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ENTRY IN TELECOMMUNICATION: CUSTOMER LOYALTY, PRICE SENSITIVITY AND ACCESS PRICES

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Entry in Telecommunication:

*Customer Loyalty, Price Sensitivity and Access Prices**

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Abstract:
The purpose of this article is to investigate the prospects for entry into an existing network in the telecommunication industry, and how public policy may promote a more competitive outcome. We apply a model that captures the fact that the incumbent has an installed base of loyal consumers, some consumers are price sensitive, and the entrant is charged an access fee for entering the network. We distinguish between classical (de novo) entry and reciprocal entry (incumbent entering the neighbouring market), and analyse how such public policy measures as (i) publication of prices by the authorities and (ii) lower access fees affect the competitive outcome. In the reciprocal entry model we find that lower access fees tend to discourage entry into a neighbouring market, while the publishing of prices has an ambiguous effect on entry.

Keywords: collusion, entry, access fee, telecommunication
JEL Numbers: L13, L51, L96

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1. INTRODUCTION

Telecommunication firms have historically held dominant market positions in most countries. One important reason is the economies of scale in the industry. Since entry of new firms has been regarded as a cost-inefficient solution, one provider has historically often been granted a legal monopoly. To minimise exploitation of market power, this dominant service provider has often faced a restrictive regulatory regime. Lately, though, the industrial structure in telecom has changed dramatically. The industry has been liberalised. Most importantly, new firms have been permitted access to the dominant firm's network. The purpose of this paper is to discuss how such a liberalisation may change the nature of competition in the telecommunication industry. We study two different kinds of entry triggered by liberalisation: the entrant may be a newcomer to the industry (de novo entry), but we might also have that incumbent firms in neighbouring markets enter each other's market (reciprocal entry). We are especially concerned with how public policy measures can lead to a more competitive outcome, either more intense rivalry between existing firms or entry of new firms. How would a reduction in access fees affect the outcome, and what if the authorities start publishing prices in order to make consumers more price sensitive?

There are some idiosyncratic characteristics of this particular industry that should be taken into account when we model the effect of entry. Telecommunication services, such as telephone usage, are to a large extent a homogenous product. Despite this, it is not plausible to assume that all the consumers use the firm with the lowest price. We wish to model the fact that some customers might harbour brand loyalty towards the old monopolist. More precisely, we assume that some customers do not take price differences into account when choosing supplier -- and that a majority of these will choose the incumbent rather than the entrant. We further assume the larger the price difference between the firms' products, the larger the number of consumers that switches to the low price producer. To capture these demand characteristics, we extend a model first introduced in Allen and Thisse (1992), as we will return to shortly.

Second, there are asymmetries on the cost side. The old monopolist has typically invested in infrastructure. We focus on the case where duplication of the infrastructure is prohibitively expensive, so the entrant needs access to this infrastructure to be able to serve consumers. The cost asymmetry between the two firms arises because the entrant is charged an access price, which typically exceeds the marginal costs faced by the incumbent.[1] We assume that this access price is set by some regulatory agency. Either the incumbent is a fully integrated firm that maximize joint profits from network revenues and sales to end users, or the incumbent is divisionalized so that each of those two units maximize profits in isolation. We investigate both cases, with a particular focus on the latter case.

As mentioned, we will distinguish between two different entry scenarios. The entrant is either newcomer to the industry (de novo entry), or a previous monopolist in some neighbouring market (reciprocal entry). The interesting distinction is that when the entrant is a neighbour monopolist, the monopolist under attack can retaliate by entering the entrant's home market. Collusion under multimarket contact then becomes an issue.

In the first, de novo entry game, we find that the entrant might set a lower price than the incumbent even if he has a cost disadvantage. The reason is two-fold. First, the incumbent sets a high price to serve its loyal base of consumers. Second, it sets a high price if it is an integrated firm than can earn revenues from the entrant's access fee. We find that a public policy to publish prices and thereby make consumers more price sensitive would lead to tougher price competition. This is good news for consumers if entry takes place. However, such a public policy might deter entry. A lower access fee will also lead to lower prices, which given entry is beneficial for the consumers. This policy, though, would either promote or have no effect on entry. Since the entrant's marginal cost is equal to the access fee, it typically gains from lower access fee. But we show that the entrant does not profit from a lower access fee if the incumbent is an integrated firm. In such a case the incumbent responds to a lower access fee by aggressive price cuts. By doing so it can recapture some of its lost revenues from the entrant's access fee.

In the second entry game, where potential entry is reciprocal, results might be distinctly different in many respects. The reason is that in this setting it is not simply a question whether a firm enters a market or not, but whether the firm enters the neighbouring market and then triggers reciprocal entry. A key question becomes under what circumstances multimarket collusion -- of the form that each firm stays in its original home market -- can be sustained. We check how a joint public policy in those two countries works, and we also check the effect of unilateral action. We find that lower access fees tends to promote entry, both for the case with a joint public policy and for the case of a unilateral reduction in access fee. In contrast, a public policy to publish prices has an ambiguous effect on entry, irrespective of whether it is a unilateral or a joint public policy.

