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# Why potential entry may increase platform sponsors' profit\*

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## Abstract

In this paper we analyze the incentives for platform sponsors to open up their networks for independent rivals. We show that open access may increase the platform sponsors' profit levels and enhance quality improving investments.

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# 1 Introduction

Platform providers are often both competitors and complementors. On the one hand, they compete for the same clientele when they try to attract customers. On the other hand, they are complementors to the extent that a quality enhancing investment by one platform sponsor benefits customers connected to the rivals' platform. When a bank increases the functionality or the size of its ATM-network, this will usually benefit the rivals' customers if they have at least imperfect access to the other bank's ATMs. An Internet backbone provider that improves its platform functionality will also increase the quality of its rivals' backbones due to peering agreements (interconnection) between the backbone providers. If an airline company improves its network, the rivals' customers also benefit to the extent that the firms have interlining agreements. Analogously, mobile phone operators share their networks through roaming agreements.

We show that potential entry of independent firms may solve the quality under-investment problem that typically arises between compatible platforms, and thus increase their profitability. In our model the platform sponsors may open up the basic platform to independent rivals and make higher profits, but the rivals will choose not to enter.

The present paper is related to Katz and Shapiro (1985) and the strand of literature that analyzes strategic choices of compatibility. A recent, comprehensive account of this literature is given by Farrell and Klemperer (2004) and Church and Gandal (2004). The literature on strategic R&D investments and spillovers, where d'Aspremont and Jacquemin (1988) is the seminal work, resembles the model structure analyzed in the present paper. However, none of this literature considers the interplay between the choice of compatibility and investments. In this respect our paper is most closely related to Ceccagnoli (2005), but contrary to his paper our work analyses endogenous determination of spillovers.

## 2 The model

We consider a context with two possibly incompatible platforms,  $A$  and  $B$ . The inverse demand curve facing platform sponsor  $i = A, B$  in the end-user market is given by

$$p_i = a_i - Q, \quad (1)$$

where  $Q$  is total output in the market. Each platform sponsor may invest in order to improve the quality of the good it offers, leading to a positive shift in the demand curve. To capture this, let

$$a_i = a + (x_i + \beta_s x_j), \quad (2)$$

where  $a > 0$  is a positive constant, and  $x_i, x_j \geq 0$  are indexes of the quality improvements undertaken by the two firms ( $i \neq j$ ). The variable  $\beta_s \in [0, 1]$  measures the degree of reciprocal compatibility between the sponsors' platforms. The platforms are completely incompatible if  $\beta_s = 0$ , while there is perfect compatibility if  $\beta_s = 1$ . Compatibility refers throughout to the extent to which one firm can take advantage of the rival's quality improvement.

The profit for platform sponsor  $i$  equals:

$$\pi_i = p_i q_i - \phi x_i^2 / 2, \quad (3)$$

where  $\phi > 0$  and sufficiently large to ensure a stable equilibrium.

In addition to the platform sponsors there are  $n$  identical potential entrants with access to at least the basic platform quality. The inverse demand curve facing entrant  $e = 1, \dots, n$  is

$$p_e = a_e - Q,$$

where

$$a_e = a + \beta_e (x_A + x_B). \quad (4)$$

The variable  $\beta_e \in [0, 1]$  indicates the level of compatibility that the sponsors offer to the entrants. If  $\beta_e = 0$  the entrants only have access to the basic platform quality, while they benefit from all the quality improvements made by the sponsors if  $\beta_e = 1$ .

With two platform sponsors and  $n$  entrants, total quantity equals

$$Q = q_A + q_B + \sum_{e=1}^n q_e.$$

The main purpose of this paper is to show that the existence of potential entrants may have a positive influence on the sponsors' profit. In order to bias the model against this result, we assume that the sponsors are unable to charge any access fee from the potential entrants. Let the profit for firm  $e$  equal:

$$\pi_e = p_e q_e. \tag{5}$$

We consider a three-stage game where sponsors determine investment levels non-cooperatively at stage 1, set compatibility levels at stage 2, and platform sponsors and entrants compete in quantities at stage 3.

## 2.1 A benchmark: A duopoly of platform sponsors

We consider the outcome if the two platform sponsors deny any entrants access to the platforms. The Cournot game between the platform sponsors at the final stage of the game implies that  $q_i = (2a_i - a_j) / 3$ . At stage 2 the platform sponsors set the level of compatibility, and, using equation (3), we find  $\partial \pi_i / \partial \beta_s = 2p_i \partial q_i / \partial \beta_s$ , where  $\partial q_i / \partial \beta_s = (2x_j - x_i) / 3$ .

