A Monopolist's Incentive to Invite Competitors to Enter in Telecommunications Services

by

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In Gerard Pogorel (ed.), *Global Telecommunications Services and Technological Changes*. Elsevier. Amsterdam: 1993; presented at the ITS conference at Cannes in June 1992.

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1. Introduction

It the post-AT&T-divestiture world, telecommunications services are provided by a variety of vendors in diverse combinations of substitute and complementary goods. Typically, consumers demand *composite* goods or services that are comprised of a number of *complementary* goods. It is not uncommon for these complementary goods to be provided by different firms, with each firm well-established in a particular market so that potential entrants may face significant difficulty. These factors would be of little importance, were it not for the complementarity of the components of telecommunications services and the associated *network externalities*.

An important feature of networks is that the size of the network contributes positively to the value of the goods generated by the network. This effect has been called a network externality. To understand this effect, consider a simple star network with a central switch S and n-spikes, SA, SB, SC, etc., as in Fig. 1. If this is a telephone network, the customers are located at A, B, C, etc., and the goods are phonecalls ASB, BSA, ASC, CSA, BSC, CSB, etc. It is clear that the number of phonecalls that can be made in an n-spike star network is $n(n - 1)$. Thus, the addition of the nth spike creates $2(n - 1)$ new potential phonecalls. Therefore the addition of the nth customer increases the number of goods in the network proportionately to the size of the (pre-existing) network. If the cost of connection is constant per customer and phonecalls are equally desirable, the total value of all goods in the network keeps increasing in n as more customers are connected to the switch. This is one aspect of network externalities.

The addition of the nth spike has a positive effect to each pre-existing customer, since he can now make phonecalls to the nth customer. This increase of utility of the old customers through the creation of additional goods is the key feature from which the "network externality" derives its name.[1,2]

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[1] It is an externality because the effect is not mediated by a market.

It is important to realize that the essential reason for the emergence of network externalities is the complementarity between the components of the good that we named a phonecall in the above discussion. Then such externalities are not confined to physical networks,[3] but rather apply to a variety of industrial structures where complementarity is crucial.

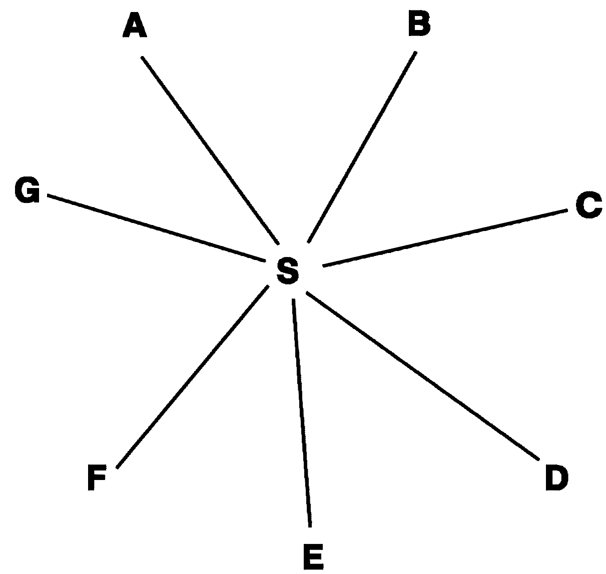

Figure 1: Diagrammatic representation of a network.

In the star network example, a phonecall ASB is composed of two complementary components, AS and SB, the access to the switch of customer A, and the access to the switch of customer B. These two goods look very similar, and typically will have the same industrial classification, and may be seen as substitutes when looked from afar. However, they are complements in the creation of good ASB. And it is this complementarity that creates the network externality: the addition of customer C through the provision of SC allows for good ASC (= AS + SC) to be created thus increasing the utility of customer A. Thus, despite the uniform appearance of the goods "access to the switch" (AS, BS, CS, etc.), they are complementary to each other, and this is the key to the creation of network externalities.

It is clear now that non-network industries, or industries that only partly utilize networks, can exhibit "network externalities" as long as the final goods demanded by the consumers are composed of complementary components, and consumers demand diverse varieties. In effect,

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[2] The network effect is not based on reciprocity, i.e., on the fact the phonecalls can originate in both directions.