Our basic model shares some similarities with switching cost models. Consumers are initially allocated to either the incumbent or the entrant, and for identical prices the entrant's market share is either equal to or lower than the

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[1] De Fraja (1999) studies the case where there are true differences between the incumbent and the entrant. In an asymmetric information model he shows that it can be optimal to set access prices 'pro-

incumbent's share. The larger the price difference, the larger the number of consumers that prefers being served by the low price firm. Since not all the consumers switch to the low price firm, we may interpret this as if the consumers incur switching costs. In that respect our model is closely related to Wang and Wen (1998), a switching cost model tailor-made to the characteristics of the telecommunication industry.[2] However, our model is distinctly different from theirs in many other respects. First, they assume two kinds of consumers and that either none or all the consumers in each group switch to the low price firm. In contrast, we assume one group of consumers and let the number of consumers that switches depend upon the price difference between the two firms. Second, they assume sequential price setting while we assume simultaneous price setting. Third, they – as well as other switching cost models – investigate only what we have labelled the classical entry game. Here the classical entry game is partially a prerequisite to study the potential for reciprocal entry and multimarket collusion.

The version of our model with potential for reciprocal entry is closely related to some models on collusion. In particular, our model shares many similarities with Lommerud and Sørgard (2001). In that model we analysed a multimarket homogenous goods duopoly with either Cournot or Bertrand competition. In contrast, in the present work the starting point is the model first presented in Allen and Thisse (1992), a price setting model where not all consumers switches to the low price firm. It turns out that limited price sensitivity and the existence of customer loyalty towards the incumbent crucially matter for results about when multimarket collusion can be sustained.

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competitive', in the sense of favoring a less efficient entrant.

[2]Their model is closely related to Klemperer (1987). For an explanation of the differences between those two models, see Wang and Wen (1998). Although the referred study is the one most closely related to ours, there are also numerous others. For a survey of the literature, see Klemperer (1995).

The article is organised as follows. In the next section we present the model structure. In section 3 we analyse the effects of entry given that the incumbent and the entrant compete non-cooperatively in the post-entry game, and discuss public policy measures. In section 4 we examine a certain kind of collusion, where entry in a neighbouring market triggers reciprocal entry in one's own market from the firm that experiences intrusion in his home market. Again, we discuss public policy measures to promote entry. In section 5 we summarise our results.

2. THE MODEL

Consider an industry where one firm at present is a monopolist and a second firm considers to enter. We assume the following rectangular demand function:

(1) $Q = 1$ if $P \leq \overline{P}$ and $Q = 0$ if $P > \overline{P}$.

Then, obviously, an unthreatened monopolist sets $P = \overline{P}$ and earns a gross profit $p = \overline{P}$.

If both firms are active, we apply the demand system introduced in Allen and Thisse (1992). The firms are price setters. If the firms set an identical price, consumers buy either from the incumbent or the entrant. A fraction $(1 - s)$ of the consumers chooses the services of the incumbent firm, a fraction s is served by the entrant. Allen and Thisse (1992) set s equal to ½, implying that with identical prices, consumers are split evenly between the firms. We think that in many contexts it is natural to assume that the incumbent has built up some brand name loyalty, so that when prices are identical, a majority of the customers chooses the incumbent. We consequently assume that $0 < s \leq ½$. The case where $s \rightarrow 0$ is the one where (almost) all the consumers are served by the incumbent when the two firms' prices are identical.

When prices differ, a fraction of the consumers would rather being served by the low price firm than the high price firm. If, for example, the entrant is the high price firm, it would then sell less than a fraction s of the total sale. The larger the price difference, the larger the fraction of consumers that would prefer being served by the low price firm. Let the parameter a ("price sensitivity") denote the tendency for consumers to notice price differences and thereby to choose being served by the low price firm. A high a implies that the fraction of the consumers that are price-concerned is large. We let superscripts I and E denote the incumbent and the entrant, respectively. The incumbent's demand system is the following:

$$(2)\qquad \begin{bmatrix} Q_I = 1 & if \quad P_I \le P_E - \dfrac{s\overline{P}}{a} \\ Q_I = 1 - s + a\left(\dfrac{P_E - P_I}{\overline{P}}\right) & if \quad P_E - \dfrac{s\overline{P}}{a} \le P_I \le P_E + \dfrac{s\overline{P}}{a} \\ Q_I = 0 & if \quad P_E + \dfrac{s\overline{P}}{a} \le P_I \end{bmatrix}$$

The entrant's demand system can be formulated analogously. In words, the incumbent has a "base demand" (*1-s*) that can be taken as a measure of customer loyalty. If the incumbent states a lower price than the entrant this will imply that the incumbent steals away some customers from the entrant's base demand. In line with an example in Allen and Thisse (1992), we assume that the gain in demand is proportional to the relative price difference, with a as the factor of proportionality. In the end, the price difference is so large that the incumbent has captured the whole market. If the incumbent states the higher price, it will *lose* customers from its base demand, again at a rate proportional to the price difference, still with a as the factor of proportionality. Naturally, at some point the whole base demand is lost, so that the incumbent is left with zero demand.

Each firm produces with a constant returns to scale technology, so average cost equals marginal cost, and this cost is normalised to zero. The incumbent operates a network. The entrant cannot serve the consumers without access to the incumbent's network. The incumbent's marginal cost in the network is normalised to zero, while the entrant's per unit access fee is denoted t. We assume that $0 < t < \overline{P}$. Furthermore, let F denote the entrant's fixed entry cost.