Assume that there exists a stable and symmetric equilibrium (which in Appendix A1 is shown to require that  $\phi > 4/9$ ), so that  $x_i = x_j$ .<sup>1</sup> We then see that  $\partial q_i / \partial \beta_s > 0$ ; improved compatibility increases the perceived quality of the goods, and therefore output. From this it follows that

$$\frac{\partial \pi_i}{\partial \beta_s} > 0,$$

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<sup>1</sup>The second-order condition is satisfied if  $\phi > 2/9$ . If  $2/9 < \phi < 4/9$  there will exist a stable equilibrium where only one of the platforms is operative. We do not focus on this equilibrium.

implying that the firms will set  $\beta_s = 1$ ; the platform sponsors will choose maximum compatibility. By doing this they will maximize the size of the market for any given investment level.

At stage 1 the platform sponsors simultaneously choose investment levels. Inserting  $\beta_s = 1$  and solving  $\partial\pi_1/\partial x_1 = \partial\pi_2/\partial x_2 = 0$  yield an investment level (with superscript  $d$  for denied access) equal to

$$x_i^d = \frac{2}{9\phi - 4}a. \quad (6)$$

## 2.2 A platform sponsor duopoly with entrants

We now allow for free entry of non-platform firms. We maintain the same timing structure as above. Solving  $\partial\pi_i/\partial q_i = \partial\pi_e/\partial q_e = 0$  ( $i = A, B$ ,  $e = 1, \dots, n$ ) it follows that the equilibrium quantities at stage 3 are given by:

$$q_i = \frac{a_i(n+2) - a_j - a_en}{n+3} \text{ and } q_e = \frac{3a_e - a_A - a_B}{n+3}. \quad (7)$$

Prior to the Cournot game, but after investments are sunk, the sponsors decide on the level of  $\beta_e$  and  $\beta_s$ . The operating profit for firm  $i$  is then given by  $\pi_i = p_i q_i$ , and by inserting for (2) and (4) into equation (7) we find that

$$\frac{\partial\pi_i}{\partial\beta_s} = 2p_i \frac{\partial q_i}{\partial\beta_s} > 0 \text{ and } \frac{\partial\pi_i}{\partial\beta_e} = 2p_i \frac{\partial q_i}{\partial\beta_e} < 0.$$

It follows that the platform sponsors will set  $\beta_s = 1$  and  $\beta_e = 0$ ; the latter ensures the platform sponsors a competitive advantage over the entrants.

At stage 1 each sponsor maximizes profit with respect to its investment level, and the marginal profitability of investing in quality improvement for firm  $i$  can be written as

$$\frac{\partial\pi_i}{\partial x_i} = p_i \frac{\partial q_i}{\partial x_i} + q_i \frac{\partial p_i}{\partial x_i} - \phi x_i. \quad (8)$$

A marginal increase in investments allows the sponsor to charge a higher price and sell a larger output. The value of this for the firm is captured by the first two terms in (8), while the third term measures marginal investment costs.

Solving  $\partial\pi_1/\partial x_1 = \partial\pi_2/\partial x_2 = 0$  we find

$$x_i = \frac{2(n+1)}{\phi(n+3)^2 - 4(n+1)^2} a \quad (9)$$

We restrict attention to considering a stable symmetric equilibrium, in which case the denominator in (9) is positive (see Appendix A2).

From equation (9) we immediately see that  $\partial x_i/\partial\phi < 0$ , so that higher marginal investment costs reduce the investment level. Lower investments in turn imply that the sponsors gain a smaller competitive advantage over the potential rivals. Inserting for (9) into (7) we thus find that  $\partial q_i/\partial\phi < 0$  and  $\partial q_e/\partial\phi > 0$ . The relationship between  $x_i$ ,  $q_i$ ,  $q_e$  and  $n$  is ambiguous. To see why, it is useful to analyze how the investment incentives depend on the number of entrants. Differentiating (8) with respect to  $n$  we find that

$$\frac{\partial^2 \pi_i}{\partial x_i \partial n} = 2 \left[ p_i \frac{\partial^2 q_i}{\partial x_i \partial n} + \frac{\partial q_i}{\partial x_i} \frac{\partial p_i}{\partial n} \right] - \phi \frac{\partial x_i}{\partial n}. \quad (10)$$

