To Commit or Not:

Reputation and Preemption Strategies in Competing Technology Networks

Completed Research Paper

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Abstract

When an incumbent technology network faces a new entrant with superior capabilities, it may choose to announce a technology improvement as a preemption strategy to avoid forfeiting users. While the incumbent faces the dilemma of how much improvement it should commit to, users face the challenge of deciding how to divide resources (e.g., time spent) between the two networks. Using a two-period decision theoretic model, where users can be loyalists (who always prefer the incumbent) or switchers (ready to switch to the new entrant and back under suitable conditions), we show that in the presence of high switching costs, a low or high reputation leads the incumbent to a pure strategy of committing to a given level of improvement in technological capability. However, an incumbent with moderate reputation may not commit to any particular level of improvement. Consumer welfare may be adversely affected as a result of chosen strategies.

Keywords: Preemption, Pre-announcement, Reputation, Strategy, Network Competition.

I. Introduction

Consumers with switching costs frequently face the dilemma of choosing to stay with their current technology provider or migrate to a competing firm[1] with superior technology. Innovative firms often use preemption (e.g., the preannouncement[2] of a future innovation) as a strategy to encourage existing consumers to wait for an improved technology, which adds to the complexity of the consumers' decision problem. In an era of rapid advances in technology, the incumbent firm faces the challenge of determining the cost of technological improvement it is ready to bear and the time of delivery of such an endeavor. In addition, the firm must ensure that the actual delivery of the innovation is in accordance with the preannouncement, since the inability to do so would hurt the firm's reputation, which, in turn, determines the certainty a consumer associates with the firm's ability to deliver the preannounced technology.

Preemptive strategies are common amongst technology networks to secure market positions. In 2010, Apple entered the tablet computer market by announcing the launch of iPad, a revolutionary change in design and interface compared to tablet PC like HP Touch Smart that dominated the tablet PC market before Apple's entry. The incumbent HP reacted by preannouncing the release of Slate 500, a major leap in design over its existing tablets. However, this did not prevent consumers from adopting the iPad, which became the industry benchmark for tablet features and pricing. Was it prudent for HP to clearly commit to a future improvement in technology in the tablet market given its moderate reputation in this market? In early 2011, Apple announced its next innovation iPad 2 and delivered it in March of the same year. HP reacted with the preannouncement of HP Touch Pad. HP made it clear how it would match some of the key iPad capabilities, but remained uncommitted about many key features[3]. Was the relatively obscure preannouncement about Touch Pad the reason why many consumers were willing to wait for the release of Touch Pad before they made an adoption decision[4]? HP, however, could not deliver according to consumer expectations, leading to less-than-expected sales. In August 2011, HP discontinued the Touch Pad[5] and other WebOS devices. While the complete reasoning behind HP's preemption strategy is not clear, the change in HP's strategy and its ability to preempt consumers raise the question regarding the role of reputation on preemption strategies in technology networks, where there are small time windows between new innovations. Is it possible that incumbents can formulate better preemption strategies by taking their reputation into account?

The preemption literature discusses firm strategies for product pricing, preannouncement, timing and markets with or without network externalities (Beggs and Klemperer, 1992; Farrell, 1987; Farrell and Shapiro, 1988; Klemperer, 1987). Gerlach (2004) discusses the effect of announcement by a new entrant and the resulting reaction of the incumbent to preempt by cutting prices in a market where consumers have switching costs. In equilibrium, the new entrant does not always announce, and not announcing increases the ex-ante total welfare. Gerlach (2004) also shows that consumers can be better off with a ban on announcement. Choi et al. (2005) show that incentives for preannouncements are stronger in markets with network effects. In such markets preannouncements can be used to induce the delay of consumers' purchases and forestall the build-up of rival products' installed bases. The extant literature suggests that "vague" preannouncements may not have a strong influence on consumers and that information should be clear and informative. However, the literature also acknowledges that firms may not have an incentive to make clear preannouncements for the fear of product cannibalization, loss of reputation due to inability to deliver, and reaction from competition. The costs and benefits of preannouncement are different for consumers and firms, and these are less explored issues especially in a market where the new entrant arrives with a superior technology and where the incumbent's reputation influences its ability to successfully deliver a preannounced technology on time (Su and Rao, 2010). This paper attempts to bridge this gap by analyzing the effect of reputation on the committed or non-committal nature of a firm's preemption strategies.

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[1] In this paper the terms firm and network are used interchangeably.

[2] Preannouncement is a preemptive announcement made by a firm to preempt consumers to stay with the incumbent.

[3] http://www.precentral.net/palm-topaz-palmpad-vs-ipad

[4] http://www.pocket-lint.com/news/38452/apple-ipad-vs-hp-touchpad

[5] http://www.wired.com/gadgetlab/2011/08/hp-webos-tablet-touchpad

We model the case of two competing technology networks, where the product (network membership) is offered for free or are similarly priced. In such markets, consumers derive benefits primarily from (i) the innovation in technology provided by the network and (ii) network effects associated with the technology. Such markets are less prone to price competition and more inclined towards innovation related rivalry. The networks earn profits from partnering with service providers, advertisement or similar sources based on membership, which, in turn, derive value from network effects. However, product innovation and delivery are not costless. In addition, consumers incur costs in switching from one network to the other. In such a setting with positive network externalities and other switching costs, what level of technological capabilities should an incumbent firm announce in response to a new entrant with superior capabilities? What choices of membership do the consumers make when they are allowed to switch between networks by incurring a cost? Moreover, is it in the best interest of the incumbent to preannounce an uncertain future innovation (i.e., '*commit*') or should it not provide any clear indication about the level of innovation (i.e., *'don't commit'*)? How does the reputation of the incumbent influence the preemption strategy? This research seeks to answer these questions that are relevant to the modern competitive landscape of technology networks.