The entrant's maximization problem is the following:

$$\pi_E = \max_{P_E} \; (P_E - t)Q_E \tag{3}$$

The incumbent operates the network, and serves the end users. One possibility is that those two units are separate profit units (divisionalization). If there is a separate profit unit serving only the end users and that unit is charged an access fee equal to marginal cost (the incumbent's true marginal cost), then its maximization problem is the following:

$$\pi_I = \max_{P_I} \; P_I Q_I \tag{4}$$

Alternatively, the network unit and the unit serving the end users are integrated. The integrated firm would earn revenues from its sale to end users as well as from selling access to the entrant. The incumbent has then the following maximization problem:

$$\pi_I = \max_{P_I} \; P_I Q_I + tQ_E \tag{5}$$

We investigate both alternatives. Unless otherwise stated, we focus on the case where the unit serving the end users acts as a separate unit.

Consider the Nash equilibrium following entry. The incumbent has the choice between a *deterrence* and an *accommodation* strategy. We examine the two possibilities separately.

The incumbent, the low cost producer, can always capture the whole market by setting a sufficient low price. From (2) we see that by setting $\breve{P}_I = t - \frac{s\overline{P}}{a}$, the entrant has zero sale when it sets its price equal to its marginal cost (t). The incumbent would then under deterrence earn $\breve{p}_I = t - \frac{s\overline{P}}{a}$.

Alternatively, the incumbent can set a higher price and allow the entrant to sell a positive quantity. We have the following maximisation problems for the two firms (follows from (3) and (4)), given that the entrant's entry cost F is sunk cost, and taking into account that both deterrence and accommodation are possibilities:

(6) $$p_I = max\left[\breve{p}_I, \max_{P_I} \; P_I\left(1 - s + a\left(\frac{P_E - P_I}{\overline{P}}\right)\right)\right] \text{ for } 0 \le P_I \le \overline{P} \text{ and } t \le P_E \le \overline{P}$$

(7) $$p_E = max\left[0, \max_{P_E} \; (P_E - t)\left(s + a\left(\frac{P_I - P_E}{\overline{P}}\right)\right)\right] \text{ for } 0 \le P_I \le \overline{P},\; t \le P_E \le \overline{P}$$

First, let us consider an interior solution where both firms sell positive quantities. From the two firms' first order conditions we have the following interior solution:

(8) $$\hat{P}_I = min\left[\overline{P}, \frac{(2-s)\overline{P} + at}{3a}\right]$$

(9) $$\hat{P}_E = min\left[\overline{P}, \frac{(1+s)\overline{P} + 2at}{3a}\right]$$

From (8) and (9) it can be found that $\hat{P}_i < \overline{P}$, where i=I,E, if:

(10) $$a > max\left[\frac{(2-s)\overline{P}}{3\overline{P} - t}, \frac{(1+s)\overline{P}}{3\overline{P} - 2t}\right] \equiv a^L.$$

The first expression inside the bracket is from (8), while the second is from (9). We focus on the case where entry results in lower prices. In line with this we assume that $a > a^L$.

If the prices expressed in (8) and (9) are set, we have the following individual firm gross profit for each of the firms:

(11) $$\hat{p}_I = \frac{\left[(2-s)\overline{P} + at\right]^2}{9a\overline{P}}$$

(12) $$\hat{p}_E = \frac{\left[(1+s)\overline{P} - at\right]^2}{9a\overline{P}}$$

From (9) it can be seen that the entrant will earn positive gross profits ($P_E > t$) if:

(13) $$a < \frac{(1+s)\overline{P}}{t} \equiv a^H$$

Second, let us consider a solution where the incumbent continues to serve the total market even after entry. It would set $P_I = \breve{P}_I$ if $\breve{p}_I > \hat{p}_I$. Solving with respect to a, we have that $\breve{p}_I > \hat{p}_I$ if:

(14) $$a^C \equiv \frac{(1+s)\overline{P}}{t} < a < \frac{(4+s)\overline{P}}{t} \equiv a^D,$$

Comparing (13) and (14), we see that $a^C = a^H$. It implies that as long as $a < a^H$ the incumbent decides not to serve the entire market after entry. Then the equilibrium prices are given by (8) and (9). In what follows we assume that $a^L < a < a^H$. Then $P_i = \hat{P}_i < \overline{P}$ and $Q_i > 0$ in the post entry equilibrium game, where $i=I,E$.

Finally, let us consider the case where the incumbent acts as a fully integrated firm and maximizes profits according to (5). In a similar manner as above, we can derive the equilibrium prices:

(15) $$P_I^{int} = min\left[\overline{P}, \frac{(2-s)\overline{P}}{3a} + t\right]$$

(16) $$P_E^{int} = min\left[\overline{P}, \frac{(1+s)\overline{P}}{3a} + t\right]$$

Then it can easily be shown, analogous to what we did above, that also in this case $P_i = P_i^{int} < \overline{P}$ are the equilibrium prices for intermediate values of a. Given such intermediate values of a, we have following individual firm gross profit for each of the firms:

(17) $$p_I^{int} = \frac{\overline{P}(2-s)^2}{9a} + t$$

(18) $$p_E^{int} = \frac{\overline{P}[1+s]^2}{9a}$$

3. DE NOVO ENTRY

Let us consider the potential for entry by an entrant that is a newcomer to the industry. This might be of interest in itself, but also serves as a stepping stone for the analysis of the more complicated entry game where the entrant is an incumbent monopolist in some neighbouring market. First, consider the market equilibrium that will emerge if the entrant has sunk the entry costs *F*.

