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Entry Decision and Pricing Policies

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Abstract

We extend the analysis of the impact of firms' pricing policies upon entry to a framework where price competition and differentiated products are present. We consider a model where an incumbent serves two distinct and independent geographical markets and an entrant may enter in one of the markets. Entry under discriminatory pricing is *more likely* than under uniform pricing when entry is profitable under discriminatory pricing but unprofitable under uniform pricing. Our results show entry under discriminatory pricing may be *more, less* or *equally likely* than under uniform pricing. We show that the degree of product substitutability affects the impact of pricing policies upon entry decision.

Keywords: Entry, Product Differentiation, Discriminatory Pricing, Uniform Pricing

JEL classification: D40, L11, L13.

1 Introduction

Entry incentives differ according to the pricing policy set in markets. Different pricing policies imply different market *equilibria* and thus different profit levels for the firms in the market (both entrants and incumbent firms). Therefore, the pricing policy is undoubtedly a determinant of competitors entrance in markets.

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One can find various studies that illustrate the impact of firms' pricing policies upon entry decision. Some of them show that discriminatory pricing tends to discourage entry. This is the case of Armstrong and Vickers (1993). They consider an incumbent firm that serves two identical independent geographical markets where entry can only occur in one of these markets. Both firms sell a homogeneous product and the entrant is price-taker.¹ They emphasize that the incumbent sets lower prices in the market where entry is possible when discriminatory pricing is effective. Thus, for intermediate levels of entry costs, there is less entry than under uniform pricing. In this analysis the impact on entry is due to the difference in the competitive threat across markets since markets' demand is identical. In a research note, Cheung and Wang (1999) extend Armstrong and Vickers (1993) analysis considering non-identical demands. Cheung and Wang show that discriminatory pricing may have a positive or negative effect on entry since the impact on entry due to the difference in markets' demand may overwhelm the impact due to the difference in the competitive threat across markets. Their analysis assumes that both markets are served by the dominant firm under uniform pricing. Therefore, in opposition to Armstrong and Vickers, they show that allowing discriminatory pricing may encourage more entry.

Other authors have explored, for very different setups, the impact of firms' pricing policies upon entry decision. On one hand, Aguirre *et al.* (1998) explore the strategic choice of pricing policies under a spatial market model. When focusing on symmetric information, they show that discriminatory pricing is more aggressive and entry is more difficult than under uniform pricing. Motta (2004) illustrates that discriminatory pricing always deters entry while uniform pricing may or may not deter entry using a very simple example with Bertrand competition and two identical independent geographical markets. On the other hand, Katz (1984) shows that allowing discriminatory pricing can increase profits and thus encourage more entry focusing on a long-run monopolistic competition analysis with a mixture of informed and uninformed consumers. Considering a differentiated products duopoly model where firms take simultaneous entry decisions in two symmetric markets and then choose prices, Azar (2003) shows that allowing discriminatory pricing encourages more entry, reduces profits and increases consumer welfare in both markets.

Our aim is to extend Armstrong and Vickers (1993) and Cheung and Wang's (1999) analysis

¹Armstrong and Vickers (1993) first study the case where the entrant firm's scale of entry is exogenous followed by the case where it is endogenous.

to a framework where product heterogeneity is present and thus add a third effect: the degree of product substitutability. This setup is more realistic since firms frequently use product differentiation as one of their strategies and consumers tend to be more diverse thus, *demanding* product differentiation in several markets. We show that the degree of product substitutability affects the impact of pricing policies upon entry decision.

Considering an incumbent firm that serves two distinct and independent geographical markets, an entrant firm may enter one of the markets with a differentiated product. If entry occurs the firms compete in prices. First we look for the price *equilibria* under monopoly and under entry for both discriminatory and uniform pricing. Then we compare the two pricing policies in terms of entry decision and analyze how this comparison is affected by the difference in the competitive threat across markets, the degree of markets' demand difference and the degree of product substitutability.

Notice that our setup has two important differences with respect to Armstrong and Vickers (1993) and Cheung and Wang (1999). On one hand, they consider a dominant firm model with a price-taker entrant where firms sell homogeneous products whereas we use a duopoly price competition model with differentiated products. On the other hand, they just analyze the case where, under entry, the incumbent firm sells in both markets under uniform pricing whereas we also study the case where the incumbent's optimal decision when entry occurs is to abandon one of the markets.

We consider that entry under discriminatory pricing is *more likely* than under uniform pricing when we have levels of entry costs where entry is profitable under discriminatory pricing but unprofitable under uniform pricing, *i.e.*, when entrant's gross post-entry profit is higher under discriminatory pricing than under uniform pricing. Our results show that entry under discriminatory pricing may be *more*, *less* or *equally likely* than under uniform pricing. For all degrees of product substitutability, there is always some degrees of markets' demand difference where under discriminatory pricing entry is *more likely* than under uniform pricing. This happens for a larger interval of degrees of markets' demand difference when there are lower degrees of product substitutability.

Previous studies do not take into consideration the effect of the degree of product substitutability. We show that this effect has an impact on determining which of the two pricing policy is more entry deterrent.

This paper is organized as follows. In Section 2 we set up the model and compute the demand functions for each market and product. Section 3 studies the monopoly solution under discriminatory and uniform pricing whilst Section 4 analyzes these two pricing policies when a competitor enters one of the markets. Comparison of pricing policies, in terms of the impact upon entry decision, is presented in Section 5. Finally, Section 6 sets the conclusions.