The terms in the bracket of equation (10) identify how an increase in the number of entrants affects the platform owner's marginal revenue on investments. First, by investing in quality improvement, the sponsor gains a competitive advantage over the entrants and captures a larger share of the market. This business stealing effect is stronger the larger is  $n$ , and indicates that, for any given price, the incentives to invest in quality improvement are increasing in the number of entrants. Formally, this is verified by using equation (7) to find

$$p_i \frac{\partial^2 q_i}{\partial x_i \partial n} = p_i \frac{2}{(n+3)^2} > 0. \quad (11)$$

A larger number of entrants also means that the price falls. This price effect has a negative effect on the investment incentives:

$$\frac{\partial q_i}{\partial x_i} \frac{\partial p_i}{\partial n} = -\frac{n+1}{(n+3)^2} q_e < 0. \quad (12)$$

An increase in  $n$  thus has two opposing effects on the investment incentives for sponsor  $i$ ; the business stealing effect raises the incentives, while the opposite is true for the price effect. If  $n$  is small, the price  $p_i$  is relatively high. Therefore the

value of the business stealing effect is high, and we may expect the sum of (11) and (12) to be positive. This does not mean that entry necessarily increases profit (see Appendix A3):

**Proposition 1:** *For any  $\phi < \infty$ , the platform sponsors invest more with some potential entry than when entry is denied, but the platform sponsors' profit levels are strictly decreasing in  $n$  if  $\phi > 4$ .*

In Appendix A4 we prove the main result of the paper:

**Proposition 2:** *Assume that:*

- a.  $\phi \leq 3/4$ . *The platform sponsors make the same profit whether there is open access or not, since a potential entrant would face no demand.*
- b.  $3/4 < \phi < \phi^* \equiv 2 + \frac{2}{9}\sqrt{57} \approx 3.68$ . *The platform sponsors make higher profits by opening up their networks than by denying independent firms entry, and will invest sufficiently to foreclose the potential entrants from the market.*

To see the intuition for Proposition 2, assume that the platform sponsors cooperate to maximize their aggregate profit at the investment stage (while still competing in the end-user market). In this case the free-rider problem between the platform sponsors would vanish and investments increase.<sup>2</sup> Put differently, with cooperation the sponsors would take into account the fact that higher investments by one firm increase the size of the market for both firms. In this respect they would internalize the positive spillover effects of investments.

The sponsors will consequently invest too little in a non-cooperative game. However, if  $3/4 < \phi < \phi^*$  the business stealing effect identified in equation (11) implies that each of the sponsors will have stronger incentives to invest and increase their profit when the entrants have access to the basic platform than when such access is denied. Thus, in this case the threat of entry is beneficial for the platform sponsors, but no entry will actually take place. This explains Proposition 2.<sup>3</sup>

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<sup>2</sup>Proof is available on request from the authors.

<sup>3</sup>The platform sponsors would consequently prefer to deny entry if  $\phi > \phi^*$ , but allow entry in order to reduce the free-rider problem at the investment stage if  $\phi < \phi^*$ . However, it should be



### 3 Concluding remarks

In the present model the compatibility choice is made after investments are sunk, but we may also imagine that the compatibility choice is made first. Usually there will be divergence in the platform sponsors' incentives to be compatible *ex ante* and *ex post* of the investment that enhances the quality of the platform. It is straightforward to show that this divergence is reduced, and possibly eliminated, if the platform sponsors open up their basic platforms for entrants. The reason is that high compatibility increases the competitive advantage over potential rivals. The main results above also hold when compatibility is decided *ex ante* of the investments.

## 4 Appendix

### 4.1 Appendix A1

Solving  $\partial\pi_i/\partial x_i = 0$  gives rise to the reaction function  $x_i(x_j) = 2(a + x_j)/(9\phi - 2)$ . The system is stable if  $x'_i(x_j) < 1$ , which holds if  $\phi > 4/9$ . Q.E.D.