Proposition 1: Post-entry equilibrium prices

(i) *If the incumbent is a separate profit unit serving the end users, then* $\hat{P}_I > \hat{P}_E$ *if* $s < \frac{\overline{P} - at}{2\overline{P}} \equiv s^*$, *where* $s^* \in [0,½]$.

(ii) *If the incumbent is an integrated firm, then* $P_I^{int} > P_E^{int}$ *if* $s < ½$.

(*iii*) $P_i^{int} > \hat{P}_i$, *where i=I,E.*

Proof: Concerning (*i*), it can easily be seen from (8) and (9) that $\hat{P}_E > \hat{P}_I$ when s = ½ and $\hat{P}_E < \hat{P}_I$ when $s \to 0$. By comparison, we have that $\hat{P}_E > \hat{P}_I$ if the condition shown in the Proposition is met. Concerning (*ii*), it can easily be verified from (15) and (16). Concerning (*iii*), it follows immediately by comparing (8) and (15) and (9) and (16), respectively. Concerning (*iv*), it follows immediately from differentiation of (8), (9), (15) and (16). *QED.*

We see from part (*i*) of the Proposition that if *s* is sufficiently low, the incumbent sets a *higher* price than the entrant. This happens despite the fact that the incumbent is the low-cost firm. The characteristics on the demand side explain the outcome. Low *s* implies that the incumbent has a high base demand of loyal customers. By lowering its price to capture price concerned consumers, the incumbent would lose revenue on its loyal consumers. This result is analogous to the result found in Wang and Wen (1998). Even though our model is quite different from that of Wang and Wen, we expect that the result that customer loyalty, modelled in some way or another, can bring the low cost producer to set the highest price, will shine through in many model formats.

From (*ii*) we see that if the incumbent is a fully integrated firm, then the incumbent will always set a higher price than the entrant for the relevant parameter values. The incumbent will in such a case earn revenues from the access fee the entrant pays. Due to this it is less eager to cut prices to capture market shares from the entrant. As can be seen from (*iii*), end user prices are always higher when the incumbent is a fully integrated firm than what is the case when the incumbent is an independent profit unit that serves the end users. Again, the reason is that the integrated firm acts less aggressively since it can earn revenues from the entrant's access fee. This, in turn, encourages the entrant to set a higher price as well.

Next, let us turn to public policy. There are at least two measures the authorities can implement. First, it can influence the consumers' price sensitivity. For example, it can start publishing prices and thereby make consumers more aware of price differences.[3] At a given price difference, we then expect that more consumers will be aware that one firm sets a lower price than the other firm and thus more consumers will tend to shift to the low price firm. Publishing of prices by the authorities can thus be modelled as an increase in a. Second, the authorities set access fees and can thus directly affect the entrant's marginal cost (t). Then we have the following result:

Proposition 2: Public policy measures

(i) *Given entry, publication of prices and a lower access fee would both lead to more intense rivalry on prices. A lower access fee has the largest impact if the incumbent is a fully integrated firm*

(ii) *If publication of prices, both firms will have lower profits.*

(iii) *If the access fee is reduced,*

(1) The incumbent will have lower profits and

[3] Albek *et al*. (1997) discuss a case in Denmark where the Danish Competition Authorities decided to gather and publish firm-specific transactions prices for two grades of ready-mixed concrete. The intention was to inform consumers about the low-cost firm, thereby triggering more price competition. It turned out that this did not trigger more price competition, but rather promoted collusion (see next section on reciprocal entry concerning how this may promote collusion).

(2) The entrant will have higher profits if the incumbent is a separate unit serving the end users, and will be unaffected if the incumbent is a fully integrated firm.

Proof: The results can easily be verified from equations (8), (9), (11), (12) and (15) – (18). *QED*

Publication of prices leads to more price sensitive consumers, and this leads to tougher price competition. This is quite obvious, since a higher own price elasticity makes it more tempting to lower its own price to capture market shares. Lower access prices leads to lower costs for the entrant, which also results in tougher price competition.

Given entry, both public policy measures are beneficial for consumers. Note, though, that a lower access fee has a larger impact on prices if the incumbent is a fully integrated firm. In such a case a lower access fee will have a direct effect on both the incumbent and the entrant's profits, and both of them have strong incentives to lower their end user prices.

The public policy measures can affect the entry decision. As shown, publication of prices will lead to tougher price competition. As a result, such a public policy measure leads to no entry if it has a sufficiently large impact on the price sensitivity.

A change in the access fee has a more complicated effect on entry. If the incumbent is an independent unit serving the end users, a lower access price reshuffles profit from the incumbent towards the entrant. This implies that the entrant's profit increases, which is in line with what we would intuitively expect. A lower access price tends to reduce the prices of both firms, but the price of the entrant falls the most. The entrant has a direct cost saving, and the rivalry between the firms increases. If the incumbent sets a higher price than the entrant, as we have shown can happen, a lower access price can in principle widen the price gap between the two firms. Lower profits for the incumbent could be a potential problem, because the incumbent's incentives to maintain the infrastructure are dampened.

