# MARKET DOMINANCE IN THE TELECOMMUNICATIONS SERVICES INDUSTRY [1]

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**Abstract**

In this paper, we analyze the telecommunications services market. This is a fast-expanding market, with Microsoft's entry into it with its Microsoft Network 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 show that *when positive externalities are dominant, we can 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). *But, 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. We also 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.

## 1. Introduction

Telecommunications is "reaching out and touching" huge chunks of both residential and commercial markets. The residential market (which has come into the limelight relatively recently), offers a great potential for telecommunications service providers. 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. On the commercial side, as organizations reengineer their business processes, a key activity is "integration." The primary facilitator of integration, both within and across organizations is telecommunications technology. The trend towards integration has led to an explosive growth in public communications technologies and services such as packet-switching, electronic data interchange and electronic mail on a global scale. (See Pauker (1990), Crockett (1991) Dowling and Witte (1991), Pentland (1992), Wilsher and Shetty (1993), Draper (1994) etc.)

The perceived explosion in market potential has attracted several providers of telecommunications services. In particular, Microsoft's new offering, the Microsoft Network has raised the concern of both its competitors as well as regulators. (See, for example, Elmer-Dewitt (1995)). In this paper, 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 – even if the products are differentiated.*

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 (also called network 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.) In such markets, by adopting such a product, a customer increases its attractiveness to other potential users. (There is a rich literature on this. See, for example, Farrell and Saloner (1985, 1986, 1987, 1992), Katz and Shapiro (1985, 1986, 1992), Saloner (1989), Church and Gandal (1992, 1993), Riggins, Kriebel and Mukhopadhyay (1989, 1990), Saloner and Shepard (1990), Economides (1991a, 1992a), Seidmann and Wang (1992), Westland (1992), Brynjolfsson and Kemerer (1993), Gandal (1994) and Elmer-Dewitt (1995)).

Another relevant characteristic of this market is the increasing technological ability to interconnect across different networks. Thus, although a user may primarily be connected to one network, typically she will have the ability to connect to other networks as well.

An important strategy of the service providers is to differentiate their products. Product differentiation is important to users also since they may potentially get to choose from different offerings. Hence, a key issue of concern both to the providers and the users is the way in which these products are differentiated.[1] In this paper, we analyze this important strategy of differentiation (and the related pricing strategy) of the service providers and the resultant impact on the industry.

Although work has been done in marketing on product differentiation, the existing work 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.

The key objective in differentiation is to lessen the competition and thereby facilitate higher prices and profits. Differentiation can be of two broad types:

(i) "Vertical differentiation", where all the customers have the same preference ordering among the offerings; and

(ii) "Horizontal differentiation", where different customers can have different preference orderings among the offerings.

The nature of the product makes an analysis of horizontal differentiation important, since it is likely that different offerings will be attractive to different people. Hence, here

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

we focus on horizontal differentiation.[2]

There are two basic modelling paradigms used for modeling horizontal differentiation. The first paradigm relates to monopolistic competition, where the basic model was introduced by Chamberlin (1933). The main issue in this stream is whether there will be too few or too many firms in the industry at equilibrium. The most-cited works in this stream (by Spence (1976) and Dixit and Stiglitz (1977)) show that, under the conditions of their model, there will be a *less-than-optimal* number of firms. Others (such as Koenker and Perry (1981)) demonstrate conditions under which there may be *excess* diversity.

The second modelling paradigm for horizontal differentiation is that of spatial competition. The two most important works here are Hotelling (1929) and d'Aspremont et al. (1979). In Hotelling (1929), customers have different "addresses" (or using another interpretation, have different "ideal products.") along a straight line. Each customer makes his choice from a set of differentiated products on the basis of the prices as well as the (possible) disutility cost in choosing a brand which may not be his ideal product. The analysis in this stream typically focuses on what the equilibrium characteristics of the products and their prices will be. Hotelling (1929) showed that the products will tend to be identical, i.e. they will have "minimal differentiation".

d'Aspremont et al (1979) pointed to an error in Hotelling's analysis. Their major results were that if the products are close to each other in their characteristics, there cannot be an equilibrium in the prices; and that any equilibrium will involve the competitors sharing the market.