Ideally the incumbent should strive to induce high cost of switching to the new entrant, reduce the switching cost of consumers back from the new entrant, enhance reputation and bolster the proportion of loyalists in an attempt to keep the new entrant out of the market. However, this is not an easy endeavor. Thus, in most cases, the incumbent may have to share the market with the new entrant. Out of the feasible strategies of the incumbent, there can be a pure strategy (*commit to a specific level of capability improvement*) or a mixed strategy (*don't commit*) equilibrium depending on the reputation of the firm and the switching cost involved in migrating from the incumbent to the new entrant and vice versa. If reputation is lower than a threshold, then an equilibrium is possible whereby the incumbent profits only from the 'loyalists' whereas all 'switchers' migrate to the new entrant. For moderate levels of reputation, the firms randomize their strategies and choose to keep the consumers guessing about the level of improvement by making vague preannouncements. Moreover, for high or low levels of reputation, the firms have a pure strategy equilibrium whereby the incumbent can preannounce and commit to a certain level of improvement to consumers.

This research combines factors specific to firms (reputation), consumers (switching costs, loyalty), industry (network effects) and innovation (level of innovation, profitability) in order to use preannouncement as a preemption strategy (Su and Rao, 2010). The incumbent firm should realize that for reputation to influence a firm's profits, it must innovate in the cost effective production of desired technological capability before using a preemptive strategy. Firms should also understand the benefits of controlling the switching costs borne by the consumers and its effect on firm strategies.

While the extant literature has explored how reputation may affect the timing of a firm's preannouncement, it is not clear how firms with disparate levels of reputation should preempt in highly competitive technology markets with network effects and other switching costs, where there are short durations between successive innovations. The key contribution of this research is to demonstrate the role of reputation on the level of commitment to future technological improvements in such markets. Our works contributes to the reputation and preemption literature by demonstrating that while a low reputation incumbent will engage in a competition involving small technological improvements (the *battle of the minnows*), a high reputation incumbent will compete with large improvements in technology (the *battle of the giants*). However, incumbent with moderate reputation may find it beneficial not to clearly signal its future innovation (*sit on the fence*).

II. The Model

A two-period model is used to represent the dynamics in a market of two competing networks. Network A is the incumbent with capability $C(>0)$, and network B enters the market in period 0 with superior capability $C+\Delta$, $\Delta>0$. T represents the intensity of network effects when all consumers are on one network. Initially all consumers are on network A. To focus on network effects and switching costs, we assume no new consumers arrive while the existing consumers do not leave the market.

A proportion μ of the consumers are *loyalists* (Gerlach 2004) and will never switch to the new entrant. The remaining proportion $1-\mu$ represents *switchers*, who are similar in characteristics and decision making and who may switch between networks under suitable conditions. S_{AB} and S_{BA} represent the switching cost of consumers (switchers) when they switch from network A to B and B to A respectively. This model does not capture any additional heterogeneity, i.e., all switchers may switch or stay back with the incumbent. All consumers have the same discount factor δ. The decision tree of a switcher is shown in Figure 1.

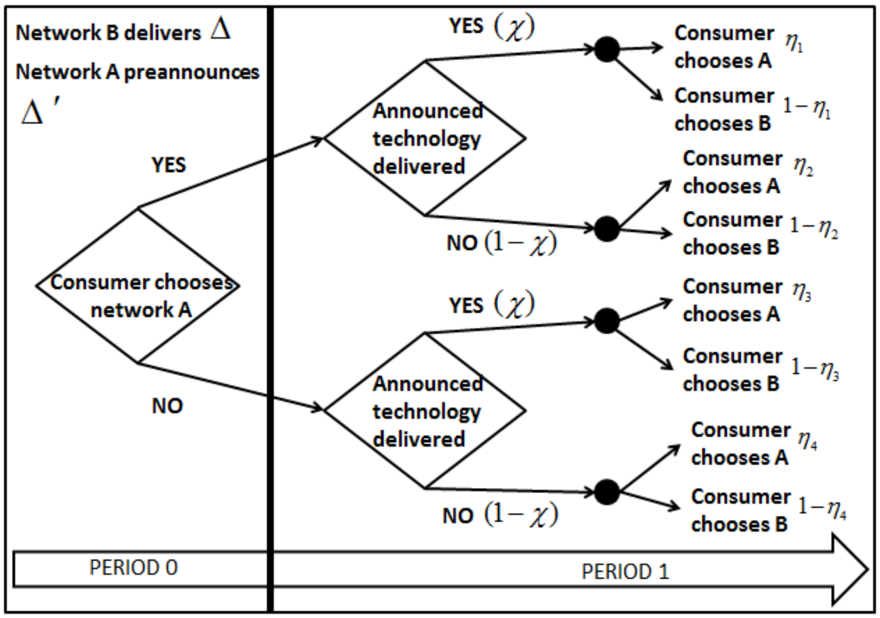

Figure 1: Decision of a switcher across time.

Upon the entry of new network B, the incumbent A preannounces an improved capability $C+\Delta'$ to be delivered in period 1, where $\Delta' \geq 0$. The consumers believe that network A will deliver the preannounced technology with a probability χ, and fail to do so with ($1-\chi$). Consumers receive services (or membership) for free, and the network (or firm) generates revenues from a single partner (on the other side of the market) that has a fixed budget pT in each period for the entire population and values all consumers equally. That is, the partner is willing to pay a fixed price p per consumer irrespective of the network size. Due to a single partner, there are no bidding mechanisms on the partner side of the market that may lead to differential pricing in this model. Content based networks are known to charge a fixed price for pay-per-click advertisements.