If the incumbent is a fully integrated firm, it turns out that a lower access fee has no effect on the entry decision. Not only the entrant, but also the incumbent, will now be directly affected by an access fee reduction. We see from (16) and (17) that a reduction in the access fee would lead to a price reduction in the end user market for both firms that are identical to the reduction in the access fee. The incumbent's aggressive response to a lower access fee in such a case implies that a public policy with a low access fee will neither promote nor discourage entry.

4. RECIPROCAL ENTRY AND COLLUSION

We now consider the case where the potential entrant is an incumbent in some other market. This means that any incumbent that experiences entry into its market can retaliate by going into the entrant's own home market. We are especially interested in studying market-sharing type collusion. In particular we will assume that collusion between two previous national monopolists takes the form of each staying put in its own domestic market. Collusion might be an issue also with de novo entry, but this type of multimarket contact is clearly only relevant in those situation where reciprocal entry is a possibility. In what follows we focus on the case where the incumbent is a separate unit that serves the end users.

Under collusion, each firm charges the monopoly price for a single market. We assume that one firm, firm 1, is based in country *A*, and a second firm, firm 2, is based in country *B*. *M* refers to the case where collusion is sustained, so that each firm is a monopolist in its own home market. *D* refers to the deviation phase. This is the period where one firm starts to export, while the other firm not yet has reacted to this behaviour. *N* stands for the punishment phase, which means a situation with non-cooperative oligopolistic behaviour. We assume that punishment takes the form of "trigger strategies", meaning that a deviation from collusion triggers reversion to static Nash equilibrium for all future periods after the deviation period.[4]

With sustained collusion, each firm sells only in its home market. The per-period profit is then $p^M = \overline{P}$. Let us consider the case where firm *i* deviates by exporting. The maximisation problem in the export market in the period of deviation is (subscripts *i* and *j* denotes country (or the firm in country) *i* and *j*, respectively):

$$(19) \qquad \underset{P_i}{Max} \ \ p_i^D = \left(P_i - t_j\right)\left[s_j + a_j\left(\frac{\overline{P} - P_i}{\overline{P}}\right)\right]$$

Solving this maximization problem, we have that:

$$(20) \qquad \tilde{P}_i = \frac{s_j \overline{P} + a_j\left(\overline{P} + t_j\right)}{2a_j}$$

Since the deviating firm will never set $P_i > \overline{P}$, we have the following optimal price in the period of deviation:

$$(21) \qquad P_i^D = min(\overline{P}, \tilde{P}_i)$$

Then it can easily be seen that if

[4]We apply a setting that is identical to the setting presented in Lommerud and Sørgard (2001). In that setting we assume identical products, and we investigate both Bertrand and Cournot competition and both trigger strategies and optimal punishment paths.

(22) $$a_j > \frac{s_j \overline{P}}{\overline{P} - t_j} \equiv \tilde{a}_j,$$

the deviator's price under deviation is lower than the domestic monopoly price. In most models of multimarket collusion it would simply not make sense for an entrant to deviate from collusion and attack the neighbouring market, only to charge the same price as the monopolist under attack. Here, however, the entrant would under these circumstances capture some "base demand", and (15) can be seen as an assumption that this temptation is not too high. We concentrate on the case where the entrant in the attack phase actually sets a price lower than the monopoly price, meaning that $a > \tilde{a}$. The per-period profit for the deviating firm is then:

(23) $$p_i^D = \overline{P} + \frac{\left[s_j \overline{P} + a_j \left(\overline{P} - t_j\right)\right]^2}{4a_j \overline{P}}$$

After deviation both firms revert to static Nash equilibrium behaviour for ever. The equilibrium outcome in each of the two markets would then be as described in the previous section. Each firm would be the low cost producer in its home market and the high cost producer in the export market. We have the following per period profits after deviation:

(24) $$p_i^N = \frac{\left[(2 - s_i)\overline{P} + a_i t_i\right]^2}{9a_i \overline{P}} + \frac{\left[(1 + s_j)\overline{P} - a_j t_j\right]^2}{9a_j \overline{P}}$$

The first term inside the bracket represents the profits in the home market, while the second term is the profits in the export market.

The following condition determines if firms have incentives to sustain collusion, with d denoting the discount factor, common for both parties:

(25) $$\frac{p^M}{1-d} \geq p^D + \frac{d}{1-d} p^N$$

If countries and firms are symmetric ($a_i = a_j = a, t_i = t_j = t, s_i = s_j = s$), we have the following critical discount factor:

$$(26)\; d \geq \frac{9\left[(s+a)\overline{P} - at\right]^2}{\overline{P}^2\left(36a + s^2 + 18sa + 9a^2 - 20 + 8s\right) - a\overline{P}t(2s+8) - a^2(18\overline{P}t - t^2)} \equiv d^*$$

It turns out that the analysis is not easily tractable. To get around this problem, we proceed in two steps. First, we evaluate the comparative statics at a =1. This makes the analysis tractable, and it can easily be shown that a =1 is in the relevant range of a we have specified previously. Second, we check our main results numerically for other values than a =1. In line with the analysis for de novo entry, we investigate how changes in t and a affect the prospects for entry.

