Focality Advantage in Platform Competition

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Abstract

We consider a methodology for studying how beliefs shape platform competition, based on the notion of a partial focality. The concept of focality is useful for modeling platform competition when the presence of network effects results in multiple equilibria for a certain set of prices. We illustrate how to implement this methodology in both static and dynamic competition between platforms that differ in their basic quality. The initial degree of focality affects the ability of the high-quality platform to win the market. Yet, dynamic considerations may have positive or negative effect on this ability.

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1 Introduction

In platform competition, agents want to join the same platform that other agents are joining in order to interact with each other and benefit from network effects. Therefore, when choosing a platform, agents need to form beliefs regarding the participation decision of other agents.

A platform can gain competitive advantage if consumers expect it to attract other consumers. We refer to such a platform as a "focal" platform. A "non-focal" platform may face a "chicken-and-egg" problem, as consumers may be reluctant to join it simply because they expect that other consumers will not join it.

An example of such challenge is Microsoft's difficulty promoting its Windows Phone operating system (Vincent, 2017). Application developers were reluctant to develop

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apps, because they were skeptical about whether Microsoft could attract consumers away from Google and Apple. The consumers were reluctant to adopt a platform that did not offer as many apps as the others (Ovide and Sherr, 2012). The same dynamics made it difficult for Blackberry to promote its BB10 operating system (Sawers, 2016). At the same time, Apple was very successful in launching its successive models of the iPhone, but was facing a chicken-and-egg problem in the market for electronic wallets, where merchants did not expect consumers to use the service, while consumers did not expect merchants to adopt it (Wakabayashi and Bensinger, 2014).

The success of Apple's iPhones shows the other side of this dynamics. Apple got a large number of pre-orders for iPhones 5, 6, and 7 (Faughnder and Satariano, 2012, Tibkin and Rubin, 2014, and King, 2016). Thus, the users were buying the new — and expensive — phones, even though there were no new applications and the existing applications could not yet support the features of the new phones. In each new generation the phone was equipped with attractive new features independent of the available apps. It is unlikely, however, that these improvements by themselves justify the huge demand at the steep price. More likely, users were also anticipating additional benefits of new apps, and improved functionality of existing apps. These benefits indeed quickly appeared, as new and incumbent app developers found it attractive to offer more and better apps to the users who adopted the new systems. That is, Apple has enjoyed favorable beliefs of the market, and thus a focal position, while Windows and Blackberry have not. Clearly then, the success of a platform depends on a firm's ability to convince customers that other customers will join as well.

This paper considers platform competition when one of the platforms benefits from a focal position. The main question we explore here is whether a high-quality but non-focal platform can overcome its unfavorable belief disadvantage, when competing against a low-quality, yet focal platform. Using a simple model, we offer a methodology for modeling a varying strength of focality advantage in both a static and a dynamic model. This methodology can provide a valuable tool to researchers, for studying additional research questions concerning platform competition. We model focality by extending the concept of platform focality defined by Caillaud and Jullien (2003) to more general environments. In the basic concept of focality agents expect that other agents will join the focal platform whenever prices allow for such an equilibrium to exist. In such a case, each agent, based on his belief, will also join the focal platform, thus fulfilling the expectations of other agents. So defined, focality offers a very strong advantage to one platform. It is possible for a non-focal platform to dominate the market, but only when it charges such low prices that an equilibrium where all agents join the focal platform does not exist.

We recognize that in many environments a focal platform, while holding some advantage in the market, may not enjoy such a dominant position. It may still be possible for a non-focal platform to dominate the market, even if both equilibria exist, as long as it offers a sufficient price advantage to compensate for the focality disadvantage. Therefore, in our definition of focality, we focus on the role of the prices the firms set in affecting customers' beliefs about the attractiveness of each platform to other customers.

We allow for the strength of the focality to vary. The stronger the focality, the larger the price advantage the non-focal platform needs to convince customers that it is sufficiently attractive to other customers, and to be adopted in the market. For any strength of focality, there exists a threshold such that if a price difference is above the threshold, customers believe that other customers will join the non-focal platform (and therefore, they also find it optimal to join the non-focal platform). Similarly, if the price difference is below the threshold, customers will join the focal platform. Thus, the price difference affects the beliefs of customers by serving as a coordination device when multiple equilibria exist.

The effect of prices on agents' beliefs depends on the strength of focality. The definition of focality does not identify how and why this focality emerges. But we can think of many reasons why a platform can become focal and how it may increase or lose focality strength. It may come from a more recognizable brand name or better past track record. We allow, however, current quality offered by the platforms to be unrelated to the track record or brand name. A platform may be non-focal even if it offers quality that is the same as, or even superior to, that of the focal platform.

In our base model, two platforms compete for one period and vary in their basic qualities. One of the platforms benefits from a focal position, which we allow to vary in strength. We start by showing that a low-quality but fully focal platform dominates the market if network effects are more important to consumers than the quality gap between the platforms. When the low-quality platform benefits from only a partial degree of focality, the high-quality platform can dominate the market (even though network effects are more important than the quality gap), if the focality advantage of the low-quality platform is below some threshold.