2 The model and demand derivations

Consider an incumbent firm, I , operating in two distinct and independent geographical markets. In one of these markets entry is possible – the *competitive market*, henceforth we denote it by market A – and in the other market entrance is not possible – the *captive market*, henceforth we denote it by market B . The incumbent firm and the entrant firm, E , compete in prices: they choose their prices simultaneously and independently. The products sold by the two firms are differentiated, *i.e.*, products are imperfect substitutes. We assume linear demand in both markets. This type of demand function can be derived from the consumer’s utility maximization problem with a quadratic utility function.

To derive demand in the *captive market*, where there is no product variety, we assume that the representative consumer’s preferences are given by:

$$U(q_B^I) = q_B^o + a_B q_B^I - \frac{1}{2} b_B (q_B^I)^2, \quad (1)$$

where q_B^I represents the quantity sold in market B by the incumbent, q_B^o represents all other *captive market* products (with a price normalized to unity) and a_B, b_B are positive constants. The consumer’s budget constraint is $M_B = p_B^I q_B^I + q_B^o$.

In the *competitive market*, the representative consumer’s utility function takes the form of a standard quadratic utility function (similar to the one suggested by Dixit (1979)):

$$U(q_A^I, q^E) = q_A^o + a_A q_A^I + a_A q^E - \frac{1}{2} \left[b_A (q_A^I)^2 + 2d_A q_A^I q^E + b_A (q^E)^2 \right], \quad (2)$$

where q_A^I and q^E represent the quantity sold in market A by the incumbent and by the entrant, respectively. All other *competitive market* products are represented by q_A^o (with a price normalized to unity) and a_A, b_A are positive constants. The degree of product substitutability can be measured by $d_A \in [0, b_A[$ where products become closer substitutes as $d_A \rightarrow b_A$ which

implies intense price competition. When $d_A \rightarrow 0$ products are completely differentiated. We require that $d_A < b_A$ in order to assure that each product price is more sensitive to a change in its product quantity than to that of the other firm's product quantity. The utility function (2) assumes the two products have symmetric effects on consumer's utility. Notice that when entry does not occur, this market has no product variety since $q^E = 0$. In this case, the consumer's utility function in the *competitive market* will be similar to the *captive market*. The consumer's budget constraint is given by $M_A = p_A^I q_A^I + p^E q^E + q_A^O$.

From constrained optimization of the utility functions given by (1) and (2), we obtain the inverse demand function in each market. In order to derive the Nash equilibrium of the price-game, we compute the demand function in each market. Thus, in market B we obtain:

$$q_B = \frac{a_B}{b_B} - \frac{1}{b_B} p_B \quad (3)$$

and in market A when there is a monopoly:

$$q_A = \frac{a_A}{b_A} - \frac{1}{b_A} p_A. \quad (4)$$

Finally, in market A when entry occurs, from constrained optimization of the utility functions given by (2) we obtain:

$$\begin{aligned} q_A^I &= \frac{a_A(b_A - d_A)}{b_A^2 - d_A^2} - \frac{b_A}{b_A^2 - d_A^2} p_A^I + \frac{d_A}{b_A^2 - d_A^2} p^E \\ q^E &= \frac{a_A(b_A - d_A)}{b_A^2 - d_A^2} - \frac{b_A}{b_A^2 - d_A^2} p^E + \frac{d_A}{b_A^2 - d_A^2} p_A^I. \end{aligned}$$

To simplify computations, when there is a duopoly in market A we define:

$$\alpha = \frac{a_A(b_A - d_A)}{b_A^2 - d_A^2}, \beta = \frac{b_A}{b_A^2 - d_A^2} \text{ and } \gamma = \frac{d_A}{b_A^2 - d_A^2}.$$

Then the last two demand functions simplify to:

$$q_A^I = \alpha - \beta p_A^I + \gamma p^E \quad (5)$$

$$q^E = \alpha - \beta p^E + \gamma p_A^I. \quad (6)$$

With this demand specification, the quantity demanded of a given product depends negatively on its own price and positively on the price of the other product. As $d_A \rightarrow b_A$, the price of the other product affects more and more the quantity demanded of a firm's product.

For simplicity we assume that both firms' production costs are nil. The entrant's cost of entering market A is non-negative.²

Finally, we assume the following relationships between market B and A 's parameters:

$$b_B = b_A \tag{7}$$

$$a_B = ka_A, k \in]0, +\infty[. \tag{8}$$

Parameter k measures the degree of markets' demand difference. Under no entry and assuming (7) and (8), when $k \rightarrow 1$ markets A and B are identical. When $k > 1$ demand in market B is larger than demand in market A and for a given market price, demand in market B is less elastic than demand in market A . Conversely, when $k < 1$ demand in market A is larger than demand in market B and for a given market price, demand in market A is less elastic than demand in market B . Therefore, low k and high k stand for high degrees of markets' demand difference and k around 1 corresponds to low degrees of markets' demand difference.

3 Discriminatory versus uniform pricing under monopoly

In this section we compare discriminatory pricing with uniform pricing when the incumbent is a monopolist in both markets. Although we are mainly interested in studying the impact of pricing policies upon entry, the monopoly analysis is interesting for comparative purposes since it allows us to identify one important effect when we compare discriminatory and uniform pricing: differences in markets' demand of the various markets.

3.1 Discriminatory pricing

Under discriminatory pricing the incumbent may set different prices in each market.³ Since firms have null production costs, the incumbent solves two separate profit maximization problems.

Given the demand functions (3) and (4), the incumbent chooses the price that maximizes his profit in each market subject to non-negativity constraint for quantities (see details of these problems in Appendix A.1 and A.2).

²We assume that the entrant's cost of entering in market B is so high that entry in this market would always be unprofitable.