Consider first the relationship between collusion and access fees. We stay with the symmetric case with identical access fees in the two countries (t) initially. Comparative statics on t then can be interpreted as if the two countries jointly reduce (or increase) their access fee. However, we also open up for the possibility that the access price can change unilaterally in one country (but from a common level).

Proposition 3: Access fees (t) evaluated at a ***=1***

(i) $\frac{\partial d^*}{\partial t} < 0$.

(ii) $\frac{\partial d_i^*}{\partial t_i} > 0; \frac{\partial d_i^*}{\partial t_j} < 0$

Proof: (*i*) A joint reduction in access prices has the following effect on the critical discount factor, evaluated at a =1:

$$(30)\quad \frac{\partial d^*}{\partial t} = -216\frac{\overline{P}}{\left[s\overline{P} + 25\overline{P} - t\right]^2}$$

(*ii*) If country i unilaterally lowers its access price, then it would affect only the home market profits after deviation for the firm located in country *i*. Obviously, then, $\frac{\partial d_i^*}{\partial t_i} > 0$.

The effect of the firm located in the neighbouring country of a change in home country's access price is a gain both in the short term and in the long term in the export market. In its own market there are no effect. Then it is obvious that

(31) $\frac{\partial d_i^*}{\partial t_j} < 0$. *QED.*

There are two opposing effects of a joint reduction in t. On the one hand, it would increase the short term profits following from a deviation. On the other hand, it would result in more intense rivalry after deviation and therefore reduce the future profits. As we see from the Proposition, the first effect dominates: Lower access prices would limit the potential for sustaining a collusive outcome.

Since this result is unambiguous, we check whether this may hold for other parameter values than $a=1$. The following can easily be checked numerically[5]:

Property 1: *The result in Proposition 3 (i) holds for* $a^L < a < a^H$ *for all combinations of t and s, where t=1/10,1/7,1/5,1/4,1/3 and s=1/10,1/7,1/5,1/3,1/2.*

Thus, the numerical simulations give support to the conclusion we draw in Proposition 1 for $a=1$. It is of interest to note that Lommerud and Sørgard (2001) in a setting with homogenous products found that lower access prices would *promote* collusion in a setting with Bertrand competition and *destabilise* a collusive outcome if Cournot competition prevails.

We find it worthwhile to explain the difference between our earlier and the present result. Bertrand competition with homogenous goods is a very harsh form of competition, and in such a setting the access price is normally the only shield against being hold down to zero profit. The profit level can be shown to depend very strongly on the access price. This in turn implies that the punishment after deviation, namely the return to non-cooperative Bertrand, becomes much harsher with a lower access price. Even though a lower access price also will increase the temptation to deviate, the "harsher punishment" effect will dominate, so collusion is easier to sustain with a lower access price. In the present context, though, the access price is not the only reason why the firms can preserve some profit even under homogenous goods Bertrand competition. Customer loyalty points in the same direction. This means that a lower access price has a much less potential to harm profit under non-cooperation. In the end we get a result contrary to our earlier one: Even in a Bertrand situation, lower access prices destabilises collusion.

If we have a unilateral reduction in access price in one country, it has distinctly different effects on the two firms in question. The home firm would then have stronger incentives to sustain collusion, since competition would now lead to more intense rivalry in its home market. The other firm would now earn more in the neighbouring market, both during unilateral deviation and in the competitive outcome that follows. Therefore, it would have stronger incentives to deviate.[6] Due to this, a

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[5]We refer to numerical results as 'Properties' to differentiate them from analytical results (labeled 'Propositions').

[6] It follows quite straight forward that since the short and long term effect goes in the same direction, this also holds for other parameter values than a =1. Therefore, we de not report any results from numerical calculations.

unilateral reduction in access price may trigger a deviation and then a shift from collusion to competition.

What are the public policy implications of this? A common initiative to lower access fees would tend to promote entry. A unilateral reduction in the access fee would also tend to promote entry, because we found that the firm in the neighbouring country would then have stronger incentives to deviate from the collusive outcome.

Proposition 4: Consumer price sensitivity (a) evaluated at a =1

(i) $\frac{\partial d^*}{\partial a} < 0$.

(ii) $\frac{\partial d_i^*}{\partial a_i} < 0\ ;\ \frac{\partial d_i^*}{\partial a_j} > 0\ \ if\ t < \left(\sqrt{4-8s+s^2}-1\right)\overline{P}$.