Since one of the sources of focality may be the past track record of the platforms, we also explore how dynamic considerations affect platforms' strategies and market efficiency. Winning in one period may improve a platform's focality in the next. The platforms may then have incentive to invest in their focality by subsidizing users to join. Halaburda, Jullian and Yehezkel (2017) study a dynamic game in which the winning platform in the current period gains a strong focality in the next period. In this paper, we extend this analysis to the case where the winning platform gains weak focality. We show that these incentives make it more or less likely that the non-focal but higher-quality platform will win the market, depending on how the focality evolves between periods.

Notice that focality is useful for modeling platform competition when the presence of network effects results in multiple equilibria for a certain set of prices. In many modeling approaches such multiplicity never occurs, as, for example when horizontal or vertical differentiation is assumed to be stronger then the impact of the network effect. In environments where the network effects are the dominant force, we need to face a coordination problem, and employ a modeling approach that takes this into account.

2 Related Literature

Our work relates to the theoretical literature on coordination problems in platform competition, which started with the pioneering work of Katz and Shapiro (1985). Caillaud and Jullien (2001 and 2003) introduce the notion of "favorable beliefs," which is equivalent to "focality." They focus on competition between two platforms that are identical except for the focality. They show that the best strategy for the non-focal platform is to adopt a "divide-and-conquer" strategy, in which the platform subsidizes one side of the market and charges a high price from the other side. Hagiu (2006) extends the concept of focality to a sequential game, where one side of the market joins a platform before the other side. Jullien (2011) considers focality in a multi-sided market, where one platform offers a quality that is superior to that of the other. Halaburda and Yehezkel (2013) consider focality when the two sides have asymmetric information concerning their valuations from joining a platform. In all of the above papers, the concept of a focal platform shapes the way platforms compete. Moreover, all the above papers consider a strong, all-or-nothing, focality.

While these results show the importance of consumers' beliefs, they do not analyze how these beliefs can be affected by the prices set by the platforms. White and Weyl (2016) argue that platforms can solve the coordination problem by using so-called insulating tariffs, where the platform's price is contingent on the number of agents who join it. Halaburda and Yehezkel (2016) consider the possibility that consumers expect other consumers to join the focal platform only if the price gap between the focal and non-focal platforms exceeds some threshold. They find that the degree of coordination bias (equivalent to strength of focality here) has a qualitative effect on the platforms' pricing and business models.

The above papers consider static platform competition. Yet, platforms typically engage in dynamic competition. Cabral (2011) analyzes dynamic competition with network effects in an environment with switching costs, installed base, and heterogeneous agents. As he shows, in that environment a platform with a smaller network may be active in the market, despite a lack of intrinsic quality advantage. Consumer heterogeneity and switching costs allow for niche firms to exist and periodically gain strong position, despite network effects. In Fudenberg and Tirole (2000) platforms compete over multiple periods, building their installed bases. It is assumed that the higher quality platform is always focal, and thus the focality does not depend on the history.

In some environments, however, dynamics may affect focality. Consumers may look at the platform's history and attach a stronger degree of focality to the platform that dominated in the past. Argenziano and Gilboa (2012) analyze a multi-period coordination game, where agents form beliefs about the choice of other agents based on the outcomes of previous periods. The platforms in their model, however, are not active players. Biglaiser and Cremer (2016) consider a dynamic competition between strategic and price-setting platforms when beliefs are history dependent. They focus on identical platforms and heterogeneous consumers, and show that the market can be inefficient, when consumers join different platforms while efficiency requires that all consumers join the same platform in order to benefit from the network effects. Halaburda, Jullien and Yehezkel (2017) consider dynamic competition between a high and a low-quality platforms, when consumers attach a strong focality to the platform that dominated the market in the previous period. The paper shows that in a finite-horizon game, when the platforms are more forward looking, it becomes more likely that the best platform will win the market, even if it is initially non-focal. However, in an infinitely repeated game, when platforms become more forward looking, a low-quality focal platform can improve its competitive advantage. Hence, dynamic considerations may increase market inefficiency.

Our paper contributes to the above literature by offering a general methodology for studying a partial focality advantage. The first part of this paper illustrates the concept of a partial degree of focality, and identifies how the degree of focality affects prices and the identity of the winning platform. In the second part of the paper we extend the dynamic model of Halaburda, Jullien and Yehezkel (2017) to a finite-horizon game where initially one of the platforms is only partially focal, and winning the market in the current period provides the platform with a partial increase in its degree of focality (instead of strong focality, as in Halaburda, Jullien and Yehezkel (2017)). We show that as platforms become more forward looking, market inefficiency may decrease or increase, depending on the degree to which focality is affected by history.

In this special issue, Biglaiser, Calvano and Cremer (2018) survey the existing literature on incumbency advantage in platform competition, including coordination and beliefs (their paper also surveys other sources of incumbency advantage). Their focus on the approach of Biglaiser and Cremer (2016) to studying coordination problem with heterogeneous agents is complementary to ours. In the terminology of our paper, their approach allows for *multiple* focality: beliefs that support an equilibrium with more than one incumbent possessing a positive market share. Our paper focuses on extending the approach of a single focality to *partial* focality: beliefs that support an equilibrium in which coordination provides a platform with only a partial incumbency advantage. We illustrate how the degree of focality affects market outcome in both a static and a dynamic model.