[3] A network is a collection of nodes that are connected in a particular fashion.

a "network externality" appears as an increase in the willingness to pay for good X when the number and the production levels of complements of X (call them Y) increase. If goods Y are produced by a number of competing firms, higher production of Y is typically accompanied by lower prices for Y. This accentuates the network externality because it enhances the value of good X.

In such a setup, a firm would like to influence positively the production of the complementary goods. It could do this directly if it produced both goods X and Y, as, for example, the pre-divestiture AT&T supplied both local and long distance services. However, if a firm cannot easily enter the complementary goods market, or if regulation prohibits a firm from entering such a market, a firm may need to find other ways to create and capture the benefits of the network externality. To create the network externality, a firm has to commit to high production. The problem is that high production is not always credible. In particular, an innovator-monopolist, say the single holder of a new technology, will generally be expected to keep production low, so that he may benefit from the restriction of output and higher prices. In contrast, the innovator may be better off if he invites competitors to enter and compete with him. Their entry automatically implies higher equilibrium production levels, a bigger network effect, and possibly greater profits for the innovator.

We present a model that has two interpretations. In the first interpretation, there is a single good sold, and consumers have expectations of sales that influence positively the demand for the good. At equilibrium, these expectations are fulfilled. In the second interpretation, there are two markets for two complementary goods. In this context, the model describes the interaction of the positive feedbacks across the two markets. Section 2 sets up the basic expectations model. Section 3 describes the market equilibrium with given expectations. Section 4 describes the fulfilled expectations equilibrium. Section 5 determines the incentive of a monopolist to invite entrants. Section 6 discusses the alternative interpretation of the model.

Section 7 discusses extensions to licensing and other market structures, and section 8 provides concluding remarks.

2. Setup

We start with a simple model in expectations.[4] Suppose that the expected size of sales in the market is S. Let the *network externality function* $f(S)$ measure the increase in the aggregate willingness to pay because of the existence of the network externality. Thus, the aggregate willingness to pay for quantity Q increases from $P(Q)$ to $P(Q; S) = P(Q) + f(S)$.

We place the following restrictions on $f(S)$.

(i) $f(0) = 0$, so that no expected sales produce no network externality. This is a normalization of the $f(S)$ function and it could have been done at a different level of S.

(ii) $f(S)$ is a continuous function of S.

(iii) $f'(S) \geq 0$, so that higher expected network sales do not produce a lower externality.

(iv) $\lim_{S\to\infty} f'(S) < \theta$, so that eventually, for large expected sales, the marginal network externality, created by an increase in the expected sales by one unit, does not exceed a constant θ. This rules out fulfilled expectations equilibria with infinite sales.[5]

3. Cournot Equilibrium with Given Expectations

Suppose that a market is described by inverse demand function[6]

$$P(Q) = A - Q$$

[4] Our model is similar to Katz and Shapiro (1985).

[5] Katz and Shapiro (1985) assume that the externality function $f(S)$ is bounded above. Our restriction of the derivative of $f(S)$ has the desirable effects on the properties of equilibria while allowing for a wider class of network externalities functions.

[6] Normalizing the size of units, we set without loss of generality the coefficient of Q to 1.

so that with the network externality the inverse market demand is[7]

$$P(Q; S) = A - Q + f(S).$$

Suppose that the innovator has invited $n - 1$ entrants, and he competes directly with them as a Cournot oligopolist in market of n participants. Firm i maximizes $\Pi_i = q_i P(Q; S)$ by choosing q_i, where $Q = q_i + \Sigma_{j\neq i}\, q_j$. The first order condition of firm i, $i = 1, ..., n$, is

$$\partial\Pi_i/\partial q_i = A + f(S) - 2q_i - \Sigma_{j\neq i}\, q_j = 0,$$

and therefore the market equilibrium is,

$$q_i = [A + f(S)]/(n + 1), \;\; Q = n[A + f(S)]/(n + 1),$$
$$P = [A + f(S)]/(n + 1), \;\; \Pi_i = [A + f(S)]^2/(n + 1)^2.$$

Quantities, prices, and profits increase in sales expectations. Given any expectation S, prices, per firm quantity and profits fall in the number of active firms while industry-wide quantity increases.[8] In the next section we restrict expectations to be fulfilled at equilibrium.