Proof: (*i*) Differentiating (26) with respect to a , and then setting $a = 1$, we obtain the following expression:

(27) $$\frac{\partial d^*}{\partial a} = -36\frac{\overline{P}\left(4s\overline{P}+\overline{P}+2t\right)}{\left[s\overline{P}+25\overline{P}-t\right]^2}$$

Concerning part (*ii*), we let a_i denote the price sensitivity parameter in country i, and a_j the price sensitivity parameter in the neighbouring country. Then we have the following effect on home firm's discount factor by a change in the price sensitivity in home market, evaluated at $a_j = a_i$ =1:

(28) $$\frac{\partial d_i^*}{\partial a_i} = 36\frac{\left(t+2\overline{P}-s\overline{P}\right)\left(t-2\overline{P}+s\overline{P}\right)}{\left[s\overline{P}+25\overline{P}-t\right]^2} < 0$$

A change in the price sensitivity in the neighbouring country has the following effect, evaluated at $a_j = a_i$ =1:

(29) $$\frac{\partial d_i^*}{\partial a_j} = -36\frac{t^2 + 2\overline{P}t + 8s\overline{P}^2 - 3\overline{P}^2 - s^2\overline{P}^2}{\left[s\overline{P} + 25\overline{P} - t\right]^2}.$$

Then the condition in the Proposition can easily be verified. *QED.*

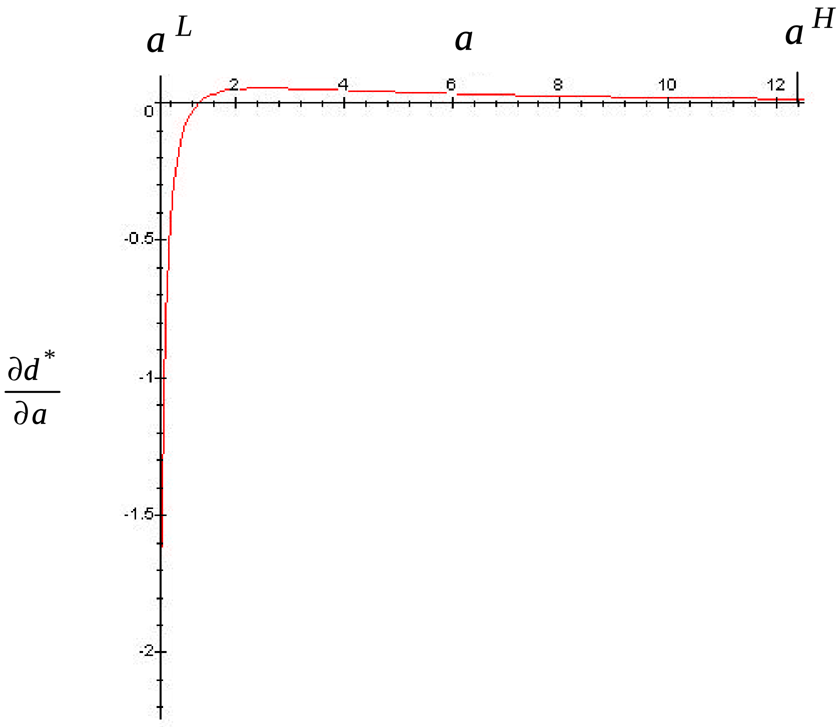
In theory, there are two opposing effects of more price sensitive consumers in both markets. On the one hand, the firm that deviates earns more in the deviation phase. On the other hand, more price sensitive consumers trigger more intense rivalry after deviation and thereby a profit loss in the periods after deviation. This trade off is analysed in Nilsson (1999) in an analogous setting, and he concludes that improving the price sensitivity has an ambiguous effect on the potential for collusion.[7] We see from part (*i*) in the Proposition that in our model, with a particular price sensitivity initially $(a = 1)$, more price sensitive consumers in both markets leads to a reduction in the critical discount factor. More price sensitive consumers result in a *larger* potential for collusion. In this case the loss of profits after deviation outweighs the short term gain in the deviation phase.

Again, let us check the robustness of this result. In Figure 1 we have a numerical example. We have set *t*=1/10 and *s*=1/4, and check the result in Proposition 4 (i) for $a^L < a < a^H$. We see that the result in Proposition 4 (i) holds for low values of a, but not for high values of a in the relevant interval. When checking numerically for other combinations of *s* and *t*, it can easily be verified that the same pattern holds:

[7]Note that the setting in Nilsson (1999) is distinctly different from our setting. In particular, firms are active in the same market also in the collusive outcome, while in our model firms are active only in its home market when collusion prevails. See also Møllgaard and Overgaard (2000). Like Nilsson (1999), they use a model that is distinctly different from ours. They show that the conclusion depends crucially on the number of firms in the industry and the punishment path. Our finding is identical to their

Property 2: *For all combinations of t and s, where t=1/10,1/7,1/5,1/4,1/3 and s=1/10,1/7,1/5,1/3,1/2, we find for the interval* $a^L < a < a^H$ *that the result in Proposition 4 (i) holds only for low values of* a *.*

Figure 1: *The effect of a change in* a *on the critical discount factor for* $a^L < a < a^H$ *, given that t=1/10 and s=1/4.*



We see that publishing prices in both countries has an ambiguous effect on the prospects for sustaining collusion. For low values of a publishing prices promotes collusion, while the opposite is true for high values of a . For high values of a it is tempting to start exporting and thereby earn a large short term gain in the export market. After deviation the firm is still sheltered in its home market by the access fee.

findings when they assume duopoly and trigger strategies, as we do. A recent study of collusion and transparency is Schulz (2002).