While $C, T, \mu, S_{AB}, S_{BA}$ are exogenously specified, Δ and Δ' are endogenous in regions specified by a range of χ. The reputation of a firm is positively correlated with the probability of successful delivery χ. Therefore, regions specified by χ can be mapped on to a region specified by the firm's reputation. The probability of successful delivery may depend on the extent of undertaking by the incumbent, and this effect is captured in regions specified by χ. A simple fixed price revenue model on the partner's side of the market helps us isolate the effect of probability of success (and therefore reputation) on preemption strategies. We do not focus on "vaporware" announcements, i.e., strategic false announcements made by the firm to deter entry by a competitor or migration of consumers. Rather the focus is on credible announcements, where the incumbent makes an honest effort to deliver the improvement, and where the chance of success is given by χ.

The binary parameters $\eta_1, \eta_2, \eta_3, \eta_4$ represent a switcher's choice of network A or B in period 0 and 1 (see Figure 1). η_1 and η_2 represent the actions of the switcher (1 represents the choice of network A and 0 represents the choice of network B) on success and failure of the incumbent to deliver the preannounced improvement in period 1, if the switcher chooses to stay back with the incumbent network A in period 0. Similarly, η_3 and η_4 represent the actions of a switcher in period 1 if she chooses to switch to the new entrant in period 1. For example, $\eta_1, \eta_2, \eta_3, \eta_4 = \{1, 0, 0, 1\}$ indicates that in period 1, a switcher will choose network A if the preannounced technology is delivered and network B if the preannounced technology is not delivered, if network A is chosen in period 0. It also suggests that in period 1 the switcher will choose network A if the preannounced technology is delivered and network B if preannounced technology is not delivered, if network B is chosen in period 0. The switcher derives an expected utility of EU_A or EU_B across two periods by choosing network A or B in period 0 respectively.

$$EU_A = C + T + \delta \begin{bmatrix} \chi\left\{\eta_1\left(C + \Delta' + T\right) + \left(1 - \eta_1\right)\left(C + \Delta + \left(1 - \mu\right)T - S_{AB}\right)\right\} + \\ \left(1 - \chi\right)\left\{\eta_2\left(C + T\right) + \left(1 - \eta_2\right)\left(C + \Delta + \left(1 - \mu\right)T - S_{AB}\right)\right\} \end{bmatrix} \quad (0.1)$$

$$EU_B = C + \Delta + \left(1 - \mu\right)T - S_{AB} + \delta \begin{bmatrix} \chi\left\{\eta_3\left(C + \Delta' + T - S_{BA}\right) + \left(1 - \eta_3\right)\left(C + \Delta + \left(1 - \mu\right)T\right)\right\} + \\ \left(1 - \chi\right)\left\{\eta_4\left(C + T - S_{BA}\right) + \left(1 - \eta_4\right)\left(C + \Delta + \left(1 - \mu\right)T\right)\right\} \end{bmatrix} \quad (0.2)$$

$$\eta_1 = 1 \text{ if } \Delta' > \Delta - \mu T - S_{AB},\ \eta_2 = 1 \text{ if } \Delta < \mu T + S_{AB},\ \eta_3 = 1 \text{ if } \Delta' > \Delta - \mu T + S_{BA},\ \eta_4 = 1 \text{ if } \Delta < \mu T - S_{BA} \quad (0.3)$$

There are sixteen possible combinations of $\eta_1, \eta_2, \eta_3, \eta_4$ (strategies of a switcher in period 1). However, not all combinations of $\eta_1, \eta_2, \eta_3, \eta_4$ are feasible. Regions are denoted by endogenous values of Δ and Δ'. Computing the equilibrium regions of operation is a two-step process. First the regions are found under which consumers would participate. Second given these feasible regions where consumers shall participate, we focus on those regions where the firm will operate given its profit maximizing problem and hence find the equilibrium regions in which the consumer will eventually operate. Table 1 and Table 2 show the infeasible and feasible combinations respectively. For a given $\mu, T, S_{AB}, S_{BA}, \Delta, \Delta'$ from Table 1, a switcher's strategy depends on the expected utilities from starting in network A or network B. The decision rule for period 0 is summarized in Table 2. Operating regions are defined by the technology provided by the new entrant and that preannounced by the incumbent in period 0 to induce the consumer to choose a strategy set denoted by $\eta_1, \eta_2, \eta_3, \eta_4$.

Table 1: Infeasible consumer strategies.

η_1	η_2	η_3	η_4	Comment
0	0	0	1	If a switcher chooses to migrate from A to B in period 0 by incurring the switching cost, then she has no incentive to migrate back to A by incurring switching costs again, if the promised improvement is not delivered.
0	0	1	1	
0	1	0	1	
0	1	1	1	
1	0	0	1	
1	0	1	1	
1	1	0	1	
0	1	0	0	This combination of decisions is not feasible because if a switcher has an incentive to switch to B in spite of delivery of technology by A, then there is no reason why she should stay with A if the improvement is not delivered.
0	1	1	0	
0	0	1	0	If a switcher has an incentive to migrate from B to A in period 1 on delivery of committed improvement by the incumbent, she has no incentive to switch from A to B in period 1.
1	1	1	1	If the switcher has an incentive to return to A irrespective of delivery of committed improvement, s/he has no incentive to switch from A to B in period 1.

Table 2: Feasible switcher strategies.