3 The Model

Consider a market with a homogeneous consumer population of size 1 and two competing platforms, $i = A, B$, with the same cost (normalized to 0). Each platform i offers to the customers a stand-alone value, $q_i > 0$, which we refer to as *quality.* Additionally, consumers benefit from network effects. A consumer's utility from adopting platform i is

$$q_i + \beta n_i - p_i,$$

where n_i is a measure of the other consumers who have adopted i, β denotes the strength of network effects, and p_i is the price of platform i.

The platforms first simultaneously set their prices, p_A and p_B. Consumers then observe the prices, and simultaneously and non-cooperatively choose whether to join platform A, B, or not join any platform. In the latter case, the utility is 0.

4 The concept of focality

To solve the model, we begin with consumers' allocation decisions given the platforms' prices. Suppose that the two platforms charge the prices p_A and p_B and now consumers need to decide which platform to join. Their decision depends on their beliefs regarding the participation decisions of other consumers, and this may result in multiple equilibria. More precisely, there is an equilibrium in which all consumers join platform A if:[1]

$$q_A + \beta - p_A \geq q_B - p_B \iff p_B - p_A \geq q_B - q_A - \beta. \quad (1)$$

[1]We focus on equilibria in which all consumers join the same platform. Any equilibrium in which some consumers join platform A while others join B is unstable. This is because in such an equilibrium, all consumers are indifferent between joining A or B. Consequently, when a marginal consumer switches from platform i to platform j, the utility of all other consumers from joining platform i (j) increases (decreases) due to network effects, and all consumers will switch to platform i.

Likewise, there is an equilibrium in which all consumers join platform B if:

$$q_A - p_A \leq q_B - p_B + \beta \iff p_B - p_A \leq q_B - q_A + \beta. \tag{2}$$

Notice that the two price ranges overlap. When $q_B - q_A - \beta < p_B - p_A < q_B - q_A + \beta$, then everybody joining A and everybody joining B are an equilibrium. The question is then which equilibrium will be played in this case. This question is important not just for consumers, but also for the two platforms, which need to anticipate consumers' choices when they set their respective prices.

Caillaud and Jullien (2001, 2003) suggest that beliefs can be in favor of one of the platforms, i.e., one of the two platforms is focal. They offer the following definition of a focal platform:

Definition 1 ***(A focal platform):*** *Consider two platforms, A and B, that compete by setting prices, p_A and p_B. Suppose that there are two thresholds, $\underline{\Delta}$ and $\overline{\Delta}$, such that for $p_B - p_A \in [\underline{\Delta}, \overline{\Delta}]$ there are two equilibria, in which all agents join A or B. Then, when platform A is "focal", agents join platform A for all $p_B - p_A \in [\underline{\Delta}, \overline{\Delta}]$.*

Focality means that whenever both equilibria are possible, consumers join the focal platform, expecting that others will do the same.[2] As we described in the introduction, there are several reasons why a platform can become focal. The definition of focality does not identify how and why this focality emerges. It only defines one of the platforms as focal. Indeed, as we describe below, we think that an interesting extension for future research is to identify how a platform can become focal.

Notice that a direct implication of Definition 1 is that there is a threshold, $\underline{\Delta}$, such that agents join platform B and expect that other agents will do the same if $p_B - p_A < \underline{\Delta}$. Otherwise, agents will join platform A. In our simple model, $\underline{\Delta} = q_B - q_A - \beta$, and platform B can attract agents by setting p_B such that $p_B - p_A < \underline{\Delta}$. Rearranging:

$$q_B - p_B > q_A + \beta - p_A. \tag{3}$$

Notice that in condition (3) it may appear as if an agent joins platform B while expecting that all other agents will join platform A. This is however not the case. When (3) holds, agents expect that other agents join platform B. Yet, if the inequality in (3) is slightly reversed, then each agent will expect all other agents to join platform A. These beliefs are rational because given (3) there is an equilibrium in which all agents join B, and joining A is an equilibrium when the inequality is reversed.

[2] Throughout this paper, we focus on homogeneous consumers and a single focality. The case where more than one platform has a positive market share in equilibrium is described by Biglaiser, Calvano and Cremer (2018).

We can now turn to solving for the equilibrium prices. In an equilibrium in which platform A wins, platform B sets $p_B = 0$ and platform A sets p_A such that $q_A - p_A + \beta = q_B - p_B$, or $p_A = \beta - (q_B - q_A)$. In an equilibrium in which platform B wins, $p_A = 0$ and platform B sets p_B such that $q_A - p_A + \beta \leq q_B - p_B$, or $p_B = (q_B - q_A) - \beta$. The following corollary defines the equilibrium when platform A is focal:

Corollary 1 ***(The equilibrium when platform** A **is focal):*** *Suppose that platform A is focal. Then, platform A wins the market if* $\beta \geq q_B - q_A$ *and platform B wins otherwise.*

Corollary 1 shows that even when platform A offers lower quality than platform B, platform A can still win the market with a positive profit, due to its superior focal position. Intuitively, such an equilibrium emerges when network effects are more important to agents than the quality gap. Corollary 1 also shows that platform B can win the market even though it is non-focal, if its quality gap is sufficiently high.