Alternatively, we may have a one-country change in price sensitivity. Obviously, more price sensitive consumers in one country weakens the incentive to deviate for the firm located in that country. There is no change in the short term gain, but a reduction in the future profits following a deviation. For the firm in the other country, though, there are two opposing forces. Its short term gain would increase, while its future profits would fall due to more intense rivalry in its export market. As we see from the Proposition, the net effect is ambiguous and depends crucially on the access fee.[8] A low access fee implies that a one-country increase in price sensitivity reduces the scope for collusion, the opposite of what holds true for a both-countries increase in price sensitivity.

As explained previously, publishing prices by the authorities can be modelled as an increase in a. The effects of such a public policy measure is ambiguous. A joint public policy in those two countries to publish prices is expected to deter rather than promote entry if price sensitivity is rather low, while the opposite is true if the price sensitivity is rather high initially. We also find that the effect of a unilateral reduction in access fee is ambiguous.

5. SOME CONCLUDING REMARKS

We have studied the interaction among some salient features in many telecom markets; customer loyalty towards the incumbent, imperfect price sensitivity, large investments in infrastructure that can only be used by an entrant at an access fee. The focus of attention has been on the rivalry between an incumbent and an entrant, both when the entrant is a start-up in the industry (de novo entry) and when the entrant is a dominant incumbent in a neighbouring market (reciprocal entry). In the latter case

[8] Since the effect is ambiguous for $a = 1$, we do not need to check for other values of a.

collusion under multimarket contact becomes a relevant issue. Our main concern has been to understand the strategic interaction in such a setting and then, in turn, discuss how public policy measures can lead to a more competitive outcome. We here review some of our central findings.

In the de novo entry model we saw how the best strategy of the incumbent could be to set a *higher price* than the entrant, even though the access price to infrastructure gives the entrant a marginal cost disadvantage. If the incumbent is a fully integrated firm, it will set an even higher price. Given entry, it is clear that both lower access fee and publishing of prices are public policy measures that lead to more intense rivalry on prices. While publishing of prices would discourage entry, a lower access fee either will promote entry or have no effect on entry.

Turning to the case of reciprocal entry by “old monopolists” into each other’s markets, the sustainability of market sharing collusion is of key interest. In much collusion analysis, one gets “paradoxical” results that what seemingly sharpens competition in effect increases the scope for collusion. This paradox may arise here concerning publishing of prices, but not concerning access fees.

Lower access fees in both countries tend to promote a deviation and thereby reciprocal entry. Then lower access fees would promote entry in both entry games, if it has any effect at all. This suggests that a joint public policy in those two countries to lower access fees would, if it has any effect at all, lead to a more competitive outcome. Any unilateral reduction in access fee would have the same effect, since it would make it more profitable for the neighboring country’s firm to deviate.

Publishing of prices in both countries, though, is a public policy with ambiguous effects on the competitive outcome. In the reciprocal entry game we found that publishing of prices in both countries would promote collusion if the price sensitivity is low initially, and promote reciprocal entry if the price sensitivity is high initially. In contrast, with de novo entry publishing of prices will always tend to deter entry. Moreover, we found that a unilateral policy to publish prices has an ambiguous effect as well on collusion in the reciprocal entry game. This illustrates that this public policy measure is expected to have less clear-cut competitive effects than what is the case with a policy to reduce the access fee.

REFERENCES

Albæk, S., P. Møllgaard and P. B. Overgaard (1997): 'Government-Assisted Oligopoly Coordination? A Concrete Case', *Journal of Industrial Economics*, 45, 429-443.

Allen, B. and J.-J. Thisse (1992): 'Price Equilibria in Pure Strategies for Homogenous Oligopoly', *Journal of Economics & Management Strategy*, 1, 63-81.

De Fraja, G. (1999): 'Regulation and Access Pricing with Asymmetric Information', *European Economic Review*, 43, 109-134.

Fudenberg, D. and J. Tirole (1984): 'The Fat Cat Effect, the Puppy Dog Ploy and the Lean and Hungry Look', *American Economic Review*, Papers and Proceedings, 74, 361-368.

Grossman, G. M. and C. Shapiro (1984): 'Informative Advertising with Differentiated Products', *Review of Economic Studies*, 51, 63-81.

Klemperer, P. (1987): ‘Entry Deterrence in Markets with Switching Costs’, *Economic Journal*, 97, 99-117.

Klemperer, P. (1995): ‘Competition when Consumers Have Switching Costs: An Overview with Applications to Industrial Organization, Macroeconomics, and International Trade’, *Review of Economic Studies*, 62, 515-540.

Lommerud, K. E. and L. Sørgard (2001): ‘Trade Liberalization and Cartel Stability’, *Review of International Economics*, 9, 343-355.

Møllgaard. H. P. and P. B. Overgaard (2000): ‘Market Transparency: A Mixed Blessing?’, Manuscript, Copenhagen Business School.

Nilsson, A. (1999): ‘Transparency and Competition’, Manuscript, Stockholm School of Economics.

Schmalensee, R. (1983): ‘Advertising and Entry Deterrence: An Exploratory Model’, *Journal of Political Economy*, 90, 636-653.

Schultz, C. (2002): ‘Transparency and Tacit Collusion’, Manuscript, University of Copenhagen.

Wang, R. and Q. Wen (1998): ‘Strategic Invasion in Markets with Switching Costs’, *Journal of Economics & Management Strategy*, 7, 521-549.

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