Consumer Strategy Set		Feasibility condition	Decision rule in Period 0	Region
η_1 η_2	η_3 η_4			
0 0	0 0	$\Delta > \mu T + S_{AB}$ $\Delta' < \Delta - (\mu T + S_{AB})$	A switcher always chooses network B. This is feasible only when the switcher heavily discounts future switching costs. (Region IB)	I
1 0	0 0	$\Delta > \mu T + S_{AB}$ $\Delta - (\mu T + S_{AB}) < \Delta' < \Delta - (\mu T - S_{BA})$	A switcher always chooses network B. (Region IIB)	II
1 0	1 0	$\Delta > \mu T + S_{AB}$ $\Delta' > \Delta - (\mu T - S_{BA})$	A switcher chooses network A (Region III A) if $\Delta < \mu T + S_{AB} + \delta\{\chi S_{BA} - (1-\chi) S_{AB}\}$ else chooses network B (Region III B).	III
1 1	0 0	$\max(0, \mu T - S_{BA}) < \Delta < \mu T + S_{AB}$ $\Delta - (\mu T + S_{AB}) < 0 < \Delta' < \Delta - (\mu T - S_{BA})$	A switchers chooses network A (Region IV A) if $\Delta < \mu T + \frac{S_{AB}}{1+\delta} + \chi \frac{\delta}{1+\delta} \Delta'$ else chooses network B (Region IV B).	IV
1 1	1 0	$\max(0, \mu T - S_{BA}) < \Delta < \mu T + S_{AB}$ $\Delta' > \Delta - (\mu T - S_{BA})$	A switcher chooses network A (Region V A) if $\Delta < \mu T + \frac{S_{AB}}{1+\delta(1-\chi)} + \chi \frac{\delta S_{BA}}{1+\delta(1-\chi)}$ else chooses network B (Region V B).	V

Each region has a strategy set $(\eta_1,\eta_2,\eta_3,\eta_4)$, Δ and Δ' specified by exogenous parameters μ, T, χ, S_{AB} and S_{BA}. Each region is divided into sub-regions (e.g., IA, IB, IIA, IIB, IIIA, IIIB, IVA, IVB, VA, and VB). IA, IIA, IIIA, IVA and VA denote the sub-regions of operation characterized by switcher strategy η_1,η_2, Δ and Δ'. Similarly, IB, IIB, IIIB, IVB and VB denote the sub-regions of operation characterized by switcher strategy η_3,η_4, Δ and Δ'. Later in the paper we show that under certain conditions, regions III, IV or V may be the dominant sub-regions of operation, i.e., networks operate in the region and consumers also have an incentive to participate.

Operating region IIIA is highlighted by Δ' being sufficiently high to make switchers stay back with the incumbent on successful delivery, while Δ is not large enough to cover the current period loss of network effects from loyalists, switching cost from A to B in period 0, and B to A in period 1 on successful delivery of the preannounced technology. However, Δ is large enough for switchers to migrate to B if the incumbent fails to deliver. Similarly, operating region IIIB is marked by Δ high enough for switchers to balance the loss in network effects from loyalists, switching cost from A to B in period 0 offset by the benefit of not bearing the switching cost to B if the incumbent A does not deliver. In this region, Δ' is not large enough to induce switchers to stay back with the incumbent in period 0, though it is high enough to balance the cost of switching from the new entrant back to the incumbent on successful delivery of the preannounced technology.

The networks operate in IVB when the preannounced technology Δ' is not high enough to keep the switchers from staying back with the incumbent but the technology delivered by the new entrant Δ is sufficient to cover the loss of network effects from the loyalist base, the cost of switching to the new entrant in period 0 and the benefit from technology that the switcher might have had if she returned to the incumbent on successful delivery of the preannounced capability. The networks operate in VB if preannounced technology Δ' is not sufficiently large to induce the switcher to stay back with the incumbent in period 0, but large enough to cover the switching cost incurred by the consumer when they return to the new entrant on successful delivery of Δ' in period 1. However, Δ is sufficiently large for switchers to have an incentive not to go back to the incumbent network if it fails to deliver the preannounced technology.

Table 3: Expected network effects in feasible sub regions.

Region	NE_A	NE_B
IB	$2\mu T$	$2(1-\mu)T$
IIB	$2\mu T$	$2(1-\mu)T$
III A	$\{1+\chi+(1-\chi)\mu\}T$	$(1-\chi)(1-\mu)T$
III B	$\{\mu+\chi+(1-\chi)\mu\}T$	$(1-\mu)T+(1-\chi)(1-\mu)T$
IV A	$2T$	0
IV B	$2\mu T$	$2(1-\mu)T$
VA	$2T$	0
V B	$\{\mu+\chi+(1-\chi)\mu\}T$	$(1-\mu)T+(1-\chi)(1-\mu)T$

Relatively speaking, sub-regions IIIA and IIIB have high technological capabilities provided by the incumbent and the new entrant, while sub-regions IVB and VB are characterized by low capabilities provided by both the networks. The incumbent must preannounce a higher technology in VB as compared to IVB and the new entrant must deliver a higher technology in IIIB as compared IIIA. Table 3 shows the expected total network effects NE_A and NE_B (across the two periods) on the incumbent and the new entrants, respectively, for different feasible regions.

The revenues earned by the networks are considered to be increasing in network effects. The profit functions of network A is given by $\Pi_A = (NE_A)\, p_A - \omega_A (C + \Delta')$ where NE_A is the total network effect in period 0 and 1 on network A, p_A is the price per consumer that the partner of the online network pay and the partner values every consumer equally, ω_A is the unit cost of developing capabilities on network A. Similarly, Network B's profit function is given by $\Pi_B = (NE_B)\, p_B - \omega_B (C + \Delta)$. Table 4 shows the maximum profits for the two networks for different regions.

