the market leader. The reservation price P_s must exceed the price P set by the market leader, i.e., $as + b + (M - s - 1)r \geq a + b + (M - 1)r$ must hold true, resulting in $R \geq s/(s - 1)$, or equivalently, $s \geq R/(R - 1)$. Because C_s is the stopping point, s should equal the Gaussian function of $R/(R - 1)$, i.e., $s = [R/(R - 1)]$ (the Gaussian function is defined as taking the largest integer value which is smaller

than the domain variable). The total number of customers who refuse to pay the renewal fee to the market leader equals s by counting $C_1 - C_{s-1}$ and C_k . Additionally, the condition $s \leq k$ must hold.

Proposition 3. (Medium-resilience networks). *Customer-capturing strategy leads to $\text{Min}\{[R/(R - 1)], k\}$ customers refusing to pay the market leader when $1 \leq R < 2$.*

A key question is whether the chain reaction goes beyond the customer C_k and stops between C_{k+1} and C_M . Based on the following calculations, the answer is negative. Since $R \geq 1$ (i.e., $a/r \geq 1$), $kr - ka = k(r - a)$ must be a non-positive term. Adding this non-positive term to P_{k+1} , which equals $(k + 1)a + b + (M - k - 1)r$, yields $a + b + (M - 1)r$ which simply equals P . Hence, P_{k+1} is constantly equal to or greater than P ($P_{k+1} \geq P$). Since $P_i > P_{k+1}$ when $k + 1 < i \leq M$, all subsequent customers (C_{k+1} to C_M) agree to pay the renewal fee to the market leader. Thus, the chain reaction is demonstrated to never go beyond the captured customer C_k . The maximal effect of customer-capturing strategies remains at k . This argument makes Proposition 3 applicable to medium-resilience networks without considering its stopping point.

The effects of customer-capturing strategies are summarized in Table 1.

The effects of customer-capturing strategies are also summarized in Fig. 1.

Table 1
Effects of the customer-capturing strategy

Scenario	The range of resilience R	No. ^a
High-resilience networks	$2 \leq R$	2
Medium-resilience networks	$1 \leq R < 2$	$\text{Min}\{[R/(R - 1)], k\}$
Low-resilience networks	$R < 1$	M

^aNo. denotes ‘the number of customers who refuse to pay the market leader’.

Fig. 1. Effects of customer-capturing strategies under various network resiliences. Note: ‘Effect’ indicates ‘the number of customers who refuse to pay the market leader’.

5. Conclusion

One new concept of *resilience* was proposed for describing the resistive strength of a network to challenger customer-capturing strategies. On the contrary, high-resilience networks defined by weak network effects are in fact compact and relatively immune to customer-capturing strategies of challengers. Hence, technology-possessing high-resilience networks are difficult to replace. On the other hand, low-resilience networks defined by strong network effects are vulnerable and relatively sensitive to the penetrating efforts of challengers. Consequently, technology-possessing low-resilience networks are easily replaced.

Medium-resilience networks are the compromise between the above two extremes. Networks with larger resilience set a *lower* upper bound on the effects of customer-capturing strategies, and networks with lower resilience set a *higher* upper bound on the effects of customer-capturing strategies.

This study makes several contributions to the literature. First, few research projects have addressed customer-capturing strategies in the context of network effects. This study introduces customer-capturing strategies and discusses their effects. Second, the analytical results indicate that technology challengers can replace existing technologies by capturing only a small number of customers. Restated, this study successfully explained technology replacement in markets with network effects. Third, this study presented the new concept of resilience, which is an indicator of the ability of leading technology to defend itself from the customer-capturing strategies of challengers.

This study also benefits technological competitors. Challenger firms can select customers with a higher reservation price to capture for exploiting network effects. Although relatively few customers are captured, the captured fraction of customers can cause a chain reaction, fueled by network effects, of reducing network size and value. The analytical results of this study reminded the owners of leading technologies to set a lower price to prevent the chain reaction from occurring. Furthermore, leading technology owners should be aware that while network effects can help build a kingdom, it can also help to destroy it. Stronger network effects not only strengthen customer linkages and the potential profits that can be drained from them, but also amplify the effects of customer-capturing strategies used by challengers.

Given the prevalence of high-tech products and services, numerous research topics exist related to network effects, and these topics can be classified into two categories: theoretical and empirical. For theoretical research, this study, along with the work of Chiang and Teng (2003), proposed a model for assessing competitive strategies in markets that are fixed in size or growing only slowly. Such an approach is new in the literature of network effects; subsequent research can apply this new approach to enrich the study of network effects. Next, the limitations of

network effects for market leaders or leading technologies have not been sufficiently discussed. More theoretical analyses can be performed to explore the influences of various offensive and defensive strategies. These research projects can provide additional insights into the dynamics of industrial competition.

For empirical research, researchers can find evidence to verify the models and arguments presented in this study. Empirical research is still lacking in relevant literature on network effects. Therefore, practical evidence would be valuable in making theories regarding network effects more solid and complete.

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