³We assume that arbitrage is not possible.

Lemma 1 *Under discriminatory pricing, the optimal monopoly prices in markets A and B are given by $p_{Am}^I = \frac{a_A}{2}$ and $p_{Bm}^I = \frac{a_B}{2} = \frac{ka_A}{2}$, where the last equalities follow from the assumptions on a_B and b_B .*

Notice that if $k < 1$, market A is larger and less elastic and thus the *equilibrium* monopoly price is higher in market A while if $k > 1$, the *equilibrium* monopoly price is higher in market B. This result is expected: a discriminatory monopolist charges a higher price in the less elastic market.

We can compute the incumbent's profits under monopoly discriminatory pricing which are given by:

$$\pi_{Am}^I = \frac{a_A^2}{4b_A} \quad (9)$$

$$\pi_{Bm}^I = \frac{a_B^2}{4b_B} = \frac{k^2 a_A^2}{4b_A}. \quad (10)$$

Therefore the incumbent's total profit is given by:

$$\pi_{(Am+Bm)}^I = \frac{a_A^2(1+k^2)}{4b_A}.$$

3.2 Uniform pricing

In order to find the incumbent's *optimal* solution under uniform pricing we need to evaluate whether the incumbent is better off selling in both markets or selling only in one of the markets.

Given the demand functions (3) and (4), if the incumbent sells his product in both markets, he will choose a unique price so as to maximize his total profit subject to non-negativity constraints for quantities (see details in Appendix B.1).

We can compute the incumbent's profit under monopoly uniform pricing when selling in both markets which is given by:

$$\bar{\pi}_{(Am+Bm)}^I = \frac{(a_B b_A + a_A b_B)^2}{4b_A b_B (b_A + b_B)} = \frac{a_A^2 (k+1)^2}{8b_A}. \quad (11)$$

If the incumbent abandons one of the markets, the *optimal* solution in that market is the one obtained under monopoly discriminatory pricing – Subsection 3.1. Therefore, the incumbent's profit function when selling in market A only is given by (9) whereas profit obtained when selling in market B only is given by (10).

Under uniform pricing the optimal monopoly price depends on whether the incumbent is better off selling in both markets or just in one of the markets. The next lemma characterizes the unique solution of the monopoly problem under uniform pricing.

Lemma 2 *Under monopoly uniform pricing, the optimal solution is as follows:*

(i) *When $k < \sqrt{2} - 1$, the incumbent is better off selling only in market A and the optimal price is precisely the same as under monopoly discriminatory pricing:*

$$\bar{p}^I = \frac{a_A}{2};$$

(ii) *When $\sqrt{2} - 1 \leq k \leq \sqrt{2} + 1$, the incumbent is better off selling in both markets and the optimal price is given by:*

$$\bar{p}^I = \frac{a_B b_A + a_A b_B}{2(b_A + b_B)} = \frac{a_A(k + 1)}{4};$$

(iii) *When $k > \sqrt{2} + 1$, the incumbent is better off selling only in market B and the optimal price is precisely the same as under monopoly discriminatory pricing:*

$$\bar{p}^I = \frac{a_B}{2} = \frac{k a_A}{2}.$$

Proof: The optimal monopoly prices in (i), (ii) and (iii) are a direct consequence of solving the maximization problems described in Appendices A.1, B.1 and A.2, respectively. The result is a direct consequence of comparing the incumbent's profit in all three alternatives (given by (9), (11) and (10), respectively). ■

Under uniform pricing selling in both markets brings lower profit than only selling in the largest market when there are large differences in markets' demand. For very low k values, demand in market A is considerably larger than demand in market B and the incumbent prefers to sell in market A only. On the other hand, when demand in market B is considerably larger than demand in market A, for high values of k , the incumbent abandons market A given its relatively smaller demand. Finally, the incumbent prefers to sell in both markets when markets are similar, *i.e.*, $\sqrt{2} - 1 \leq k \leq \sqrt{2} + 1$ and for these k values, the incumbent's quantities produced in markets A and B are non-negative.

3.3 Comparison of pricing policies

In this subsection we limit our analysis to the comparison of prices in market A under the two pricing policies since this is the market where entry is possible.

With discriminatory pricing the incumbent practices a higher price in the more inelastic market. Moreover, if the incumbent serves both markets the uniform price will be between the discriminatory prices in markets A and B . When $\sqrt{2} - 1 < k < 1$, under uniform pricing the incumbent serves both markets and under discriminatory pricing the incumbent sets a higher price in market A . Therefore, under monopoly, if demand in market A is larger, discriminatory price in this market will be higher than uniform price, *i.e.*, $p_{Am}^I > \bar{p}^I > p_{Bm}^I$, as long as both markets are served under uniform pricing. This shows that one needs to take into account differences in markets' demand in order to know whether the incumbent's price in market A is higher under discriminatory or uniform pricing.

As we will see later this effect is also present when the entrant decides to enter market A . The intuition is that under duopoly the incumbent is a monopolist of the residual demand, thus he also needs to compare the elasticity of demand in market B with the elasticity of the residual demand in market A . If the residual demand in market A is less elastic than demand in market B , the incumbent will charge a higher price in this market than in market B under discriminatory pricing. This is precisely the message conveyed on Cheung and Wang (1999).

4 Discriminatory versus uniform pricing when E enters market A

Suppose now that the entrant decides to enter market A but the incumbent remains a monopolist in market B . In this section we analyze the Nash *equilibrium* under discriminatory and uniform pricing.