These results show how beliefs are important in platform markets: the "wrong" platform can win simply because agents expect that other agents will join it. In what follows, we focus on the case where $\beta > q_B - q_A > 0$. This raises the question of how the high-quality platform can overcome the problem of unfavorable beliefs. We address this question in the next sections.

5 Partial focality

The previous section considered a rather strict version of focality: for *all* price gaps such that both *joining A* and *joining B* exist, i.e., $q_B - q_A - \beta < p_B - p_A < q_B - q_A + \beta$, agents play the equilibrium in which they join the focal platform A. In Halaburda and Yehezkel (2016), we extend the concept of focality by introducing partial focality.[3] The paper considers an applied IO model in which two competing platforms connect between sellers (mobile application developers, for example) and buyers (mobile users, for example). The paper shows how the degree of focality affects the platforms' equilibrium business models (i.e., which side to attract). In this section, we illustrate how it is possible to apply the approach of partial focality to other models of platform competition, using the simple model of Section 3. In Section 7 we describe potential limitations of this approach, and offer ideas for future research.

[3] In our paper, we refer to this approach as "partial degree of coordination bias."

5.1 The definition of partial focality

We start by explaining the intuition of this approach, and then we formally define it. Generally, partial focality means that there is a threshold in the price gap, $p_B - p_A$, such that agents join platform A if the price gap is above the threshold. The motivation for this approach is the following. Suppose that platform A is focal, but agents observe a price gap $p_B - p_A$ slightly above $q_B - q_A - \beta$. While focality means that agents should play the equilibrium in which they join A, the price gap is only slightly above the threshold from which downwards it is a dominant strategy for agents to join platform B. An agent may think that if a small mass of agents will make the "wrong" decision and join B, it would not be worthwhile for the agent to join A. More importantly, this agent will expect that other agents think the same, and will also be reluctant to join A, because they expect that other agents will not join A. Consequently, the beliefs shared by all agents will be that even though A is "generally" focal, all other agents join B. If however the price gap is sufficiently higher than $q_B - q_A - \beta$ (though lower than $q_B - q_A + \beta$), agents will indeed join platform A. Notice that such beliefs are fully rational: agents have identical and correct expectations concerning the beliefs of other agents.

Below we offer a general definition of partial focality:

Definition 2 ***(Partial focality of degree*** α***):*** *Consider two platforms, A and B, that compete by setting prices,* p_A *and* p_B*. Suppose that there are two thresholds,* $\underline{\Delta}$ *and* $\overline{\Delta}$*, such that for* $p_B - p_A \in [\underline{\Delta}, \overline{\Delta}]$ *there are two equilibria, in which all agents join A or B. Then, when platform A is "focal of a degree* α*"* ($0 \leq \alpha \leq 1$)*, agents join A if* $p_B - p_A \in [\alpha\underline{\Delta} + (1-\alpha)\overline{\Delta}, \overline{\Delta}]$ *and join platform B otherwise.*

Notice that the full focality that we described in Section 3 is a special case of partial focality. When $\alpha = 1$, platform A is focal and wins for all price gaps $p_B - p_A \in [\underline{\Delta}, \overline{\Delta}]$. As α decreases, platform A has a weaker focal position, and platform B becomes fully focal at $\alpha = 0$.

In our simple model, $\underline{\Delta} = q_B - q_A - \beta$ and $\overline{\Delta} = q_B - q_A + \beta$. Agents join platform A if $p_B - p_A \geq \alpha\underline{\Delta} + (1-\alpha)\overline{\Delta}$. Rearranging:

$$q_A - p_A + \alpha\beta \geq q_B - p_B + (1-\alpha)\beta. \tag{4}$$

In condition (4) it may appear as if agents expect other agents to join platform A with probability α. Yet, recall that agents believe that all agents will join platform A if (4) holds, and they will join B if (4) is reversed. Given such beliefs about the decisions of other agents, it is indeed worthwhile for an agent to join platform A if (4) holds, so such beliefs are rational.

We can now solve the equilibrium prices given any degree of α. In an equilibrium in which platform A wins, $p_B^* = 0$ and p_A^* is the solution to (4) in equality. Such an equilibrium exists if platform A's equilibrium profits are positive: $\pi_A^* = (2\alpha - 1)\beta - (q_B - q_A) \geq 0$.[4] Likewise, in an equilibrium in which platform B wins, $p_A^* = 0$ and p_B^* is the solution to (4) in equality. Such an equilibrium exists if platform B's equilibrium profits are positive: $\pi_B^* = (q_B - q_A) - (2\alpha - 1)\beta \geq 0$. We therefore have the following result:

Corollary 2 ***(The equilibrium with a partial focality):*** *Platform A wins the market iff:*

$$\alpha \geq \hat{\alpha} \equiv \frac{1}{2} + \frac{q_B - q_A}{2\beta}. \tag{5}$$