Table 4: Maximum profit of network A and B for feasible regions

Region	Maximum Π_A	Maximum Π_B	Comments
I	$2\mu TP_A - \omega_A C$	$2(1-\mu)TP_B - \omega_B (C + \mu T + S_{AB})$	$S_{BA} > \mu T$
II	$2\mu TP_A - \omega_A (C + \Delta - \mu T - S_{AB})$	$2(1-\mu)TP_B - \omega_B (C + \mu T + S_{AB})$	$S_{BA} > \mu T$
IIIA	$\{1+\chi+(1-\chi)\mu\}TP_A$ $-\omega_A (C + S_{AB} + S_{BA})$	$(1-\chi)(1-\mu)TP_B - \omega_B (C + \mu T + S_{AB})$	$\frac{\chi}{1-\chi} > \frac{S_{AB}}{S_{BA}}$ $S_{BA} > \mu T$
IIIB	$\{\mu+\chi+(1-\chi)\mu\}TP_A -$ $\omega_A \left\{ \begin{matrix} C + S_{AB} + S_{BA} + \\ \delta(\chi S_{BA} - (1-\chi) S_{AB}) \end{matrix} \right\}$	$\{(1-\mu)+(1-\chi)(1-\mu)\}TP_B -$ $\omega_B \{C + \mu T + S_{AB} + \delta(\chi S_{BA} - (1-\chi) S_{AB})\}$	$\frac{\chi}{1-\chi} > \frac{S_{AB}}{S_{BA}}$ $S_{BA} > \mu T$
IVA	$2TP_A - \omega_A C$	$-\omega_B C$	$S_{BA} > \mu T$
IVB	$2\mu TP_A - \omega_A C$	$2(1-\mu)TP_B - \omega_B \left(C + \mu T + \frac{S_{AB}}{1+\delta} \right)$	$S_{BA} > \mu T$
VA	$2TP_A - \omega_A (C + S_{BA} - \mu T)$	$-\omega_B C$	$S_{BA} > \mu T$
VB	$\{\mu+\chi+(1-\chi)\mu\}TP_A -$ $\omega_A \left(\begin{matrix} C + \frac{S_{AB}}{1+\delta(1-\chi)} + \\ \frac{S_{BA}(\delta(2\chi-1)-1)}{1+\delta(1-\chi)} \end{matrix} \right)$	$\{(1-\mu)+(1-\chi)(1-\mu)\}TP_B$ $-\omega_B \left(\begin{matrix} C + \mu T + \frac{S_{AB}}{1+\delta(1-\chi)} \\ + \frac{\chi \delta S_{BA}}{1+\delta(1-\chi)} \end{matrix} \right)$	$\frac{\chi}{1-\chi} < \frac{S_{AB}}{S_{BA}}$ $S_{BA} > \mu T$

If $S_{BA} > \mu T$, i.e., if the switching cost faced by a switcher to return to network A is greater than the benefit derived from the network effect of the loyalists, network A prefers region I to II, while network B is indifferent between these two regions. Therefore, region II can be ruled out as a contender for the operating region. Further, network B will stay out of the market and never operate in regions IVA and VA because it suffers a loss in these regions, while network A prefers IVA to VA. Thus, if network A operates in IVA, network B stays out of the market. However, network A operates in IVA (i.e., all consumers remain on the incumbent) only if $\Delta < \mu T + \frac{S_{AB}}{1+\delta} + \chi \frac{\delta}{1+\delta} \Delta'$ (from Table 2). This condition is met with high switching cost from A to B, high reputation and proportion of loyalists. If the above condition is not met, then network A would consider IVB and VB as possible contenders for the operating region. In region IVB, the switchers choose to switch to network B and never return, while in region V, the switchers switch to network B in period 0, but switch back to network A if the preannounced technology is delivered. However, network A is indifferent between regions IB and IVB, whereas network B prefers IVB to IB, thus ruling out region I. While Network A prefers to operate in sub region VB, network B prefers IVB.

Proposition 1: *An incumbent with low or high levels of reputation commits to a given level of improvement in capability in its preannouncement. An incumbent with moderate level of reputation will not commit to any specific improvement.*

When the reputation of the incumbent is low, i.e. if $\chi < \chi_{th}$, IVB or VB is the strategic choice of operation for both the networks, where $\chi_{th} = \frac{S_{AB}}{S_{AB} + S_{BA}}$. This suggests that when S_{AB} forms the minor part of the total switching cost, it becomes relatively easier for switchers to migrate to B in period 0 and operate in region IVB or VB. If $\Delta^{'} < \Delta - (\mu T - S_{BA})$, i.e., the incumbent is not able to preannounce a capability that can match the improvement in the new entrant's capability over the network effect provided by the loyalist base and switching cost to switch back to network A, IVB (switchers migrate to the new entrant) is the equilibrium region of operation. However, if the incumbent can generate a higher technology, i.e., $\Delta^{'} > \Delta - (\mu T - S_{BA})$, VB is the equilibrium region of operation. For example, if switching costs across networks are identical and IVB is the region of operation, network A would prefer to announce no improvement in technology if the probability of delivery is less than 0.5. In this case, the incumbent profits purely from the loyalists.

If reputation of the incumbent such that $\chi > \chi_{th}$ indicating a high probability of delivery (for example, in case of similar switching costs $\chi > 0.5$) and also implying that switching cost from A to B is the major part of the total switching cost, then there are three final contenders for the operating region, namely IIIA, IIIB and IVB. While network B prefers region IVB to IIIB to IIIA, network A prefers IIIA to IIIB. Network A prefers IVB to IIIA (and both networks operate in IVB) if $\chi < \frac{\omega(S_{AB} + S_{BA})}{1-\mu} - 1$ otherwise network A prefers IIIA. Similarly, network A prefers IVB to IIIB if $\chi < \frac{\omega\{(1-\delta)S_{AB} + S_{BA}\}}{(1-\mu)TP - \omega\delta(S_{AB} + S_{BA})}$. Thus, unless operating in IVB is the dominant strategy, the networks do not have any pure strategies and would play a mixed strategy between regions IIIA, IIIB and IVB for incumbent firms with moderate reputation.