4.1 Discriminatory pricing

Since the incumbent may set a different price in each market and he continues to be a monopolist in market B , the optimal solution in this market is the same as in Subsection 3.1. However, market A is now a duopoly and we need to find the Nash *equilibrium* of the price-game. Given the demand functions (5) and (6), the incumbent and entrant choose the prices that maximize their profits in market A . Notice that all quantities must be non-negative. The details of the solutions to these problems and first order conditions are described in Appendix A.3. The first order conditions show that, under our assumptions, prices are strategic complements. Solving

the system of first order conditions we obtain the following result:

Lemma 3 *Under discriminatory pricing, the post-entry unique Nash equilibrium in market A is symmetric and it is given by:*

$$p_{Ad}^I = p^E = \frac{\alpha}{2\beta - \gamma} = \frac{a_A (b_A - d_A)}{2b_A - d_A},$$

where the last expression is obtained from the definitions of α , β and γ .

Under discriminatory pricing, incumbent's post-entry profit in market A is equal to entrant's gross post-entry profit and given by:

$$\pi_{Ad}^I = \pi^E = \frac{\beta\alpha^2}{(2\beta - \gamma)^2} = \frac{b_A (b_A - d_A) a_A^2}{(b_A + d_A) (2b_A - d_A)^2}. \quad (12)$$

One can show that $p_{Ad}^I < p_{Am}^I$ and $\pi_{Ad}^I < \pi_{Am}^I$ as long as $d_A > 0$. Conversely $p_{Ad}^I = p_{Am}^I$ and $\pi_{Ad}^I = \pi_{Am}^I$ when $d_A = 0$. In other words, the incumbent's price and profit in market A is lower when the entrant decides to enter this market than when the incumbent is a monopolist unless the two products are completely differentiated. This result is quite obvious: as long as there exists some product substitutability, the incumbent loses with the competition of the entrant. Also notice that the difference between p_{Ad}^I and p_{Am}^I is bigger when products become highly substitutable, *i.e.*, when d_A rises and becomes close to b_A .

And the incumbent's total profit is given by:

$$\pi_{(Ad+Bm)}^I = \frac{b_A (b_A - d_A) a_A^2}{(b_A + d_A) (2b_A - d_A)^2} + \frac{k^2 a_A^2}{4b_A}.$$

4.2 Uniform pricing

In order to find the *equilibrium* solution under uniform pricing when the entrant decides to enter market A, we have to study the incumbent's alternatives of selling in both markets and of only selling in one of the markets.

Given the demand functions (3) and (5), if the incumbent sells his product in both markets, he will choose a unique price so as to maximize his total profit taking into account that there is a duopoly in market A. Given the demand function (6), the entrant chooses the price that maximizes his profit in market A. Notice that all quantities must be non-negative (see details of these problems in Appendix B.2).

Under uniform pricing and when the incumbent sells in both markets, incumbent's post-entry profit in market A and entrant's gross post-entry profit are respectively given by:

$$\bar{\pi}_{(Ad+Bm)}^I = \frac{a_A^2 (b_A - d_A) (2b_A^2 - d_A^2) [2k(b_A + d_A) + (2b_A + d_A)]^2}{b_A (b_A + d_A) [8b_A^2 - 5d_A^2]^2}$$

$$\bar{\pi}^E = \frac{a_A^2 (b_A - d_A) [b_A d_A (k + 1) + 2(2b_A^2 - d_A^2) + k d_A^2]^2}{b_A (b_A + d_A) [8b_A^2 - 5d_A^2]^2}.$$

If the incumbent abandons market B , he solves the following problem:

$$\max_{\bar{p}_d^I} \bar{p}_d^I (\alpha - \beta \bar{p}_d^I + \gamma \bar{p}^E)$$

while the entrant's problem remains the same. Notice that this problem is precisely the same as under discriminatory pricing (see Subsection 4.1). Therefore, the incumbent's profit is given by (12).

Finally, if the incumbent abandons market A , the entrant becomes a monopolist in this market whereas the incumbent remains a monopolist in market B . Thus, the incumbent's total profit is given by (10).

The Nash *equilibrium* under uniform pricing depends on whether the incumbent is better off selling in both markets or just in one of the markets. Let k_A and k_B be defined as follows:

$$k_A = \frac{b_A (8b_A^2 - 5d_A^2) \sqrt{2b_A^2 - d_A^2} - (2b_A^2 - d_A^2) (4b_A^2 - d_A^2)}{2 (2b_A^2 - d_A^2) (b_A + d_A) (2b_A - d_A)}$$

$$k_B = \frac{2 (2b_A + d_A) \left[4 (b_A^2 - d_A^2) (2b_A^2 - d_A^2) + (8b_A^2 - 5d_A^2) \sqrt{(2b_A^2 - d_A^2) (b_A^2 - d_A^2)} \right]}{(b_A + d_A) (32b_A^4 - 32b_A^2 d_A^2 + 9d_A^4)}.$$

The next lemma characterizes the unique Nash *equilibrium* under uniform pricing when entry occurs.