4. <u>Fulfilled Expectations Equilibrium</u>

At the full equilibrium, sales expectations are fulfilled. The fulfilled expectations equilibrium is defined by

$$S^* = Q(S^*) \quad \Longleftrightarrow \quad S^* = n[A + f(S^*)]/(n + 1).$$

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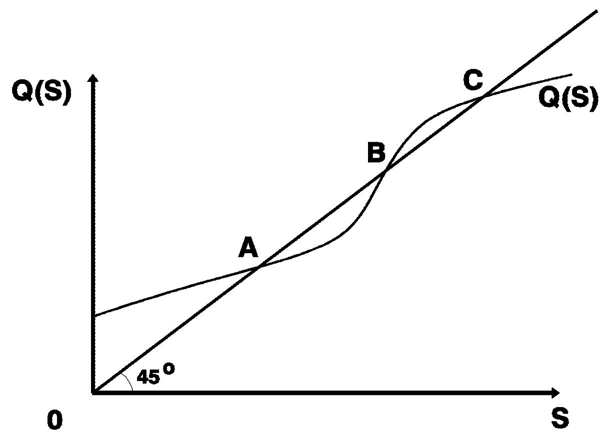
[7] We assume that the network externality pushes the demand outward without changing its slope, that is, $P'(Q) = \partial P(Q; S)/\partial Q$. This means that the increase in willingness to pay because of the externality is the same for each unit sold. We use this particular functional form to avoid introducing spurious strategic effects from the existence of the externality.

[8] These are the standard comparative statics as expected since S changes only the intercept of the industry demand.

See Fig. 2. Q(S) can be thought of as a mapping of sales expectations into actual sales. Fulfilled expectations then define a fixed point S^* of function Q(S). It is shown in Economides (1992) that equilibrium S^* exists, and that if the network externality function f(S) is weakly concave, $f''(S) \leq 0$, then the fulfilled expectations equilibrium is unique.

The equilibrium is *locally stable in expectations* if and only if in the neighborhood of equilibrium S^* the slope of Q(S) is less than 1, which means that if the marginal network externality is not too large. Then,

$$dQ(S^*)/dS < 1, \text{ i.e., } f'(S^*) < (n + 1)/n.$$

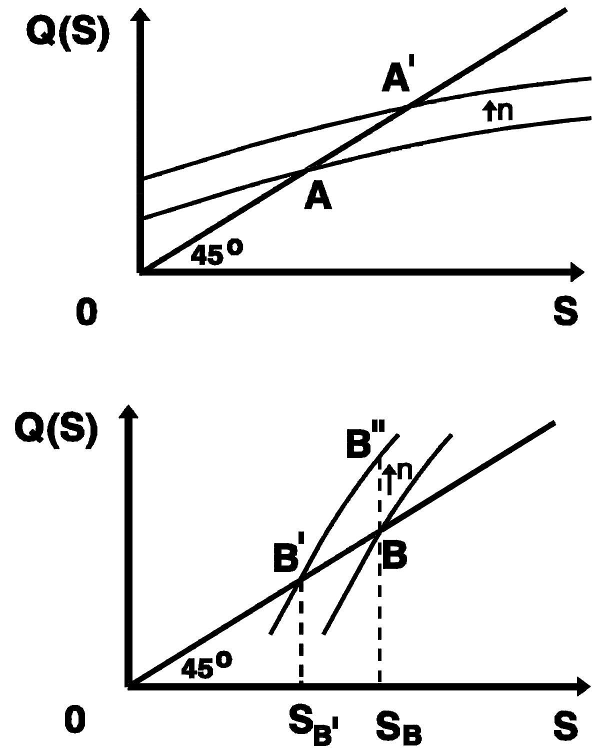


<u>Figure 2</u>: Fulfilled expectations equilibria.

For weakly concave network externality functions, $f''(S) \leq 0$, the unique equilibrium is globally stable. In Fig. 2, equilibria A and C fulfill this condition, but equilibrium B does not. Starting with expectations in the neighborhood of an unstable equilibrium but not exactly at the equilibrium value, there will be a tendency to move away from it. Given an unstable equilibrium, such as B, with $Q'(S) > 1$, there always exists another stable equilibrium, such as C at a higher level of sales, $S_C > S_B$. This is because for large S we have $Q'(S) < 1$, and eventually there will be a crossing of Q(S) and the 45° line with $Q'(S) < 1$. Thus, it may not be unreasonable to expect that an unstable equilibrium will be avoided in favor of a stable equilibrium at a higher S.

