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DOMINANCE IN THE TELECOMMUNICATIONS SERVICES INDUSTRY

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Abstract

In this paper, we analyze the telecommunications services market. This is a fast-expanding market, with Microsoft's announced entry into it providing additional impetus, and raising policy issues. We look for the market structure that will arise from the decisions of the service providers (in terms of product characteristics and pricing) and the customers, all acting in their own interests. We derive sufficient conditions for restricting the number of possible outcomes to three out of several potential ones. These conditions are satisfied by the common assumptions. We also show that *when positive externalities are dominant, we will have only market-cornering at equilibrium. This result holds even when the products are differentiated.* (We are already seeing near-complete market-cornering in the similar market for operating systems). *That does not deter any of the competitors from entering the fray in the first place, since all have positive expected profits.* We derive the probability that each will be the player to corner the market. *We also show the non-intuitive result that when externalities are dominant, the providers do not have to worry about externalities at all in taking their decisions.* We have also introduced a new solution concept called "odds of dominance" in analyzing our game.

1. INTRODUCTION

Telecommunications is "reaching out and touching" huge chunks of both residential and commercial markets. For example, the announcement of Microsoft recently to enter the on-line services market with its Microsoft Network product is expected by many to be a watershed event in on-line services. The trend toward integration has led to an explosive growth in public communications technologies and services such as on-line services, packet-switching, EDI, and electronic mail on a global scale. In particular, Microsoft's announced product, the Microsoft Network has raised the concern of both its competitors as well as regulators. (See Pauker 1990; Crockett 1991; Dowling and Witte 1991; Pentland 1992; Wilsher and Shetty 1993; Draper 1994; Elmer-Dewitt 1995.)

In this study, we look for the market structure that will arise from the decisions of the service providers (in terms of product characteristics and pricing) and the customers, all acting in their own interests. *We show that the nature of the product is such that a monopoly outcome is the likely one.*

The chief characteristic of the market that we are considering is a highly distributed and inter-dependent demand structure, that is, this market exemplifies those with "demand externalities." Demand externalities are said to arise when the demand for a product is a function of the number of other adopters of the product. (Other markets such as those for operating systems also exhibit demand externalities.)

Another relevant characteristic of this market is the increasing technological ability to interconnect across different networks.

An important strategy of the service providers is to differentiate their products.[1] Product differentiation is important to users also since they may potentially get to choose from different offerings. In this paper, we analyze this important strategy of differentiation (and the related pricing strategy) and the resultant impact on the industry.

The existing work on differentiation does not take into account the specific characteristics of the telecommunications markets, namely

(i) network externalities; and

(ii) network interconnection

We consider these characteristics and derive results peculiar to this market.

We adopt the modeling paradigm of spatial competition, as Hotelling (1929) and d'Aspremont, Gabsewicz and Thisse (1979). (See Giridharan (1993) for an extensive list.)

We adopt a non-cooperative game theoretic model and

(i) derive sufficient conditions for there being at most three equilibrium outcomes out of several possible ones and show that the usual modeling assumptions satisfy the sufficient conditions mentioned above;

(ii) demonstrate that when externalities are not dominant, there may be market-splitting or market-cornering; however, when externalities are dominant, at equilibrium there will be a *single* provider, (i.e., there will be market-cornering);

(iii) show that, when externalities are dominant, although there will be market-cornering at equilibrium, each competitor has a non-zero probability of cornering the market as the game is being played out and derive the probability of each competitor cornering the market;

(iv) show that when externalities are dominant, the competitors actually do *not* have to consider the externalities at all in setting the product characteristics and prices; and

(v) introduce a new solution concept called *odds of dominance* in analyzing the game.

We present the model in section 2, the analysis in section 3 and summarize the paper in section 4.

2. THE MODEL

The utility that a customer derives from a particular offering is an increasing and concave function of the number of adopters of that offering. Hence, this model may be readily adapted to other products where there are network externalities, such as operating systems. Our model can be used to analyze differentiation between Windows 95 and OS/2. (See, for example, Cortese 1994; Darrow 1994; Petreley 1994). We also model the ability of networks to connect to each other.