Lemma 4 *Under uniform pricing, the post-entry equilibrium is as follows:*

(i) *When $k < k_A$, the incumbent is better off selling only in market A and the Nash equilibrium prices are precisely the same as under discriminatory pricing:*

$$\bar{p}_d^I = \bar{p}^E = \frac{a_A (b_A - d_A)}{2b_A - d_A};$$

(ii) When $k_A \leq k \leq k_B$, the incumbent is better off selling in both markets and the Nash equilibrium prices are given by:

$$\begin{aligned}\bar{p}_d^I &= \frac{a_A (b_A - d_A) [2k (b_A + d_A) + (2b_A + d_A)]}{8b_A^2 - 5d_A^2} \\ \bar{p}^E &= \frac{a_A (b_A - d_A) [b_A d_A (k + 1) + 2 (2b_A^2 - d_A^2) + k d_A^2]}{b_A [8b_A^2 - 5d_A^2]};\end{aligned}$$

(iii) When $k > k_B$, the incumbent is better off selling only in market B and the Nash equilibrium prices are precisely the same as under monopoly discriminatory pricing:

$$\bar{p}^I = p_{Bm}^I = \frac{a_B}{2} = \frac{k a_A}{2}$$

Thus, the entrant becomes a monopolist and his optimal price is:

$$\bar{p}^E = \frac{a_A}{2}.$$

Proof: The equilibrium prices in (ii) are the solution of solving the system of best response functions of the two firms, taking into account that the incumbent's best response function depends on k and d_A . The result is a direct consequence of comparing the incumbent's profit in all three alternatives when entry occurs (selling in both markets, selling in market A only, selling in market B only). ■

Figure 1 illustrates these results. For the set of parameters in dark grey, the incumbent's demand in market A is considerably larger than demand in market B . Thus, the incumbent prefers to sell in market A only even when there is a competitor in this market. On the other hand, when demand in market B is considerably larger than the incumbent's demand in market A , the set of parameters in white, the incumbent prefers to sell in market B only. In this case, the entrant becomes a monopolist in market A .

The incumbent prefers to sell in both markets when there are smaller degrees of markets' demand difference, *i.e.*, $k_A \leq k \leq k_B$ (the set of parameters in light grey) and, for these values of k , the incumbent's quantities in markets A and B , are non-negative.

When the entrant decides to enter market A , the incumbent's decision of serving both or just one of the markets depends on the relative size of demand in market B and the incumbent's demand in market A under duopoly. This comparison depends on the degree of markets' demand difference but it also depends on the degree of product substitutability. The higher d_A is, the

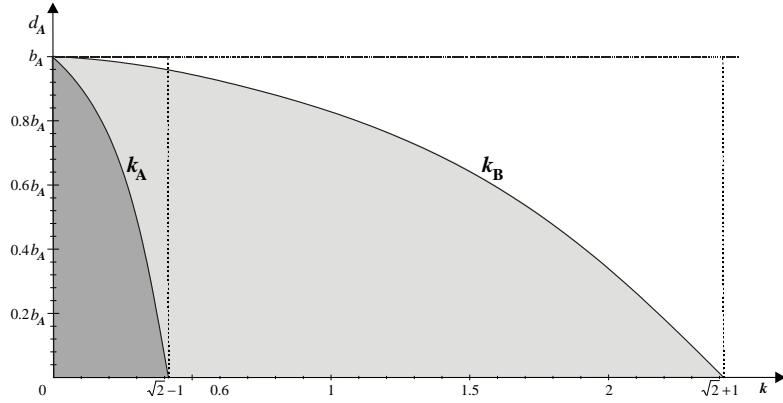


Figure 1: Uniform pricing under duopoly in market A

larger is the reduction in the incumbent's residual demand in market A when entry occurs. Thus, as d_A increases, demand in market A has to be much bigger in order for the incumbent to prefer to sell only in market A under duopoly, *i.e.*, the value of k below which the incumbent prefers to sell only in market A , k_A , is decreasing with d_A . For the same reason, k_B is also decreasing with d_A . As d_A increases, market A becomes more competitive. Thus, the incumbent prefers to abandon this market for smaller values of k .

Notice that as products become virtually homogeneous, duopoly profits in market A are so low that selling in market A only or even selling in both markets is more unprofitable than selling in market B only. When products are highly substitutable ($d_A \rightarrow b_A$), competition in market A is so fierce that even when market A is much larger (very low values of k) the incumbent prefers to sell in market B only. On the other hand, when products are very differentiated ($d_A \rightarrow 0$), competition in market A is soft and consequently market B has to be much larger than market A for the incumbent to start selling in market B only.

As expected, when the incumbent sells in market A under duopoly, $k < k_B$, the incumbent's price in market A , with competition, is lower than under monopoly except when there is complete differentiation, in which case the price is the same. The incumbent's profit under entry is also lower than under monopoly unless the two products are completely differentiated ($d_A = 0$).

4.3 Comparison of pricing policies

When the incumbent serves both markets under uniform pricing, one can show that the price decrease in market A due to competition is higher under discriminatory pricing than under uniform pricing. This happens because uniform pricing makes the incumbent softer. When the incumbent considers a marginal price decrease he has to take into account the reduction in profits in markets A and B . So he has less incentives to decrease the price. The competitive threat is higher under discriminatory pricing. This is the effect described by Armstrong and Vickers (1993).

However the previous effect does not mean that the incumbent's *equilibrium* price in market A is always lower under discriminatory than under uniform pricing. If demand in market A is much larger and less elastic than demand in market B , the discriminatory price may be higher than the uniform price even when there is a competitor in market A . This is the effect described by Cheung and Wang (1999) since the effect of the difference in markets' demand when k is low and lower than one (*i.e.*, when demand in market A is relatively larger than demand in market B) may overwhelm the effect of difference in the competitive threat across markets. Thus, the price decrease in market A due to competition is higher under discriminatory pricing than under uniform pricing but the incumbent's *equilibrium* price in market A is higher under discriminatory than under uniform pricing.

As described in the next section, the degree of product substitutability affects the value of k such that the effect of the difference in markets' demand overwhelms the effect of the difference in the competitive threat across markets. Thus, we add a third effect to Armstrong and Vickers (1993) and Cheung and Wang's (1999) analysis.