Since the publication of d'Aspremont et. al (1979), much work has been done in this area. (See Giridharan (1993) for an extensive list of these studies.) However, these do not take into account the specific characteristics of the telecommunications industry.

We adopt a non-cooperative game theoretic model and:

(i) derive sufficient conditions for there being at most three equilibrium outcomes out

[2] Vertical differentiation under positive externalities is studied in Esser and Leruth (1988).

of several possible ones; and show that the usual modelling 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.

In what follows, we present the model in Section 2, the analysis in Section 3 and summarize the paper in Section 4.

## 2. The Model

We adopt the spatial competition paradigm; in particular, we use the most common model where the product preferences of the customers are located along a straight line. (This is called the "linear city" model. There are other models like the "circular city" model). As noted earlier, the existing literature however does *not* model

(i) network externalities which characterize telecommunications networks; as well as

(ii) the ability for networks to interconnect among themselves.

We model the utility that a customer derives from a particular offering as an increasing and concave function of the number of adopters of that offering. Thus, the net-value that a customer derives from a particular product is a function of its price, her utility loss in choosing a product that is not "just right" for her (in terms of its characteristics) as well as the total number of users of the product. Hence, this model may be readily adapted to other products where there are network externalities. Another relevant product would be operating systems. Our model can be used to analyze differentiation between Windows

95 and OS/2. (See for example, Cortese (1994), Darrow (1994) and Petreley (1994)). We also model the ability of networks to connect to each other.

Specifically, the ideal products of the customers are located uniformly along a line of length $l$. 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 $(l-x)$ adopters for the other product), then the utility $U$ for the adopters of that product is given by

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

where $u$ is the baseline utility, and $f(\cdot)$ is the externality function that is increasing and concave and $k$ is the cross-connectivity factor.[3]

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. In addition, customers also incur a disutility cost in choosing a product that is not ideal for them. This disutility cost is clearly a function of how removed the chosen product is from their ideal product. Hence, we refer to this cost 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 $d(\cdot)$ in increasing and convex. Each customer chooses the product with the higher net value for herself.

The game is modelled in three stages. In the first stage, the competitors decide simultaneously on the characteristics for their products, i.e. they choose the "locations" for their respective products. In the second stage they decide on the prices simultaneously; and in the third stage, the customers make their choice simultaneously.

[3] We set $k$ to be less than one, implying that there may not be full cross-connectivity, and even if it is there, there are likely to be costs associated with cross-connectivity.

## 3. Analysis

We start our analysis from the last stage.

### 3.1 Customer Choice Stage

At the time when the customers make their choice, they do not know how many other adopters of the product there will be. This is a common problem in the analysis of products with positive externalities. 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 (1992a).

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 $(a_2, l]$ 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 $e_2$ $(= (l - e_1))$. 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:** The net-value of product $i$ to a customer located at $x$, denoted by $U_i(x)$ is

$u + f(e_i + k(l - e_i)) - p_i - d(|x - a_i|)$. Replacing $u + f(e_i + k(l - e_i)) - p_i$ by $b_i$, this can be written as $U_i(x) = b_i - d(|x - a_i|)$. By the convexity of $d(.)$, there is at most one $x$ at which $U_1(x)$ and $U_2(x)$ will intersect. Hence, for any given product characteristics, prices and expectations about market sizes, we can always find a transition point – the point of intersection of $U_1(x)$ and $U_2(x)$ or (if there is no point of intersection), one of the endpoints of the line $[0, l]$. (In fact, if the convexity of $d$ is strict, then all the customers located in $[0, t(a_1, a_2, p_1, p_2, e_1))$ will prefer product 1 and all the customers located in $(t(a_1, a_2, p_1, p_2, e_1), l]$ will prefer product 2.) **Q.E.D.**

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 $f(\cdot)$ and $d(\cdot)$ are linear functions, these conditions are satisfied. We further show that when $d(\cdot)$ 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:** We are looking for values for $e_1$ ($a_1 \leq e_1 \leq a_2$) that will solve the equation

$$u + f[e_1 + k(l - e_1)] - p_1 - d(e_1 - a_1) = u + f[(l - e_1) + k \cdot e_1] - p_2 - d(a_2 - e_1) \quad (1)$$