The ideal products of the customers are located uniformly along a line of length 1. There are two competitors each offering a differentiated product. They can choose any set of characteristics for their products (i.e., they can locate their products anywhere along the line). Each customer chooses exactly one of the two competing products. In general, if there are x adopters for a given product (and hence $(1 - x)$ adopters for the other product), then the utility U for the adopters of that product is given by

$$U(x) = u + f(x + k.(1 - x)),\ 0 \leq k < 1,$$

where u is the baseline utility, and $f(.)$ is the externality function that is increasing and concave and k is the cross-connectivity factor.[2]

One of the ends of the line is taken to be the origin for purposes of measurement. The two competitors locate their products (denoted by 1 and 2) at a_1 and a_2 respectively, with $a_1 \leq a_2$. (Clearly, if $a_1 = a_2$, the products are undifferentiated and the competition is only on the basis of price. Hence, to capture the effect of differentiation, we have $a_1 < a_2$.) They charge prices p_1 and p_2 respectively for their products. We refer to the disutility cost of not choosing the ideal product by $d(y)$, where "y" is the distance of the ideal product from the chosen product. Thus the effective price that a customer pays for product i that is located at a "distance" y from her ideal product is $p_i + d(y)$. The cost function $d(.)$ is increasing and convex. Each customer chooses the product with the higher net value for herself.

In the first stage of the game, the competitors decide simultaneously on the characteristics for their products, i.e., they choose the "locations." In the second stage they decide on the prices simultaneously. In the third stage, the customers make their choice simultaneously.

3. ANALYSIS

We start our analysis from the last stage.

3.1 Customer Choice Stage

When the customers make their choice, they do not know how many other adopters of the product there will be. We use a "fulfilled expectations" model to describe their behavior. The customers have an expectation about the size of the customer base for each product, and in equilibrium, their expectation comes true. This model has been used, for example, in Katz and Shapiro (1985) and Economides (1992).

We define some useful terms. All the customers in the region $[0,a_1)$ are said to be in the *backyard* of product 1; and, similarly, all the customers in $(a_2, 1]$ are in the backyard of product 2.

A *market-cornering* equilibrium is said to arise when, in equilibrium, either of the products captures the entire market; otherwise a *market-splitting* equilibrium is said to arise.

If, in a market-splitting equilibrium, the inhabitants of either of the backyards are split between the two products, then it is said to be a *backyard equilibrium*; otherwise, the market-splitting equilibrium is an *internal equilibrium*.

Consider the behavior of customers, given the product "locations" (i.e., the product characteristics) and prices. Let the expected market sizes of products 1 and 2 respectively be e_1 and e_2 $(= (1 - e_1))$. With such given values for a_1, a_2, p_1, p_2 and e_1, the customers make their choice. We show below in Lemma 1 that we can always find a cut-off point, called a *transition point*, denoted by

$t(a_1, a_2, p_1, p_2, e_1)$ such that all customers located in $[0, t(a_1, a_2, p_1, p_2, e_1))$ will prefer one of the two products (say, 1) over the other; and all the customers located in $(t(a_1, a_2, p_1, p_2, e_1), l]$ will prefer the other product (which is 2 in this case), with at least one of the two groups having a strong preference.

Lemma 1: There always exists a transition point $t(a_1, a_2, p_1, p_2, e_1)$.

Proof: Available in the full paper.

We look for a fulfilled expectations equilibrium, where $t(a_1, a_2, p_1, p_2, e_1) = e_1$. Obviously, for any given level of expectation, there can be at most one fulfilled expectation equilibrium (i.e., the expectation either comes true or it does not). However, different expectations can, in general, lead to multiple equilibria. We now show sufficient conditions for there being *at most one interior equilibrium.* In particular, we show that when $f(.)$ and $d(.)$ are linear functions, these conditions are satisfied. We further show that when $d(.)$ is linear, then there cannot be any backyard equilibrium. Thus, under linearity of f and d there can be at most three equilibria (two market-cornering equilibria and one interior equilibrium).

Theorem 1: When $d'(0) \geq (1 - k)f'(0)$ or $d'(l) \leq (1 - k)f'(l)$, then there is at most one internal equilibrium.

Proof: Available in the full paper.

We note that if f and d are linear, both of the conditions in the above theorem are satisfied. We then go on to assume $f(.)$ and $d(.)$ to be linear (with F and D denoting the constants of proportionality respectively). For notational convenience, we denote $(1 - k)$. F by G. The linearity of the externality function and the transportation cost is standard in much of the respective literature on externalities and differentiation.

In Lemma 2, we further restrict the number of possible equilibria.

Lemma 2: Under linearity of d, there cannot be any backyard equilibria.

Proof: Available in the full paper.

Thus, given the product prices and their characteristics, there can be *at most three* possible fulfilled expectations equilibria (two market-cornering ones and one interior one). We next consider which of these three potential cases will actually be realized.