5 Entry decision

The entrant's decision to enter market A depends on whether his gross post-entry profit is smaller or higher than his entry costs. When the entrant's gross post-entry profit is higher under discriminatory pricing than under uniform pricing, there is an interval of entry costs values where entry is profitable under discriminatory pricing but unprofitable under uniform pricing. Therefore we consider that entry under discriminatory pricing is *more likely* than under uniform pricing. From Subsection 4.1 we conclude that under discriminatory pricing the incumbent

always sells in market A and the entrant's profit function is given by (12). However, under uniform pricing, the entrant's profit function depends on whether the incumbent sells in market A or not. For high k values, the incumbent prefers to abandon market A and consequently the entrant becomes a monopolist in market A . Therefore, under uniform pricing, the entrant's gross post-entry profits are:

$$\begin{aligned}\bar{\pi}^E &= \frac{a_A^2(b_A-d_A)[b_Ad_A(k+1)+2(2b_A^2-d_A^2)+kd_A^2]^2}{b_A(b_A+d_A)[8b_A^2-5d_A^2]^2} && \text{for } k \leq k_B \\ \bar{\pi}^E &= \frac{a_A^2}{4b_A} && \text{for } k > k_B.\end{aligned}\tag{13}$$

The following proposition presents the main result of this paper since it shows, for different degrees of markets' demand difference and degrees of product substitutability, which of the two pricing policies implies higher entrant's gross post-entry profit.

Proposition 1 *The entrant's profit under discriminatory pricing is:*

- (i) *Equal to the entrant's profit under uniform pricing when $k \leq k_A$ and also when there is complete differentiation and $k_A < k < k_B$.*
- (ii) *Higher than the entrant's profit under uniform pricing when $k_A < k < k^E$ where $k^E = \frac{2(b^A-d^A)}{2b^A-d^A}$.*
- (iii) *Lower than the entrant's profit under uniform pricing when $k \geq k^E$ where for $k \geq k_B$ the entrant is the only firm in market A .*

Proof: The result is a direct consequence of comparing the entrant's profit under discriminatory pricing (12) and under uniform pricing (13). ■

Figure 2 illustrates this proposition where the area marked with circles stands for (i), the area marked with squares stands for (ii) and the area in white stands for (iii).

This proposition shows that entry under discriminatory pricing may be *more*, *less* or *equally likely* than under uniform pricing. Entry under discriminatory pricing is *more likely* than under uniform pricing for $k_A < k < k^E$, *i.e.*, for the set of parameters corresponding to the area with squares. Thus our results corroborate Cheung and Wang (1999) since the impact on entry due to the difference in markets' demand overwhelms the impact due to the difference in the competitive threat across markets. Notice that when products are highly substitutable there is only a small interval of k values where entry under discriminatory pricing is *more likely* than

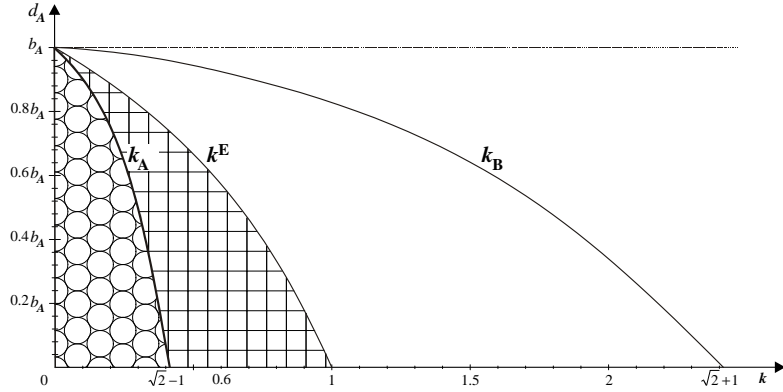


Figure 2: Entrant's profits comparison

under uniform pricing. Entry under discriminatory pricing is *more likely* than under uniform pricing for large intervals of k when there are lower degrees of product substitutability. Thus, the degree of product substitutability affects the interval of the degrees of markets' demand difference where entry under discriminatory pricing is *more likely* than under uniform pricing. For a given k , if the degree of product substitutability rises, the entrant's profits under both pricing policies decrease except when the entrant is monopolist. For intermediate and high degrees of product substitutability, this decrease is bigger under discriminatory pricing and thus, entry under uniform pricing starts to be *more likely* than under discriminatory pricing.

Entry under uniform pricing is *more likely* than under discriminatory pricing for $k \geq k^E$, *i.e.*, for the set of parameters corresponding to the area in white. Notice that for $k \geq k_B$ the entrant has the highest profit possible since he is a monopolist in market A .

Finally, when market A is much larger than market B , *i.e.*, $k \leq k_A$ the entrant has the same profit under both pricing policies since under uniform pricing the incumbent prefers to sell in market A only, which leads to the same Nash *equilibrium* in market A as under discriminatory pricing. Entry is also *equally likely* under both pricing policies when $k_A < k < k_B$ and there is complete differentiation.

6 Conclusion

Pricing policies imply different entry incentives. There are some studies which support the view that discriminatory pricing tends to discourage entry and conversely other studies show

that discriminatory pricing can increase profits and thus encourage entry. We extended the analysis of the impact of pricing policies upon entry considering a framework where there exists price competition and differentiated products. In addition to the analysis of the impact of the difference in the competitive threat across markets and of the difference in markets' demand, we explore the effect of product differentiation on the comparison of the impact of pricing policies upon entry.