Define $g(e_i)$ as $f[e_i + k(l - e_i)]$. Hence $g'(e_i) = (1 - k) \cdot f[e_i + k(l - e_i)] > 0$ and $g''(e_i) \leq 0$. Thus $g$ is increasing and concave. We note that equation (1) can be rewritten as

$$g(e_1) - d(e_1 - a_1) - g(l - e_1) + d(a_2 - e_1) = p_1 - p_2$$

The first derivative of the $LHS$ wrt $e_1$, denoted by $LHS'$ is

$$LHS' = g'(e_1) - d'(e_1 - a_1) + g'(l - e_1) - d'(a_2 - e_1)$$

From the definition of $g$ and the fact that $d$ is convex and $f$ is concave, note that $LHS' \leq (1-k)f'(0) - d'(0) + (1-k)f'(0) - d'(0)$ and $LHS' \geq (1-k)f'(l) - d'(l) + (1-k)f'(l) - d'(l)$ It follows then that if $d'(0) \geq (1-k)f'(0)$, then $LHS' < 0$ and thus $LHS$ is monotone decreasing; and if $d'(l) \leq (1-k)f'(l)$, then $LHS$ is monotone increasing. In either case, there is at most one interior equilibrium. **Q.E.D.**

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 $f(\cdot)$ and $d(\cdot)$ to be linear (with $F$ and $D$ denoting the constants of proportionality respectively). For notational convenience, we denote $(1-k)\cdot F$ 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:** A backyard equilibrium (say, in product 1's backyard) would imply, given the product characteristics, prices and customer expectations, a transition point, $t$ in product 1's backyard. Recall that the definition of a transition point is that the groups on either side prefer different products, with at least one group having a strong preference. Without loss of generality, let the group to the left of the transition point have a strong preference for product 1. This implies that we have to find a point $t$ in $[0, a_1)$ such that

$$u + f[e_1 + k(l - e_1)] - p_1 - D \cdot (a_1 - x) > u + f[(l - e_1) + k \cdot e_1] - p_2 - D \cdot (a_2 - x)$$

for $x < t$ and

$$u + f[e_1 + k(l - e_1)] - p_1 - D \cdot (a_1 - x) \leq u + f[(l - e_1) + k \cdot e_1] - p_2 - D \cdot (a_2 - x)$$

for $t < x < a_1$.

It can be easily seen that, for a given $a_1$, $a_2$, $p_1$, $p_2$ and $e_1$, the above two equations cannot both hold simultaneously. **Q.E.D.**

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. We do this in the next stage of the analysis.

### 3.2 Choice of prices

Going one step back, when the competitors set their prices, they choose them so as to maximize their respective profits. We look for a Nash equilibrium where neither party can be better off by setting an off-equilibrium price, given that its competitor sets the equilibrium price.

The first issue that we consider is the possibility of multiple equilibria (at stage 3) as a result of certain price combinations set during stage 2. In other words, there may be some price combinations for which multiple equilibria are possible, based on different customer expectations. The key question is as to which of these possible outcomes the service-providers should reckon while setting their prices.

To deal with this issue, 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 other.

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) $G \cdot \frac{\min\{a_2, l-a_1\}}{(a_2-a_1)}$. Note that the factor $\frac{\min\{a_2, l-a_1\}}{(a_2-a_1)}$ 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. We show in Theorem 2 that when the preference effect is dominant, we can have either a market-cornering or a market-splitting equilibrium; however when the externality effect is dominant, only a market-cornering equilibrium will result.

**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:** First consider a market-splitting equilibrium. For such an equilibrium, we need

$$u + F \cdot [e_1 + k(l - e_1)] - p_1 - D \cdot (e_1 - a_1) = u + F \cdot [(l - e_1) + k \cdot e_1] - p_2 - D \cdot (a_2 - e_1)$$

Simplifying and using the definition of $G$, we get

$$e_1 = \frac{p_2 - p_1 - Gl + D(a_1 + a_2)}{2(D - G)}$$

From the above equation, for $e_1$ to lie in the range $[a_1, a_2]$, we need

$$p_1 \leq p_2 - (l - 2a_1)G + (a_2 - a_1)D \tag{2}$$

and

$$p_1 \geq p_2 - (l - 2a_2)G - (a_2 - a_1)D \tag{3}$$

Next, for a market-cornering equilibrium, we need

$$p_1 > p_2 - Gl + D(a_2 - a_1) \tag{4}$$

or

$$p_2 > p_1 - Gl + D(a_2 - a_1) \tag{5}$$

For ease of analysis, we consider the following four cases:

( i) $D \geq G \cdot \frac{l}{a_2 - a_1}$

( ii) $G \cdot \frac{l}{a_2 - a_1} > D > G \cdot \frac{\min\{a_2, l - a_1\}}{(a_2 - a_1)}$

( iii) $G \cdot \frac{\min\{a_2, l-a_1\}}{(a_2-a_1)} > D \geq G$

( iv) $G > D$

Note that the first (last, respectively) two cases make up preference (externality, respectively) dominance.

Case (i): $D \geq G \cdot \frac{l}{a_2-a_1}$

Combining the results for market-sharing and market-cornering (equations (2) through (5)), we get the following figure:

**Insert Figure 1**

The figure shows the resulting equilibrium for each combination of prices.

In the area marked $A(E$, respectively), product 2(1, respectively) will corner the market; in the area marked $B(D$, respectively), there can be either market-splitting or cornering by product 2(1, respectively); and in the area marked $C$, there will be market-splitting.

Thus, in areas $A$, $C$ and $E$, the equilibrium outcome is clear. However, in areas $B$ and $D$, we can have market-splitting or cornering. The actual outcome depends on the consumer's expectations. The competitors have to take this fact into account while setting the product characteristics and the prices.

Using the "odds of dominance" concept introduced earlier, in area $B(D$, respectively), the probability of 2(1, respectively) cornering the market is equal to the fraction of customers preferring that equilibrium rather than a market-splitting one.

Consider area $D$. Here, clearly, all those who will choose product 1 under a market-splitting equilibrium will prefer 1 to corner the market (as the number of adopters of their product of choice will be higher), rather than have a market-splitting equilibrium. However, how about the customers who will choose product 2 under a market-splitting equilibrium? Clearly, they face a trade-off in selecting between a market-splitting equilibrium and a market-cornering by product 1. If they choose market cornering by product 1, they will have the benefit of additional members. However, they may also have to "travel" a larger distance to reach product 1 than product 2.

Looking first at the benefit, the number of adopters of the product they choose will go up from $(l - e_1)$ to $l$ – representing a gain of $e_1$ and thus an increase in their utility of $Ge_1$. How about the additional cost? All the members in product 2's backyard will incur an additional transportation cost of $D(a_2 - a_1)$.

Since $D > G \cdot \frac{l}{a_2 - a_1}$ in the case that we are considering, we get that, for all the customers in the backyard of product 2, the marginal cost of choosing 1 as the dominant product outweighs the marginal benefit; and hence none of the members in product 2's backyard will choose market cornering by product 1.

How about the non-backyard customers? If they are close enough to product 2, then they will prefer market-splitting rather than cornering by 1. The cut-off point $x$ such that all the members in $[0, x)$ preferring market-cornering by 1 and all the members in $(x, l]$ preferring market-splitting is given by

$$D[(x - a_1) - (a_2 - x)] = Ge_1$$

This implies

$$x = \frac{Ge_1 + D(a_1 + a_2)}{2D}$$

Thus the probability of 1 cornering the market is given by $\frac{x}{l}$, i.e. $\frac{Ge_1 + D(a_1 + a_2)}{2Dl}$ and the probability of a market-splitting equilibrium is given by $1 - \frac{x}{l}$. The area $B$ can be analyzed in an exactly symmetric fashion.

<u>Case (ii):</u> Next consider the case $G \cdot \frac{\min\{l - a_1, a_2\}}{a_2 - a_1} < D < G \cdot \frac{l}{a_2 - a_1}$.

Without loss of generality, let $(l - a_1) \geq a_2$. First consider $D > G \cdot \frac{(l - a_1)}{(a_2 - a_1)}$, i.e., we have $G \leq G \cdot \frac{a_2}{a_2 - a_1} \leq G \cdot \frac{l - a_1}{a_2 - a_1} < D < G \cdot \frac{l}{a_2 - a_1}$. Again combining the results for market-cornering and market-splitting (equations (2) through (5)), we get figure 2:

**Insert Figure 2**

Areas $B$ and $D$ can be analyzed as before. Consider area $C$. Here there are *three* equilibria possible. We apply the odds of dominance concept. All those who will choose product 1 under a splitting equilibrium will prefer market-cornering equilibrium by product 1 (because market dominance by 1 will lead to greater externality benefits). In a similar manner, all those who will choose product 2 under a splitting equilibrium will prefer market-cornering equilibrium by product 2. Hence, only the market-cornering equilibria have non-zero probabilities in area C.