Intuitively, we expect an increase in market production for any given level of consumers expectations S should support higher fulfilled expectations and therefore higher equilibrium production. This intuition is confirmed for stable equilibria. An increase in the number of firms *n* increases the quantity produced for any consumers expectations S. That is, an increase in n shifts up the Q(S) function. As a result of the shift, Q(S) intersects the 45° line at a larger

S^* if the slope of $Q(S)$ is less than 1 (as in Fig. 3a); conversely, the upward shift of $Q(S)$ results in a smaller S^* if the slope of $Q(S)$ is larger than 1 (as in Fig. 3b). Thus, increases in n lead to increases in S^* if and only if the fulfilled expectations equilibrium is locally stable.



<u>Figure 3</u>: Upward shifts in Q(S).

Formally, an increase in the number of competitors increases market production (by differentiating the fixed point condition) iff

$$dS^*/dn = S^*/\{n[n + 1 - nf'(S^*)]\} > 0 \iff f'(S^*) < (n + 1)/n.$$

This condition is equivalent to local stability of the fulfilled expectations equilibrium. Now we examine if the increase of sales at the fulfilled expectations equilibrium can also lead to higher profits.

5. <u>The Monopolist's Incentive to Invite Entry</u>

The equilibrium profits of a firm at an n-firm fulfilled expectations equilibrium are

$$\Pi_i^* = (A + f(S^*))^2/(n + 1)^2 = (S^*/n)^2$$

As the number of firms increases, there are two opposite effects on the innovator-monopolist's profits. First, because the number of competitors increases, his profits fall. This is the *competitive effect*. Second, as the number of competitors increases, the market can support larger expected sales as a fulfilled expectations equilibrium S^*. Increases in expected sales increase the innovator-monopolist's profits because they push up the industry demand through the expansion of the network. This is the *network effect*. These effects can be identified on Π_i^* as follows:

$$d\Pi_i^*/dn = \partial\Pi_i^*/\partial n + (\partial\Pi_i^*/\partial S)(dS^*/dn) > 0.$$

The first term, capturing the competitive effect, is negative. The second term, capturing the network effect, is positive since higher expected sales increase profits, and a higher number of firms increases the fulfilled equilibrium (expected and realized) sales. By substitution and simplification we find

$$d\Pi_i^*/dn = S^{*2}[nf' - (n - 1)]/[n^3(n + 1 - nf'(S^*))].$$

Therefore,

$$d\Pi_i^*/dn > 0 \iff (n - 1)/n < f'(S^*) < (n + 1)/n.$$

It follows that an exclusive holder of a technology in a market with strong network externalities at the margin, $f'(S) > (n - 1)/n$, has an incentive to invite competitors to enter the industry and compete directly with him.

6. Mutual Feedbacks in Markets for Complementary Goods

There is another interesting interpretation and extension of our model in the context of two industries that produce complementary goods. Suppose that one firm is the exclusive holder of the technology in industry 1, but there is free entry in industry 2. The monopolist in industry 1 can invite $n_1 - 1 \geq 0$ competitors. When production levels in industries 1 and 2 are Q_1 and Q_2, the willingness to pay for product 1 is

$$P(Q_1; Q_2) = A - Q_1 + f(Q_2).$$

Here Q_1 plays the role of Q, and Q_2 plays the role of S of our previous discussion. Why is the willingness to pay for product 1 increasing in the production level of product 2? Higher production Q_2 implies a larger number of varieties of product 2 and a lower price for them. Thus, with higher Q_2, the surplus realized by consumers of product 2 is higher. Since products 1 and 2 are complementary, higher surplus generates a higher willingness to pay for product 1. This is captured by $f(Q_2)$.

For example, suppose that there are n_2 locationally differentiated products of zero marginal cost and fixed cost F on a circumference as in Salop (1979). Let consumers be distributed uniformly with density μ according to their most preferred variety and have a reservation price R.[9] The symmetric equilibrium price is $p^*(n_2) = 1/n_2$. Profits are $\Pi(n_2) = \mu/n_2^2 - F$. With free entry, $\Pi(n_2) = 0$, and therefore there will be (approximately) $n_2^* = \sqrt{(\mu/F)}$ active firms. The average benefit of a consumer from the consumption of one unit of product 2 is then

$$R - [p^*(n_2^*) + 1/(4n_2^*)] = R - (5/4)\sqrt{(F/\mu)}.$$

Since all consumers on the circle buy the differentiated product we can interpret μ as Q_2, and we can write the average benefit to a consumer as $f(Q_2) = R - (5/4)\sqrt{(F/Q_2)}$ when output in market 2 is Q_2. Assuming that products 1 and 2 are consumed in 1:1 ratio, this average benefit is added to the willingness to pay of consumers for good 1.[10,11]

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[9] We assume that R is sufficiently large so that all consumers buy a differentiated good.