Corollary (2) identifies the minimum degree of focality, $\hat{\alpha}$, that platform A needs to hold in order to win the market, given the market's parameters. In our simple model, $\hat{\alpha}$ depends on the quality gap, $q_B - q_A$, discounted by the network effects, β. Intuitively, if $q_B = q_A$, $\hat{\alpha} = \frac{1}{2}$, so a slight degree of focality is enough for platform A to win the market and earn positive profits. As $q_B - q_A$ increases, $\hat{\alpha}$ increases above $\frac{1}{2}$, and platform A needs to be sufficiently "more focal" than B in order to overcome its quality disadvantage and win the market. As $q_B - q_A \to \beta$, $\hat{\alpha} \to 1$, so platform A cannot win the market even if it is fully focal.

5.2 Implications

The approach of partial focally has two main implications. First, as we described in the previous section, it is possible to use this approach to identify the size of the belief advantage that a platform needs to have, in order to win the market. In any general IO model with platform competition, the cutoff level of focality can identify how the model's parameters determine the belief advantage that a platform needs to gain in order to win the market.

Second, the degree of focality affects the platforms' incentive to facilitate the interaction between agents within its platform. We can informally illustrate this point as follows. Suppose that each platform $i = A, B$ offers network effects of size $\beta(s_i)$. Moreover, a platform can invest s_i in increasing the size of $\beta(s_i)$. For example, a platform can adopt technological innovations that enhance the connectivity between agents, subsidize agents for conducting more transactions, etc. Then, a winning platform A earns $\pi_A^* = \alpha\beta(s_A) - (1-\alpha)\beta(s_B) - (q_B - q_A)$. The degree of focality affects the platform's incentive to invest in enhancing $\beta(s_A)$, because the platform only internalizes its network effects up to its degree of focality.

[4] Notice that $\pi_A^* = -[\alpha\underline{\Delta} + (1-\alpha)\overline{\Delta}]$ and $\pi_B^* = \alpha\underline{\Delta} + (1-\alpha)\overline{\Delta}$.

In Halaburda and Yehezkel (2016), platforms compete in a two-sided market with competing sellers and a finite set of identical buyers. All buyers choose the same platform so buyers are the "bottleneck" side. The buyer's decision on which platform to join is determined in a qualitatively similar way to condition (4), where $\beta(s_i)$ measures the buyer's benefit from meeting sellers of size s_i. We find that partial focality implies that platforms internalize only a fraction of the benefit that sellers provide buyers. Consequently, a platform may have an incentive to under-supply sellers. The level of focality also affects the platforms' business models. When a platform suffers from a small degree of focality, it is unprofitable for it to attract buyers — which relies on the buyers' beliefs — and instead the platform adopts a business model that relies on attracting sellers. In this case the platform will over-supply sellers, because the buyers are its only source of revenues. The degree of focality is therefore impotent for determining the platforms' optimal business models as well as for the effect of these business models on welfare.

We expect that the degree of focality may have a similar effect on other models of platform competition. In Halaburda and Yehezkel (2013), for example, we assumed the deterministic, all-or-nothing version of focality. By the same logic as above, introducing a partial degree of focality should affect the extent to which platforms distort their quantities, as well as the platforms' decisions concerning which side to compete on.

6 Dynamic Model

The concept of focality explored in the previous two sections is defined in a static environment. The degree of focality in such environment is exogenously given. In a dynamic environment, however, it is possible that the degree of focality changes depending on the history of the market. The platform that succeeded in the market in the past period may increase its degree of focality in the next.

In Halaburda, Jullien and Yehezkel (2017), we explore one possible version of such a dynamic environment, in which the platform that wins in one period enjoys strong focality in the next. This may give a platform the incentive to invest in improving its focality, by subsidizing user participation early on. In a static model, platforms never find it optimal to charge prices below zero. In the dynamic model, the more weight is put on the future, the more incentive a non-focal but high-quality platform has to invest in winning the market, and thus future focality. Yet, the same effect also increases the incentive of a low-quality but focal platform to fight back and maintain its focal position. This raises the question of whether dynamic considerations increase or decrease the likelihood that a non-focal, high-quality platform will take over the market.

In this section, we illustrate with a simple two-period model, how dynamic consideration affect the pricing strategies of the platforms and the identity of the winning platform. We take a more general approach to the changes in focality between periods than Halaburda, Jullien and Yehezkel (2017). Here we allow for weak focality, as in Section 5. We show that whether the high-quality platform has higher or lower incentives to invest in the future focality as future becomes more important depends on how the focality evolves with time.

Consider a two-period environment. In the first period, platform A enjoys weak focality of degree $\alpha_1 > \hat{\alpha}$, implying that in a one-period game, platform A will dominate the market. The focality in the second period depends on which platform wins the market in the first period. If A wins in $t = 1$, then it may improve its degree of focality; that is, A enjoys focality of degree $\alpha_2(A) \geq \alpha_1$. If B wins in the first period, then in the second period platform A may lose some degree of focality; that is, A has focality of degree $\alpha_2(B) \leq \alpha_1$.[5] Moreover, we assume that $\alpha_2(B) < \hat{\alpha} < \alpha_2(A)$. By Corollary 2, this last assumption implies that the platform that wins in the first period will also win the second period. Suppose also that platforms discount future profits by $\delta \in (0, 1)$.