Similarly, if we have $G \leq G \cdot \frac{a_2}{a_2-a_1} < D \leq G \cdot \frac{l-a_1}{a_2-a_1} \leq G \cdot \frac{l}{a_2-a_1}$, we have figure 3:

**Insert Figure 3**

In figure 3, product 2 (1 respectively) will corner the market in area $A$ (area $D$ respectively); either product can corner the market in area $B$; and there will be a market-split or cornering by product 1 in area $C$.

Case (iii):

Next consider the case where $G \cdot \frac{\min\{a_2, l-a_1\}}{(a_2-a_1)} > D \geq G$. Performing the same analysis, we get figure 4:

**Insert Figure 4**

Here product 2 (1, respectively) corners the market in area $A$ (area $E$, respectively); and either product can corner the market in areas $B$ and $D$; and finally, the region where there is a possibility of market-splitting, namely area $C$, is totally enclosed in a region where both the market-cornering equilibria are possible, and hence, as seen in the previous case, we cannot have a market-splitting equilibrium. In other word, even in area $C$, we can have only market-cornering.

Case (iv): $D < G$

We can easily verify that constraints (2) and (3) cannot hold simultaneously in this case. Hence, we cannot have market-splitting. We get figure 5:

**Insert Figure 5**

In figure 5, product 1 (2, respectively) can corner the market in area $A$ ($C$ respectively); and either product can corner the market in area $B$. **Q.E.D.**

Note 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, $\pi_1$, the probability that provider 1 corners the market is given by $\frac{p_2-p_1}{2 \cdot l \cdot D} + \frac{a_2+a_1}{2 \cdot l}$ and $\pi_2 = 1 - \pi_1$.

**Proof:** Under externality-dominance, the prices will be set such that each provider has a chance of cornering the market. The probability that product $i$ will corner the market is given by the fraction of customers who would prefer $i$ to corner the market rather than $j$. The number of customers $z$ who will prefer product 1 to be dominant is given by

$$u + F \cdot l - p_1 - D \cdot (z - a_1) = u + F \cdot l - p_2 - D \cdot (a_2 - z)$$

Solving for $z$, we get

$$z = \frac{p_2 - p_1}{2 \cdot D} + \frac{a_2 + a_1}{2}$$

The desired result follows. **Q.E.D.**

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.* To see this, note that from theorem 2, we know that at equilibrium, there will only be one dominant player. So, irrespective of who the dominant player is, each user will have an added utility of $F \cdot l$ because of the externality effect. This effectively eliminates the impact of the externality effect. (We can think of the problem as being equivalent to a case where the baseline utility has been increased by $F \cdot l$, but with no externality effect). As a result, for any choice of prices and characteristics by the players, the probability of each player being the dominant one (and hence his expected market share and profits) are exactly the same as the market-share that he would have when externalities are absent. Thus, the optimal decisions for the players during the first two stages are exactly the same as under the situation when externalities are totally absent. We formally show this in the next theorem.

**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:** We showed in Lemma 3 the probability of each provider cornering the market. Hence, during the pricing stage, the *expected* profit for provider $i$ is given by $l \cdot p_i$ if $p_i < p_j - D(a_2 - a_1)$; 0 if $p_i > p_j + D(a_2 - a_1)$; and $a_i p_i + \frac{1}{2}(a_2 - a_1)p_i + \frac{1}{2D}p_i p_j - \frac{1}{2D}p_i^2$ if $|p_i - p_j| \leq D(a_2 - a_1)$. This expected profit function is exactly the same as the profit function as in d'Aspremont et.al (1979), where there are no externalities. Hence, the optimal decisions are the same as under the case without externalities. **Q.E.D.**

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 inter-connectivity. 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 can 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).

But, 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 taking their decisions. This has an important managerial implication. If this result were not rue, 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.

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