3.2 Choice of Prices

The competitors choose the prices so as to maximize their respective profits. We look for an equilibrium where neither party can be better off by setting an off-equilibrium price, given that its competitor sets the equilibrium price.

We first consider is the possibility of multiple equilibria (at stage 3) as a result of certain price combinations set during stage 2. The key question is as to which of these possible outcomes the service-providers should reckon while setting their prices.

We introduce a solution concept that we call *odds of dominance.* If, for any given set of product characteristics and prices, there are multiple equilibria possible, it is reasonable to expect that those equilibria which are not preferred by many customers are less likely to occur than those that are preferred by many customers. In particular, when there are multiple equilibria possible, we model the probability of each of those *potential* equilibria being the *actual* equilibrium as equal to the proportion of customers preferring that equilibrium over the others.

Next, the relative strength of the externality factor (with respect to how strongly customers want their "ideal" products) plays an important role in the analysis. Clearly, G is a measure of the externality factor and D is a measure of the preference for the ideal product (i.e., the greater the value of D, the greater is the disutility in moving from the ideal product).

Specifically, we say that the externality (preference, respectively) effect is dominant if $D <$ ($>$, respectively)

$$G \cdot \frac{(\min\{a_2, 1 - a_1\}}{(a_2 - a_1)}$$

Note that the factor

$$\frac{(\min\{a_2, 1 - a_1\}}{(a_2 - a_1)}$$

is greater than or equal to 1.

We are primarily interested in the case where externalities are dominant. However, for ease of exposition, we consider both preference-dominance and externality-dominance.

Theorem 2: When the preference effect is dominant, there may be market-cornering or market-splitting. However, when the externality effect is dominant, there will only be market-cornering.

Proof: Available in the full paper.

As part of the proof of theorem 2, we show that under externality-dominance, under certain price-combinations, market cornering by provider 1 is assured; under certain other price-combinations, cornering by provider 2; and under all other price-combinations, either one may be the provider to corner the market. Rationality dictates that, for any given price by the competitor j, provider i will not choose a price that will shut himself out of the market for sure. Hence, we have the following corollary:

Corollary: Under externality-dominance, even though there will be only one player at equilibrium, each player has a non-zero probability of being that dominant player as the game is being played out (i.e., during the first two stages).

We derive in Lemma 3 the probability of each player being the one to corner the market:

Lemma 3: When the externality effect is dominant, the probability that provider i corners the market is given by

$$\frac{p_1 - p_i}{2 \cdot l \cdot D} + \frac{a_2 - a_1}{2 \cdot l}, \text{ for } j \neq i.$$

Proof: Available in the full paper.

Finally, we show that when externalities are dominant, the providers do *not* have to consider the actual extent of the externality; that is, *they can take their decisions as though externalities are absent.*

Theorem 3: When externalities are dominant, the optimal decisions for the providers (in terms of the product characteristics and the prices) are exactly the same as when externalities are completely absent.

Proof: Available in the full paper.

If the optimal decisions are the same, then what is the difference between the cases where there are no externalities at all and where the externalities are dominant? The difference lies in the fact that, once the prices are set, the two providers know *for sure* what their profits will be when externalities are absent. However, when externalities are dominant, that is only an expectation. The reality will be that either of the two providers will corner the market.

4. SUMMARY

In this paper, we have analyzed the telecommunications services market which is characterized by positive externalities and interconnectivity. An interesting issue is the likely market structure that we can expect in this industry, especially in light of the entry of a company like Microsoft. We have shown that when externalities are not dominant, we may have market-cornering or market-splitting; however, when externalities are dominant, we will have only market-cornering at equilibrium. This result holds even if the products are differentiated. The intuition here is that, if the externality effect is strong enough, then it will swamp any possible advantage from differentiation. (We are already seeing near-complete market dominance in the operating systems market, which has similar characteristics.)

However, this expected market-dominance does not deter any of the competitors from entering the fray in the first place, since both have positive *expected* profits. This may explain why several entrants are seen in the field. We derive the probability that each will be the player to corner the market.

We also show the non-intuitive result that, when externalities are dominant, the providers do not have to worry about externalities at all in making their decisions. This has an important managerial implication. If this result is not true, then managers have to factor externalities into their decision making. This is normally a very difficult task. However, our model shows that they do not have to do it.

We have also introduced a new solution concept called "odds of dominance" in analyzing our game.

5. ACKNOWLEDGMENTS

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7. ENDNOTES

1. Some of the avenues for differentiation in this market are speed, reliability, user interface, ability to connect with internal systems, platforms supported, etc.

2. We set $k < 1$, implying that cross-connectivity is not costless.

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