When setting their prices in the first period, each platform takes into account that capturing the market in this period will give it an advantage in the second period and additional profit. The consumers, however, treat the participation in the two periods independently.

To solve the model, we start with the second period. By the results in Section 5, if platform A wins the first period, the degree of focality in the second period is $\alpha_2(A) > \hat{\alpha}$. Platform A wins in the second period and earns $\pi^*_{A(t=2)} = (2\alpha_2(A) - 1)\beta - (q_B - q_A)$. Likewise, if platform B wins in the first period, the degree of A's focality in the second period is $\alpha_2(B) < \hat{\alpha}$. Platform B wins in the second period and earns $\pi^*_{B(t=2)} = (q_B - q_A) - (2\alpha_2(B) - 1)\beta$.

Next, we turn to the first period. Since in the first period platform A is weakly focal of degree α, agents join A in the first period if $p_A \leq p_B + q_A - q_B + (2\alpha_1 - 1)\beta$.

Consider first an equilibrium in which platform A wins in the first period; and consequently wins in the second period. The lowest price platform B is willing to charge in the first period is $p_B = -\delta(q_B - q_A - (2\alpha_2(B) - 1)\beta)$. Note $\alpha_2(B)$ in this formula: $q_B - q_A - (2\alpha_2(B) - 1)\beta$, is the profit platform B would earn in the second period had it won in the first period. Setting the price lower than this p_B will yield negative overall profit for B even in the best scenario. Platform A wins in the first period if it sets the price $p_{A\,(t=1)} = (1 + \delta)(q_A - q_B - \beta) + 2\beta(\alpha_1 + \delta\,\alpha_2(B))$. After winning in the first period, it enjoys improved focality of $\alpha_2(A)$ and also wins the second

[5] At any time, when A has focality of degree α, B has focality of complementary degree $1 - \alpha$.

period. The total profit from winning the two-period game is $\Pi_A = p_{A\,(t=1)} + \delta\pi^*_{A(t=2)} = (1+2\delta)(q_A - q_B - \beta) + 2\beta(\alpha_1 + \delta\,\alpha_2(A) + \delta\,\alpha_2(B))$. It is worthwhile for platform A to win in the first period only if $\Pi_A > 0$.

By similar arguments, in an equilibrium in which platform B wins in the first period (and consequently also in the second period), it sets $p_{B(t=1)} = (1+\delta)(q_B - q_A + \beta) - 2\beta(\alpha_1 + \delta\,\alpha_2(A))$. This is because the lowest price platform A is willing to set in $t = 1$ is $p_A = -\delta(q_A - q_B + (2\alpha_2(A) - 1)\beta)$. With improved focality in the second period, platform B's total profit is $\Pi_B = p_{B\,(t=1)} + \delta\pi^*_{B(t=2)} = (1+2\delta)(q_B - q_A + \beta) - 2\beta(\alpha_1 + \delta\,\alpha_2(A) + \delta\,\alpha_2(B))$. It is worthwhile for platform B to win the first period only if $\Pi_B > 0$.

Notice that $\Pi_B = -\Pi_A$. Let $\hat{\hat{\alpha}}$ denote solution to $\Pi_A = \Pi_B = 0$. This means that if $\alpha_1 > \hat{\hat{\alpha}}$, platform A wins in both periods. And if $\alpha_1 < \hat{\hat{\alpha}}$, platform B wins. We therefore have the following result:

Corollary 3 ***(The dynamic equilibrium with partial focality):*** *Platform A wins the market in both periods iff:*

$$\alpha_1 > \hat{\hat{\alpha}}(\delta) \equiv \frac{(1+2\delta)(q_B - q_A + \beta)}{2\beta} - \delta\big(\alpha_2(A) + \alpha_2(B)\big). \tag{6}$$

As in the static game considered in the previous section, platform A wins the market if its initial focality advantage in the first period is above a certain threshold. In a dynamic game, this threshold is affected by the degree to which the two platforms care about the future. At $\delta = 0$, $\hat{\hat{\alpha}}(0) = \hat{\alpha}$, implying that platform A wins in both periods as in the static case, because $\alpha_1 > \hat{\alpha}$. Yet, as δ increases, $\hat{\hat{\alpha}}(\delta)$ may increase or decrease, such that the dynamics may increase or decrease platform A's competitive advantage due to its initial focallity advantage.

We can illustrate this point by considering two special cases. Suppose first that winning in the first period yields strong focaility in the second period. That is, $\alpha_2(A) = 1$ and $\alpha_2(B) = 0$. Then,

$$\frac{d\hat{\hat{\alpha}}(\delta)}{d\delta}\bigg|_{\alpha_2(A)=1,\ \alpha_2(B)=0} = \frac{q_B - q_A}{\beta} > 0.$$

Here, as the two platforms become more forward looking, the low-quality platform A needs a stronger initial focal position (that is, a higher α_1) in order to maintain its leadership position. Intuitively, as platforms become more forward looking, they both have a stronger incentive to compete in the first period for a strong second-period focal position. Yet, platform B earns higher second-period profits as a focal platform than platform A and therefore has more of an incentive to fight for focality than platform A.