It should be noted that to focus on the effect of reputation on preemption strategy, the price charged per consumer by both network to their advertisers have been considered to be equal, i.e., $p_A = p_B = p$. This assumption has been made to make the analysis tractable and isolate the effect of price competition on the other side of the market (i.e. partner) from innovation for the consumer side. Moreover, to observe the effect of reputation alone, the cost per unit improvement in capability has been considered to be the same for both networks ($\omega_A = \omega_B = \omega$), i.e., networks do not have a competitive advantage over each other in building the improvement. This may be true in many cases today, where the production of Information Technology (IT) based technological improvements has been standardized and resources in the form of programmers, analysts and architects are not scarce. These assumptions are relaxed in the later part of the analysis.

Thus, we find that the incumbent firm would commit (preannounce an upcoming improvement) or not commit (obscure the ex-post improvement by not giving any clear signal) depending on its reputation. Figure 2 illustrates the effect of reputation on the incumbent's strategies. While the incumbent firm with low or high reputation will commit to operating in region IVB/VB or IIIA/IIIB respectively, an incumbent with medium levels of reputation will prefer not to commit to any one strategy and would rather have a mixed strategy equilibrium. Firms with medium reputation will thus engage in "vague" preannouncement strategies (Su and Rao 2010). Thus when region IIIA or IIIB is a pure strategy equilibrium, i.e., when switchers start from A or B respectively, but always end up with network A on success and network B on failure to deliver the preannounced technology, we call the incumbent's reaction to the new entrant as a *'battle of the giants'* where a highly reputed incumbent network engages in a high technology battle to secure its market positions.

For example, in 2008, Roku pioneered the streaming player and allowed consumers to stream content from Netflix. With the only streaming player that had a partnership with Netflix, Roku built a high reputation in this market. In the same year, Apple TV entered the market (similarly priced as Roku) and allowed its consumers to stream content from iTunes, MobileMe and Flickr. While some of the streaming services offered by Roku and Apple TV are free, consumers have to pay a monthly subscription fee for others. It became clear that consumers wanted to adopt the player that could give them more streaming services options. When Apple TV added Netflix to its service providers, Roku preempted its customers from switching by preannouncing the addition of services like Amazon VOD, Hulu Plus and Pandora. The high reputation incumbent Roku (synonymous to a giant in this case) was successful in forestalling a widespread adoption of the new entrant Apple TV by committing to future improvements in technology.

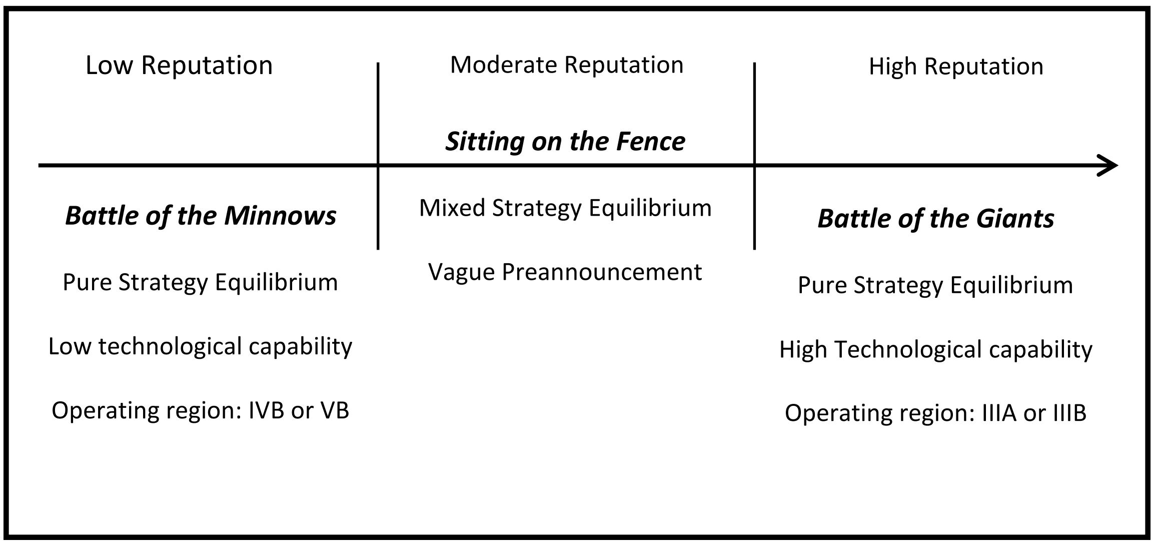

Figure 2: Effect of reputation of the incumbent network on the operating region.

Similarly, when the technological improvements provided by the new entrant and the preannouncement by the incumbent are low, a low reputation incumbent engages the new entrant in a *'battle of the minnows'* where a switcher always switches to the new entrant in period 0 and never returns (IVB), forcing the incumbent to profit only from the loyalists, or returns only on successful delivery of preannounced technology (VB).

For moderate levels of reputation, the incumbent and the new entrant do not have pure strategy equilibrium, and therefore the incumbent's preannouncement may not commit to any specific technology. Rather the incumbent network would prefer to 'sit on the fence', make obscure preannouncements and keep the consumers guessing about its future strategies. Not committing would mean that the networks do not have pure strategy equilibrium i.e. it has more than one feasible region of operations and will play a mixed strategy (Nash equilibrium refinement concept like the trembling hand perfection can be used). Randomizing over different strategies means they could play any of the feasible strategies and are not committing to any one strategy in particular. Thus, consumers may not assume that $\Delta' = 0$. Under such a scenario, consumer's dilemma is deepened by vague preannouncements made by the incumbent. Thus, consumers can either choose to wait or take a leap of faith. The effect of 'sitting on the fence' may delay consumers from switching to the new entrant who may want to take a decision only after the incumbent's technology is delivered in period 2.