We show that the impact of pricing policies upon entry is ambiguous. Entry under discriminatory pricing may be *more*, less or *equally likely* than under uniform pricing. For all degrees of product substitutability, there is always some level of degree of markets' demand difference where under discriminatory pricing entry is *more likely* than under uniform pricing. The degree of product substitutability has impact on the set of degrees of markets' demand difference where entry under discriminatory pricing is *more likely* than under uniform pricing.

Focusing solely on the difference in the competitive threat across markets and the effect of the degree of markets' demand difference as determinants of when discriminatory pricing entry is *more likely* than under uniform pricing ignores an important effect – the effect of the degree of product substitutability. Therefore, we reinforce Cheung and Wang (1999) idea that there should always be a complete evaluation of the market conditions adding to their analysis, the impact of product differentiation. In addition, our analysis extends previous results since we study the cases where, under entry, the incumbent firm sells in both markets under uniform pricing as well as the case where the incumbent abandons one of the markets. Interesting extensions could consider settings where there are complementary products and where firms have positive symmetric or asymmetric production costs.

A Discriminatory Pricing

We present the computations of the first order conditions and solutions for three different optimization problems under discriminatory pricing: monopoly in market A , monopoly in market B and duopoly in market A .

A.1 Monopoly in market A

Let p_{Am}^I, q_{Am}^I denote the incumbent's monopoly price and quantity in market A under discriminatory pricing. The incumbent solves the following problem:

$$\max_{p_{Am}^I} p_{Am}^I \left(\frac{a_A}{b_A} - \frac{1}{b_A} p_{Am}^I \right)$$

The first order condition is given by:

$$\frac{d\pi_{Am}^I}{dp_{Am}^I} = \frac{a_A}{b_A} - \frac{2}{b_A} p_{Am}^I = 0.$$

The monopoly solution is:

$$p_{Am}^I = \frac{a_A}{2} \quad \text{and} \quad q_{Am}^I = \frac{a_A}{2b_A}$$

Under our assumptions, this quantity is positive.

A.2 Monopoly in market B

Let p_{Bm}^I, q_{Bm}^I denote the incumbent's monopoly price and quantity in market B under discriminatory pricing. The incumbent solves the following problem:

$$\max_{p_{Bm}^I} p_{Bm}^I \left(\frac{a_B}{b_B} - \frac{1}{b_B} p_{Bm}^I \right)$$

The first order condition is given by:

$$\frac{d\pi_{Bm}^I}{dp_{Bm}^I} = \frac{a_B}{b_B} - \frac{2}{b_B} p_{Bm}^I = 0.$$

The monopoly solution is:

$$p_{Bm}^I = \frac{a_B}{2} = \frac{ka_A}{2} \quad \text{and} \quad q_{Bm}^I = \frac{a_B}{2b_B} = \frac{ka_A}{2b_A},$$

where the last equalities follow from the assumptions on a_B and b_B . Under our assumptions, this quantity is positive.

A.3 Duopoly in market A

Let p^E , q^E denote the entrant's price and quantity when the incumbent uses a discriminatory pricing policy and p_{Ad}^I , q_{Ad}^I are the incumbent's price and quantity in market A under discriminatory pricing and duopoly in market A . Given the demand function (5), the incumbent solves the following problem in market A :

$$\max_{p_{Ad}^I} p_{Ad}^I (\alpha - \beta p_{Ad}^I + \gamma p^E)$$

and similarly, given the demand function (6), the entrant solves:

$$\max_{p^E} p^E (\alpha - \beta p^E + \gamma p_{Ad}^I),$$

The first order conditions are respectively given by:

$$\begin{aligned} \frac{\partial \pi_{Ad}^I}{\partial p_{Ad}^I} &= \alpha - 2\beta p_{Ad}^I + \gamma p^E = 0 \\ \frac{\partial \pi^E}{\partial p^E} &= \alpha - 2\beta p^E + \gamma p_{Ad}^I = 0. \end{aligned}$$

And thus the best response functions of the two firms are given by:

$$\begin{aligned} p_{Ad}^I &= \frac{\alpha + \gamma p^E}{2\beta} \\ p^E &= \frac{\alpha + \gamma p_{Ad}^I}{2\beta}. \end{aligned}$$

The *equilibrium* prices are given by:

$$p_{Ad}^I = p^E = \frac{\alpha}{2\beta - \gamma} = \frac{a_A (b_A - d_A)}{2b_A - d_A}$$

and the *equilibrium* quantities are given by:

$$q_{Ad}^I = q^E = \frac{\beta \alpha}{2\beta - \gamma} = \frac{a_A b_A}{(b_A + d_A)(2b_A - d_A)},$$

where the last expressions are obtained from the definitions of α , β and γ .

Under our assumptions, q_{Ad}^I and q^E are always positive.

B Uniform Pricing

We present the computations of the first order conditions and solutions for two different optimization problems under uniform pricing: sell both markets when there is a monopoly in market A and sell both markets when there is a duopoly in market A .