In the second special case, suppose that platform A gains a higher increase in focality by winning in the first period than platform B. Taking it to the extreme, suppose that $\alpha_2(A) = 1$, but now $\alpha_2(B) = \hat{\alpha}$. Then:

$$\frac{d\hat{\hat{\alpha}}(\delta)}{d\delta}\Big|_{\alpha_2(A)=1,\, \alpha_2(B)=\hat{\alpha}} = \frac{q_B - q_A - \beta}{2\beta} < 0.$$

Now, as the two platforms become more forward looking, the low-quality platform A maintains its leadership position even if it starts with a weaker initial focal position (that is, a lower α_1). To see why this is the case, notice that at $\alpha_2(B) \to \hat{\alpha}^-$, $\pi_{B(t=2)} \to 0^+$, while $\alpha_2(A) = 1$ offers platform A: $\pi^*_{A(t=2)} = \beta + q_A - q_B > 0$. Hence, an increase in δ does not increase B's incentives to win in the first period. But it does increase A's incentives to do so.

Combining the two examples above, we can conclude that dynamic considerations may increase efficiency (i.e., make it more likely that the non-focal but higher-quality platform B wins in both periods) if winning in the first period provides the winning platform B with a sufficiently strong focal position in the second period, compared with the degree of focality platform A enjoys in the second period after winning the first one.

More generally, it is possible to use the definitions of $\hat{\alpha}$ and $\hat{\hat{\alpha}}(\delta)$ in (5) and (6), respectively, for rewriting the effect of δ on $\hat{\hat{\alpha}}(\delta)$ as:

$$\frac{d\hat{\hat{\alpha}}(\delta)}{d\delta} = \big(\hat{\alpha} - \alpha_2(B)\big) - \big(\alpha_2(A) - \hat{\alpha}\big).$$

Consequently, what matters is the difference between $\alpha_2(A)$, $\alpha_2(B)$ and $\hat{\alpha}$. If the α_2's are equidistant from $\hat{\alpha}$, i.e., $\alpha_2(A) - \hat{\alpha} = \hat{\alpha} - \alpha_2(B)$, then $\frac{\partial\hat{\hat{\alpha}}}{\partial\delta} = 0$, and $\hat{\hat{\alpha}} = \hat{\alpha}$.

This result may appear puzzling because the platforms are asymmetric: platform B offers a higher base quality than A. Yet, recall that $\hat{\alpha}$ already reflects this difference, because $\hat{\alpha} > \frac{1}{2}$. The value of $\hat{\alpha}$ exactly balances between B's quality advantage and A's focality advantage. If $\alpha_2(A) - \hat{\alpha} = \hat{\alpha} - \alpha_2(B)$, this balance follows to the next period and therefore current actions do not affect the future. When $\hat{\alpha} - \alpha_2(B)$ is larger than $\alpha_2(A) - \hat{\alpha}$, this balance is breached and as the future becomes more important for the two platforms, platform A needs a stronger initial focal position (i.e., a higher α_1) in order to win the market. Hence, the dynamics increases market efficiency. The opposite case applies when $\hat{\alpha} - \alpha_2(B)$ is smaller than $\alpha_2(A) - \hat{\alpha}$. In such a case, $\hat{\hat{\alpha}}(\delta)$ decreases with δ, implying that the dynamics decreases market efficiency. This result raises the question of whether it is likely to expect that $\alpha_2(A) - \hat{\alpha} > \hat{\alpha} - \alpha_2(B)$ or the opposite. We comment on this question in the next section.

Halaburda, Jullien and Yehezkel (2017) provide other explanations for why the dynamics may decrease market efficiency, by extending the analysis to an infinitely repeated game. When platforms are very forward looking (i.e., δ is sufficiently high) there are multiple Markov equilibria in which either platform A or platform B wins the market in all periods. This is because when the platforms are forward-looking, they will not both compete aggressively to win the market. One of them will do so, while the other will give up. This result is due to the coordination problem between consumers, and does not hold if instead of a mass of consumers with network effects, the model includes consumers with only switching costs and no network effects.

Halaburda, Jullien and Yehezkel (2017) also look at stochastic qualities, where the quality gap between the two platforms varies between periods and can be positive or negative. In every period, each platform can win the market with some positive probability, depending on whether the platform won in the previous period and on the strength of its current quality advantage. If one of the platforms has a higher expected quality than the other, then as δ increases, this platform wins the market even when its current quality realization is low. Consequently, expected social welfare can decrease with δ.

7 Conclusion and future research

This paper considers a methodology for studying how beliefs shape platform competition, based on the notion of a partial degree of focality. We illustrate how to implement this methodology in both static and dynamic models of platform competition.

Yet, this approach has some potential limitations which call for future research. In this section we describe our view on the potential interesting research questions in this field.