As discussed before, such a strategy may have been taken by HP with Touch Pad in its competition against Apple's iPad2. Twitter's strategy could be another example. By 2009, Twitter had built moderate levels of reputation in the market of micro blogging and social networking service. However, Twitter protocols could be used by other micro blogging or social networking service providers to create mash-ups[6] or Twitter like applications. Thus, Twitter was directly competing with other networks providing Twitter based applications. In late 2009, Twitter made an announcement about increasing its capabilities by joining hands with YCombinator led Twitter projects (Justin.Tv, Scribd, Dropbox) by giving them a better access to tweet[7] streams. The announcements did not clarify what level of access was going to be granted to YCombinator led companies and how this would affect other companies using the Twitter protocol. Twitter's vague announcement can be seen as a signal its consumers to use applications developed by YCombinator led companies to get reliable and uninterrupted service. This may be Twitter's strategy of getting a share of the mash-up market which was generating revenue based on the Twitter protocol without sharing profits with Twitter. Moreover, this non-committal nature of Twitter has also left other consumer of the Twitter protocol (mash-up development firms) in a dilemma about their future strategies of building Twitter based mash-up applications.

Proposition 2a: *For a large improvement in technology over the incumbent, reputation has a positive influence on profits of the incumbent in a 'battle of the giants' only if the ratio of investment per unit improvement in capability to total revenue generated from switchers is low; otherwise reputation influences profits negatively.*

For incumbents with high reputation (as shown in Table 5), the profit increases with reputation when operating in sub-region IIIA. In this sub-region a switcher begins with network A in period 0 and remains on A if preannounced capability is delivered by the incumbent, and switches to B otherwise. Thus, a high reputation has a positive effect on profits of the incumbent in this sub-region. However, in IIIA, the new entrant's profit decreases with increase in reputation. In sub region IIIB, the switchers start with B and move back to A only if the preannounced capability is delivered. In this case, since the switcher chooses the new entrant in period 0, the reputation plays a role to influence these switchers to come back to the incumbent in period 1 on successful delivery of committed improvement. In such a scenario, it is crucial for the incumbent to keep low its ratio of investment made to the total revenue generated from switchers (proof provided in the Appendix). If it is able to do so, then the incumbent can increase its profits when its reputation increases. However, if the investments made are not cost effective then increase in reputation hurts the incumbent. Furthermore, in IIIB the new entrant's profit decreases with increase in reputation.

Table 5: Effect of increase in reputation of the incumbent on consumer welfare and network profit in a 'Battle of the Giants'.

Total Consumer Welfare		*Network A's Profit*		*Network B's Profit*	
New-Entrant Technology		*New-Entrant Technology*		*New-Entrant Technology*	
High	*Low*	*High*	*Low*	*High*	*Low*
⬆	⬆	*Increases if technology production is cost effective.*	⬆	⬇	⬇

[6] Mash-up is a term used in web development to characterize a web page or application that combines services from different sources to create a new service.
[7] Tweet is a post or an update in status on Twitter which is a micro blogging service.

Proposition 2b: *For a high preannounced improvement in technology, reputation has a positive influence on profits of the incumbent in a 'battle of the minnows' only if the ratio of investment per unit improvement in capability to the total revenue generated from switchers is low; otherwise reputation influences profits negatively.*

For incumbents with low reputation (as shown in Table 6) profits of the networks are not influenced by reputation, when operating in sub-region IVB. In this sub-region a switcher begins with B in period 0 and remains on B in period 1. However, in sub-region VB, a switchers start with B and migrate back to A only if the preannounced capability is delivered. In this case, since the switcher chooses the new entrant in period 0, reputation plays a role to influence these switchers to come back to the incumbent in period 1 on successful delivery of the committed improvement. In such a scenario, it is crucial for the incumbent to keep low its ratio of investment made to the total revenue generated from switchers (*proof provided in Appendix*). If it is able to do so, then the incumbent can increase its profits when its reputation increases. However, if the investments made are not cost effective then increase in reputation hurts the incumbent.

Table 6: Effect of increase in reputation of the incumbent on the total consumer welfare and networks' profits in the 'Battle of the Minnows'.

Total Consumer's welfare		*Network A's Profit*		*Network B's profit*	
Preannounced Technology		*Preannounced Technology*		*Preannounced Technology*	
High	*Low*	*High*	*Low*	*High*	*Low*
⬆	*No Effect*	*Increases if technology production is cost effective.*	*No Effect*	⬇	*No Effect*

Given a sub-region of operation (a given reputation), the total consumer welfare and profits of the firm may vary with switching costs. For a given sub-region (strategy set of consumers, improvement delivered by new entrant and improvement preannounced by the incumbent), the total consumer welfare is given by the sum of the expected utilities of the loyalists and switchers.

Table 7: Effect of switching costs on total consumer welfare and networks' profits in the 'Battle of the Giants'.