[10] Note that the network externality $f(Q_2)$ (average consumers' surplus) is increasing in Q_2 because a high level of production in industry 2 implies both a larger number of varieties n_2 and a higher degree of competition resulting in lower prices.

[11] We could also allow the reservation price R in industry 2 to vary in Q_1 without changing the result.

Firms play an oligopoly game in market 1, taking Q_2 as given. Let the resulting equilibrium output be $Q_1^*(Q_2; n_1)$. This is a direct reinterpretation of $Q(S; n)$. Firms in market 2 take Q_1 as given. Let equilibrium output in market 2 be $Q_2^*(Q_1)$. In the expectations model we used $S^*(Q) = Q$, i.e., $Q_2^*(Q_1) = Q_1$, and this applies well in a model where the two types of products are consumed in 1:1 ratio, as in our circumference example. In general, $Q_2^*(Q_1)$ will not be the identity function. Then equilibrium across markets defines Q_1^{**}, Q_2^{**} as the intersection of $Q_1^*(Q_2; n_1)$ and $Q_2^*(Q_1)$. See Fig. 4. Increasing the number of firms n_1 shifts $Q_1^*(Q_2;n_1)$ to the right. The effect of the increase of n_1 on equilibrium output in industry 1 is $dQ_1^{**}/dn_1 = (dQ_1^*/dn_1)/[1 - (dQ_1^*/dQ_2)(dQ_2^*/dQ_1)]$, which is positive if the equilibrium is stable $(1 > (dQ_1^*/dQ_2)(dQ_2^*/dQ_1))$.[12]

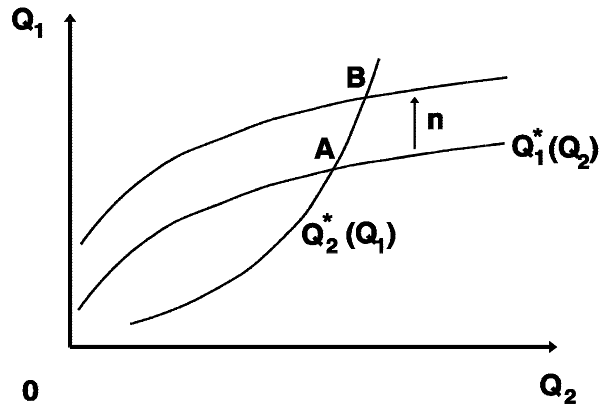

Figure 4: Complementary markets with feedbacks.

The effect of increases in n_1 on the profits of the innovator depends on the particulars of the oligopolistic interaction in markets 1 and 2, as well as on the degree of complementarity between the two markets. For example, if goods 1 and 2 are consumed in 1:1 ratio, this model of interaction across complementary markets is an exact reinterpretation of the expectations model. Thus, all results of the expectations model can be directly reinterpreted for complementary goods model. In particular, when the marginal network externality effect is strong enough, the monopolist-innovator will invite firms to enter.

We have shown in this section that the traditional fulfilled expectations model of network externalities can be re-interpreted and extended to describe markets with positive feedbacks

[12] We assume that an increase of the number of active firms in industry 1 results in an increase of its equilibrium output, i.e., $dQ_1^*/dn_1 > 0$.

across complementary goods or components. Thus we provided a concrete example of the way in which network effects arise and how and when invitations to enter will be beneficial to the innovator-monopolist.

7. Extensions

The oligopoly game played among the firms is not critical for the results. Economides (1992) shows similar results when the monopolist is a quantity leader and the entrants are quantity followers. Extensions to the case of uncertainty about expectations are also discussed in Economides (1992).