When solving both the static and the dynamic version of our model, we assumed that the degree of focality, α, is identical for all agents and is common knowledge. Notice that both platforms and all agents share the same beliefs. In real life, it is unclear how a heterogeneous set of agents and competing platforms will all converge to the same beliefs concerning the degree of focality.

It is possible to address this question in three ways. First, by developing a model in which agents are uncertain, or differ, in the degree of focality. Naturally, such an extension will make a contribution only if it qualitatively changes the results obtained with the identical, commonly known degree of focality. Second, by conducting an empirical study and estimating the degree of focality. It might be possible to use data on access prices and platforms' objective characteristics for evaluating the degree of focality that could explain the agents' observable participation decisions. To date, we are unfamiliar with empirical studies that have attempted to study how platform competition is affected by beliefs. Third, it is possible to conduct laboratory experiments, to study how agents and platforms form their beliefs. Muller, Spiegel and Yehezkel (2018) are conducting on-going research on experiments with platforms. One interesting question that they plan to address in that study is whether the market converges to uniform beliefs concerning the degree of focality. To this end, the experiments in Muller, Spiegel and Yehezkel test not only for the market outcome, but also for the players' beliefs.

The second limitation of the partial focality approach described here is that Definition 2 focuses on one-sided network effects. In a two-sided market, say, side 1 and side 2, platform competition involves four prices: p_A^1, p_A^2, p_B^1 and p_B^2. This requires an adjustment of the definition and condition (4). Such an extension may not be trivial, because the beliefs of each side depend on the beliefs of the other side.[6]

Another non-trivial extension of Definition 2 would be needed to account for multihoming. The current definition of focality assumes that users are restricted to join only one platform; so such an extension would not be trivial, because the possibility of multihoming changes the nature of the coordination game in platform competition.[7]

A different direction for future research is to model the factors that determine the degree of focality. One such factor can be advertising aimed at convincing agents that other agents will join the platform. As we describe in the conclusion to Halaburda and Yehezkel (2016), when Apple advertised its early generation iPhones in 2009, it used the slogan "There is an app for that". Such advertising may not only convince users that application developers will develop applications for the new operating system, but also convince developers that users will join, as users observe this advertising and will expect that developers will join. As another example, Apple's Apple Pay's launch in 2014 was rather slow, because merchants and buyers didn't believe that the other side would adopt it.[8] In 2015, Apple's CEO, Tim Cook, declared in the popular press that "We are more convinced than ever that 2015 will be the year of Apple Pay".[9] Such declaration may serve as a signal to buyers that merchants will start adopting the new service, and at the same time signal merchants that buyers will adopt it as well. It is therefore possible to think of a model in which there is an initial degree of focality, and the two platforms can affect it by competing with costly but uninformative advertising. This raises the question of how parameters such as the initial level of focality and the platforms' quality gap affect the level of advertising and the identity of the winning

[6] In Halaburda and Yehezkel (2016), platforms compete in a two-sided market. However, we assume that buyers are a bottleneck side, and therefore we analyze partial focality by applying condition (4) to the buyers' decision only.

[7] See Bakos and Halaburda (2018).

[8] See for example in Wakabayashi and Bensinger (2014).

[9] See Hof (2015).

platform.

The degree of focality can also be affected by history. A platform can enhance its future degree of focality by winning the market today. Halaburda, Jullien and Yehezkel (2017) offer a model of history-dependent full focality, that this paper extends to partial focality. The current research raises interesting questions for future research. The first question is how the degree of current focal position affects future focal position. As we have shown, the effect of dynamics on the winning platform depends on the increase in focality that each platform gains by winning the market today. This raises the question of whether a platform with a partial focality advantage can further enhance its focal position in future periods more than the platform with a focality disadvantage. This question can be answered both theoretically and from experimentally.

A second interesting question concerns the relation between the dynamics driven by focality, that is, by beliefs, and the dynamics driven by installed base or switching cost. In other words, it might be interesting to combine the approach of Cabral (2011) on dynamics driven by installed base and switching on one side, with the approach of Biglaiser and Cremer (2016) and Halaburda, Jullien and Yehezkel (2017).

At first glance, it may look as though focality is equivalent to the switching costs: in the former case the incumbent platform benefits from beliefs and network effects, in the latter from avoiding switching costs. Indeed, as we show in Halaburda, Jullien and Yehezkel (2017), in a one-period model the two approaches are equivalent, but this is not the case in a dynamic model. This is because under focality an agent's beliefs about the future of the market do not depend on his decision in the current period. The relative appeal of the platforms depends on other agents' behavior. However, under switching costs, the relative appeal of the platforms depends on the agent's decision, and not on other agents.

A third interesting question is how multihoming affects dynamics. In recent years, many two-sided markets involve multihoming on one of the sides. For example, in the market for smartphones, users typically single home, while developers join both Android and iOS. Halaburda and Yehezkel (2013) and Belleflamme and Peitz (2017) show how such one-sided multihoming affects platform competition. And Bakos and Halaburda (2018) shows that the results are qualitatively different when multihoming occurs on both sides. Yet, these papers only focus on a static game. These papers too, can be extended to a dynamic setting.

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