Assuming  $\phi > 4/9$ , and solving  $\partial\pi_1/\partial q x_1 = \partial\pi_2/\partial x_2 = 0$ , yield  $x_i^d$  as given by equation (6). The equilibrium quantity and profit for the sponsors are then equal to

$$q_i^d = \frac{3\phi}{9\phi - 4}a \quad (13)$$

and

$$\pi_i^d = \frac{9\phi - 2}{(9\phi - 4)^2}\phi a^2. \quad (14)$$

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noted that for any  $\phi < \infty$ , potential as well as actual entry means that the platform sponsors have a common interest in gaining a competitive advantage over the non-platform owners.

## 4.2 Appendix A2

With free entry of non-platform firms, the equilibrium quantities in the final stage are given by equation (7). Inserting for this into the profit functions, we find that

$$\frac{\partial^2 \pi_i}{\partial x_i^2} = -\frac{\phi(n+3)^2 - 2(n+1)^2}{(n+3)^2}.$$

The second-order condition for an optimum is thus satisfied if  $\phi > \phi^{SOC} \equiv 2\frac{(n+1)^2}{(n+3)^2}$ . Solving  $\partial\pi_i/\partial x_i = 0$  we further find that  $x_i(x_j) = 2\frac{a(n+1)+x_j(n+1)^2}{\phi(n+3)^2-2(n+1)^2}$ . The stability condition  $x'_i(x_j) < 1$  consequently holds if

$$\phi > \phi_1 \equiv 4\frac{(n+1)^2}{(n+3)^2}. \quad (15)$$

This verifies that the denominator in equation (9) is positive in a stable equilibrium. Q.E.D.

## 4.3 Appendix A3

Let us first prove that the investment incentives increase if there is some potential entry. Using equations (6) and (9) we find that the difference between sponsor investments with denied entry and entry accommodation equals

$$x_i - x_i^d = 2an\frac{(3-n)\phi + 4(1+n)}{(\phi - \phi_1)(9\phi - 4)(n+3)^2}. \quad (16)$$

A sufficient condition for equation (16) to be positive, is that  $n < \frac{3\phi+4}{\phi-4}$ . From (16) we immediately see that this always holds for  $n \leq 3$ .

Let us now prove that profit is strictly decreasing in  $n$  is  $\phi > 4$ . We insert for (9) into (7) to find that equilibrium quantities equal

$$q_i = \frac{a\phi}{(\phi - \phi_1)(n+3)} \text{ and } q_e = \frac{(\phi - \phi_2)a}{(\phi - \phi_1)(n+3)}, \quad (17)$$

where  $\phi_2 \equiv 4(n+1)/(n+3)$ . Note that a potential entrant will face a non-positive demand if  $\phi < 4/3$  (since we then have  $\phi - \phi_2 < 0$ ).

Inserting for (9) and (17) into (3) we further have

$$\pi_i = \frac{\phi - \phi^{SOC}}{(\phi - \phi_1)^2(n+3)^2}\phi a^2. \quad (18)$$

Differentiation of equation (18) yields

$$\frac{\partial \pi_i}{\partial n} = 2a^2 \phi \frac{(\phi_3 - \phi)(\phi - \phi_4)}{(\phi - \phi_1)^3 (n+3)^3},$$

where  $\phi_3 = (n+1) \left( \frac{3}{n+3} + \sqrt{\frac{n+19}{(n+3)^3}} \right)$  and  $\phi_4 = (n+1) \left( \frac{3}{n+3} - \sqrt{\frac{n+19}{(n+3)^3}} \right)$ . Straightforward algebra shows that  $\phi_1 - \phi_4 > 0$ . In a stable equilibrium, it thus follows that  $\text{sign}(\partial \pi_1 / \partial n) = \text{sign}(\phi_3 - \phi)$ . Since  $\partial \phi_3 / \partial n > 0$  with  $\lim_{n \rightarrow \infty} \phi_3 = 4$ , it follows that  $\partial \pi_i / \partial n < 0$  if  $\phi > 4$ . Q.E.D.

#### 4.4 Appendix A4

Solving  $\phi - \phi_2 = 0$ , we find that  $q_e = 0$  if  $n = \max\{0, n^*\}$ , where  $n^* \equiv \frac{3\phi-4}{4-\phi}$  ( $n = 0$  if  $\phi \leq 4/3$ , as shown by equation (17)). Inserting for this into (18) yields

$$\pi_i(n^*) = \frac{8-\phi}{32} a^2 > \pi_i^d \text{ for } 4/3 < \phi < \phi^* \equiv 2 + \frac{2}{9} \sqrt{57}.$$

This proves Proposition 2.

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