Without network externalities, i.e., if $f(S) = 0$ for all S, an innovator-monopolist may want to license competitors. We have shown in earlier sections that, in the presence of strong network externalities, the monopolist would like to invite competitors (charging them zero fees). Now, if he can charge any fees to entrants, he can construct a combination of marginal and lump sum fees that absorbs all profits from the entrants. Essentially with such fees the innovator-monopolist can fully internalize the externality created by entrants. Thus, Economides (1992) shows that in general the monopolist will invite a larger number of competitors to enter if he can charge any licensing (including lump sum) fees.

When lump sum fees are unfeasible, the innovator-monopolist is limited to marginal fees. Economides (1992) shows that the innovator-monopolist charges a positive licensing fee in a market with weak network externalities. Conversely, *in a market with strong network externalities, the innovator-monopolist is willing to give a subsidy to his competitors to encourage higher production*. In the case when the licensing fee chosen by the innovator is positive, the fee also increases with the number of competitors. When the innovator-monopolist chooses to subsidize the followers, his subsidy increases with the number of his competitors.

These results are rather intuitive. In a market with small network externalities, the result is the same as in a market with no externalities, i.e., the innovator-monopolist charges a positive licensing fee. Since in this case the benefit from the externality is small, the innovator-monopolist increases his profit by restricting at the margin the level of output of his competitors through a positive licensing fee. This fee is higher if there are more competitors, to compensate for the higher output. Conversely, when the network externalities are strong, the innovator-monopolist gives a subsidy to his competitors to encourage increased production and greater network effects from which he will benefit. In this case the optimal subsidy increases in the number of competitors to create the strongest externality.

We also find that when the innovator-monopolist uses marginal licensing fees, profits increase in the number of competitors. Thus, the innovator-monopolist has an incentive to invite competitors. Note that it is to the benefit of the innovator-monopolist to invite competitors, both when the license fee is positive and again when it is negative. The intuitive reasons are different in each case. When network externalities are strong, the innovator-monopolist invites competitors, and provides them with a subsidy to enjoy the strong network effects. When the network externalities are relatively weak, the first objective of the innovator-monopolist is to collect the licensing fees; cultivating the network effects is secondary. Of course, in both cases, optimal marginal fee licensing is superior to licensing for free.

8. Concluding Remarks

In the fragmented world of today's telecommunications' industry, firms have difficulty capturing or internalizing the underlying network externalities that naturally occur in this industry. Traditionally, network externalities were captured and internalized to a large extent by vertically integrated national monopolies where they appeared as *economies of scope*. The present level of fragmentation in the industry and the inability of many competitors to vertically integrate (because of regulatory or other restraints) limits the ability of firms to exploit network externalities. Our model suggests that in these circumstances it may be desirable to invite competitors to enter, and even subsidize them.

We have shown that in a market with strong network externalities, in the absence of other means of committing to high production (such as vertical integration in the complementary industry or other contractual commitments), it is beneficial for a sole holder of a new technology to invite competitors to enter the industry by giving away his proprietary knowledge. The expansion of output required for the creation of a large network cannot be done in the absence of competitors. The innovator-monopolist cannot credibly commit himself to create a large network (and reap its benefits) because, for any given level of consumers expectations of sales, the monopolist has an incentive to produce a relatively low output. Nevertheless, the innovator can use the fact that a more competitive market will result in a higher output (for any given expectations). By inviting competition, the innovator commits to an expanded amount of market output for any given expectations. Thus, the innovator credibly sustains the expectation of a high production by inviting competition, and thereby creates the desired large network effect.

We also showed that the expectations model is formally equivalent to a model of strategic interaction with mutual feedbacks between two complementary markets. In this framework, the size of sales in industry 2 affects positively the surplus realized by consumers who buy good 2. This in turn affects positively the willingness to pay for the complementary good 1. Because of the formal equivalence, all results can be reinterpreted in the framework of two complementary markets. Thus, in the presence of strong network externalities and strong complementarities, it pays for a monopolist-innovator to invite competitors to enter and compete on equal terms with him.

The innovator does even better and invites more competitors if he can charge lump sum licensing fees. If the innovator can charge only marginal licensing fees, his optimal licensing fee will be positive for markets with weak network externalities, and negative (i.e., a subsidy) when the externalities are strong. For both weak or strong network externalities, the innovator invites entry as well, and has higher profits than when licensing was free.

In conclusion, offering an invitation to enter by an innovator-monopolist is a useful strategy for a firm in markets with strong network externalities arising because of strong complementarities, if vertical integration or other means of commitment to high output are not available.

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