Switching Cost	*Total Consumer Welfare*		*Network A's Profit*		*Network B's profit*	
	New-Entrant Technology		*New-Entrant Technology*		*New-Entrant Technology*	
	High	*Low*	*High*	*Low*	*High*	*Low*
S_{AB} increases	⬇	⬆	⬆	⬇	⬇	⬇
S_{BA} increases	⬆	*No Effect*	⬆	⬇	⬇	*No Effect*

***Proposition 3**: In a 'Battle of the Giants', if the new entrant delivers a high improvement in technology and switching costs S_{AB} and S_{BA} are high and low respectively, the total consumer welfare is lower than what it would be if S_{AB} and S_{BA} are low and high respectively.*

If the new entrant delivers a high improvement in technology, it is more likely that switchers will migrate to the new entrant network B in period 0 while loyalists always stay with the incumbent. Therefore, the switching cost from A to B, S_{AB} must be incurred by switchers in period 0 to induce the switchers in this sub region. Since in the 'battle of the giants' a switcher chooses the incumbent if the committed improvement in technology is delivered, she must incur S_{BA} in order to switch back to the incumbent if the preannounced improvement in technology is delivered. This suggests that consumers would prefer a high S_{AB} and low S_{BA} in this sub-region *(see Table 7)*. However, it should be noted that while the incumbent would prefer a high S_{AB} and S_{BA}, the new entrant would prefer a low switching costs *(see Table 7)*. It may be observed that if the incumbent could induce S_{AB} (incumbent prefers high switching cost) and the new entrant could induce S_{BA} (new entrant prefers low switching cost), the total welfare of the consumer will be high because in terms of switching costs, the interests of the incumbent and the new entrant will be aligned with the consumers.

***Table 8:** Effect of switching costs on total consumer welfare and networks' profits in a 'Battle of the Minnows'.*

Switching Cost	*Total Consumer welfare*		*Network A's Profit*		*Network B's profit*	
	Preannounced Technology		*Preannounced Technology*		*Preannounced Technology*	
	High	*Low*	*High*	*Low*	*High*	*Low*
S_{AB} increases	↑	*No Effect*	↓	*No Effect*	↓	↓
S_{BA} increases	↓	*No Effect*	↓	*No Effect*	↓	*No Effect*

***Proposition 4:** In a 'Battle of the Minnows' when the incumbent preannounces a large improvement in technology, for a given S_{BA}, a high S_{AB} leads to high welfare for the consumers but low profit for the networks, while a low S_{AB} leads to low welfare for the consumers but high profit for the networks.*

From Table 8, we note that when a low reputation incumbent preannounces a high improvement in technology, consumers may feel that it is more likely to fail given its low reputation. Therefore, a switcher expects to migrate to B in period 0 and then migrate to A only if the delivery of the preannounced technology is successful. However, the new entrant in this sub-region also delivers a high improvement in technology and must motivate a switcher to migrate to the new entrant in period 0. Thus, the higher the switching cost, the higher the technology delivered by the new entrant, safeguarding the switcher in case the incumbent fails to deliver in period 1. Both the networks generate low profits in order to balance switching costs.

III. Conclusion

In technology networks with switching costs, incumbent networks often use preemption strategies like the preannouncement of future technologies in order to dissuade consumers from migrating to the new entrant with superior technology. However, not all preemption strategies succeed. This paper explores the role of reputation of the incumbent on preemption strategies. Our results show that in order to preempt consumers from migrating permanently, an incumbent with high reputation should make clear preannouncements, committing to a considerable future improvement in technology when the new entrant offers a high improvement over the status quo. We call this high technology competition between two networks as the ‘battle of the giants’. A similar strategy is advisable for incumbent with low reputation. In a ‘battle of the minnows’ between two low technology networks, the incumbent is better of giving clear signals of it future improvements in technology. However, an incumbent with moderate reputation should engage the market with vague announcements and not commit to any specific improvements in technology (*sit on the fence*). The implication of vague preannouncements could be that the incumbent informs the market with *incremental disclosure* of its improvement as the delivery date comes closer or devise a marketing campaign with *teaser advertisements*. Further, while the reputation of the incumbent may help justify the preemption strategy, the profit of the firm is dependent on its ability to deliver technology in a cost effective manner. Our study also shows that consumer welfare may be adversely affected depending on the switching cost and preemption strategy of the incumbent for its reputation of delivering the preannounced technology.

IV. References

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Appendix

Proof of proposition 2a:

When the high reputation incumbent engages the new entrant in a ‘battle of the giants’ in region IIIB, the incumbent’s profit is given by

$$\Pi_A = \left\{\mu + \chi + (1-\chi)\mu\right\} TP_A - \omega_A \left\{C + S_{AB} + S_{BA} + \delta\left(\chi S_{BA} - (1-\chi) S_{AB}\right)\right\}.$$

$\frac{\partial \Pi_A}{\partial \chi} > 0$ if $\frac{\omega_A}{(1-\mu)TP_A} < \frac{1}{\delta\left(S_{AB} + S_{BA}\right)}$. If the ratio of the cost per unit improvement in technology to the total revenue generated from the switcher is less than a threshold determined by discounted total switching costs then the reputation influences the profit of the incumbent positively. Otherwise, the profit of the firm suffers due to increase in reputation in this region, because technology is not produced in a cost effective manner.

Proof of proposition 2b:

When the low reputation incumbent engages the new entrant in a 'battle of the minnows' in region VB, the incumbent's profit is given by, $\left\{\mu+\chi+(1-\chi)\mu\right\}TP_A-\omega_A\left(C+\frac{S_{AB}}{1+\delta(1-\chi)}+\frac{S_{BA}\left(\delta(2\chi-1)-1\right)}{1+\delta(1-\chi)}\right)$.

$\frac{\partial\Pi_A}{\partial\chi}>0$ if $\frac{\omega_A}{(1-\mu)TP_A}<\frac{\left(1+\delta(1-\chi)\right)^2}{\delta S_{AB}+\delta(1+\delta)S_{BA}}$. If the ratio of the cost per unit improvement in technology to the total revenue generated from the switcher is less than a threshold determined by discounted switching costs then the reputation influences the profit of the incumbent positively. Otherwise, profit of the firm suffers due to increase in reputation in this region, because technology is not produced in a cost effective manner. When $\chi\to 0$, $\frac{\omega_A}{(1-\mu)TP_A}<\frac{1+\delta}{\delta S_{AB}+\delta(1+\delta)S_{BA}}$.