B.1 Sell both markets and monopoly in market A

Let \bar{p}^I , \bar{q}_{Am}^I , \bar{q}_{Bm}^I denote the incumbent's price and quantities produced in markets A and B , respectively, under uniform pricing and monopoly in both markets. The incumbent solves the following problem:

$$\max_{\bar{p}^I} \bar{p}^I \left(\frac{a_A}{b_A} - \frac{1}{b_A} \bar{p}^I \right) + \bar{p}^I \left(\frac{a_B}{b_B} - \frac{1}{b_B} \bar{p}^I \right) \quad (14)$$

The first order condition is given by:

$$\frac{d\bar{\pi}_{(Am+Bm)}^I}{d\bar{p}^I} = \left(\frac{a_A}{b_A} - \frac{2}{b_A} \bar{p}^I \right) + \left(\frac{a_B}{b_B} - \frac{2}{b_B} \bar{p}^I \right) = 0.$$

The solution is:

$$\begin{aligned} \bar{p}^I &= \frac{a_B b_A + a_A b_B}{2(b_A + b_B)} = \frac{a_A(k+1)}{4} \\ \bar{q}_{Am}^I &= \frac{2a_A - a_B}{2(b_A + b_B)} + \frac{a_A b_B}{2b_A(b_A + b_B)} = \frac{a_A(3-k)}{4b_A} \\ \bar{q}_{Bm}^I &= \frac{2a_B - a_A}{2(b_A + b_B)} + \frac{a_B b_A}{2b_B(b_A + b_B)} = \frac{a_A(3k-1)}{4b_A}, \end{aligned}$$

Notice that $\bar{q}_{Am}^I > 0$ if $k < 3$ and $\bar{q}_{Bm}^I > 0$ if $k > \frac{1}{3}$.

B.2 Sell both markets and duopoly in market A

Let \bar{p}^E , \bar{q}^E denote the entrant's price and quantity when the incumbent practices uniform pricing and sells in both markets and \bar{p}_d^I , \bar{q}_{Ad}^I , \bar{q}_{Bm}^I are the incumbent's price and quantities in markets A and B , respectively, under uniform pricing and duopoly in market A . Given the demand functions (3) and (5), the incumbent solves the following problem:

$$\max_{\bar{p}_d^I} \bar{p}_d^I (\alpha - \beta \bar{p}_d^I + \gamma \bar{p}^E) + \bar{p}_d^I \left(\frac{a_B}{b_B} - \frac{1}{b_B} \bar{p}_d^I \right)$$

and similarly, given the demand function (6), the entrant solves:

$$\max_{\bar{p}^E} \bar{p}^E (\alpha - \beta \bar{p}^E + \gamma \bar{p}_d^I)$$

The first order conditions are respectively given by:

$$\begin{aligned} \frac{\partial \bar{\pi}_{(Ad+Bm)}^I}{\partial \bar{p}_d^I} &= (\alpha - 2\beta \bar{p}_d^I + \gamma \bar{p}^E) + \left(\frac{a_B}{b_B} - \frac{2}{b_B} \bar{p}_d^I \right) = 0 \\ \frac{\partial \bar{\pi}^E}{\partial \bar{p}^E} &= \alpha - 2\beta \bar{p}^E + \gamma \bar{p}_d^I = 0. \end{aligned}$$

And thus the best response functions of the two firms are given by:

$$\bar{p}_d^I = \frac{\alpha b_B + a_B + \gamma b_B \bar{p}^E}{2(b_B \beta + 1)}$$

$$\bar{p}^E = \frac{\alpha + \gamma \bar{p}_d^I}{2\beta}.$$

The *equilibrium* prices are given by:

$$\begin{aligned} \bar{p}_d^I &= \frac{2\beta a_B + \alpha b_B (2\beta + \gamma)}{4\beta + b_B (4\beta^2 - \gamma^2)} = \\ &= \frac{a_A (b_A - d_A) [2k (b_A + d_A) + (2b_A + d_A)]}{8b_A^2 - 5d_A^2} \\ \bar{p}^E &= \frac{\gamma a_B + 2\alpha + \alpha b_B (2\beta + \gamma)}{4\beta + b_B (4\beta^2 - \gamma^2)} = \\ &= \frac{a_A (b_A - d_A) [b_A d_A (k + 1) + 2 (2b_A^2 - d_A^2) + k d_A^2]}{b_A [8b_A^2 - 5d_A^2]} \end{aligned}$$

and the *equilibrium* quantities are given by:

$$\begin{aligned} \bar{q}_{Ad}^I &= \frac{\alpha (2\beta + \gamma) (2 + \beta b_B) + a_B (\gamma^2 - 2\beta^2)}{4\beta + b_B (4\beta^2 - \gamma^2)} = \\ &= \frac{a_A [(2b_A + d_A) (3b_A^2 - 2d_A^2) + k (b_A + d_A) (d_A^2 - 2b_A^2)]}{b_A (b_A + d_A) [8b_A^2 - 5d_A^2]} \\ \bar{q}_{Bm}^{I'} &= \frac{2\beta a_B + a_B b_B (4\beta^2 - \gamma^2) - \alpha b_B (2\beta + \gamma)}{b_B (4\beta + b_B (4\beta^2 - \gamma^2))} = \\ &= \frac{a_A [3k (2b_A^2 - d_A^2) - (b_A - d_A) (2b_A + d_A)]}{b_A [8b_A^2 - 5d_A^2]} \\ \bar{q}^E &= \beta \frac{2\alpha (1 + \beta b_B) + \gamma a_B + \alpha \gamma b_B}{4\beta + b_B (4\beta^2 - \gamma^2)} = \\ &= \frac{a_A [b_A d_A (k + 1) + 2 (2b_A^2 - d_A^2) + k d_A^2]}{(b_A + d_A) [8b_A^2 - 5d_A^2]}, \end{aligned}$$

Under our assumptions, \bar{q}^E is always positive. Notice that $\bar{q}_{Ad}^I > 0$ if $k < \frac{(2b^A + d^A)(3(b^A)^2 - 2(d^A)^2)}{(b^A + d^A)(2(b^A)^2 - (d^A)^2)}$ and $\bar{q}_{Bm}^{I'} > 0$ if $k > \frac{(b^A - d^A)(2b^A + d^A)}{3(2(b^A)^2 - (d^A)^2)}$.

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