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MARKET SEGMENTATION, MARKET INTEGRATION AND TACIT COLLUSION

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Abstract

This paper shows that moving from market segmentation to market integration (i.e. firms can no longer discriminate among markets) may have anti-competitive effects in a repeated game setting in which a simple trigger strategy is the enforcement strategy. In particular, we show that two countries can never both experience pro-competitive gains and that two similar countries always both experience anti-competitive effects from market integration. We show that the same conclusions hold when trade liberalization is understood as being a decrease in bilateral barriers to trade followed by the switch from market segmentation to market integration.

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1. Introduction

At least since Brander and Krugman (1983), the firm's ability to discriminate among markets, known as market segmentation, has been central to many theoretical contributions in international trade with imperfect competition. Several papers have contrasted the outcomes with and without market segmentation, the latter being known as market integration (Markusen and Venables (1988), Haaland and Wooton (1992), Smith and Venables (1988)). The switch from market segmentation to market integration has generally been shown to have pro-competitive effects. The reason is straightforward. With market segmentation, a firm selling in two markets (a domestic and a foreign market) typically faces a higher demand elasticity abroad than at home due to the presence of barriers to trade affecting its foreign residual demand. If products are differentiated, it will therefore set a lower (producer) price abroad than at home if it has the possibility to discriminate between these markets. Forcing firms to have the same price in both markets typically increases the (producer) price of exports and decreases the domestic price of the same product since both firms are now forced to set their price according to an average demand elasticity over both markets. The pro-competitive effect comes then from the fact that a domestic firm has generally a much larger market share of its home market than the foreign firm. This pro-competitive effect of market integration however is based on a static model of competition where firms are assumed to have the same behavior (Cournot, Bertrand, etc) both before and after market integration.¹ The main purpose of this paper is to relax this assumption by considering the switch from market segmentation to market integration when the firms interact repeatedly through time.

Games where firms interact indefinitely can be interpreted as endogenizing firm's behavior since they determine whether, given a particular shock, tacit collusion becomes easier or more difficult to sustain among a continuum of possible degrees of competition. Indeed, infinitely repeated games are useful precisely because they provide a framework where firm's behavior is endogenous.

We show below that, in such an environment, moving from market segmentation to market integration is not generally accompanied by pro-competitive effects since, in most

¹ Hence, the pro-competitive effect amounts to a decrease in the firm's markup given the type of rivalry it is engaged in with other firms.

situations, tacit collusion is easier to sustain with market integration than with market segmentation. In particular, we show that two countries can never both experience pro-competitive effects from market integration and that two similar countries (in terms of market size given identical firm's cost or in terms of firm's cost given identical market size) always both experience anti-competitive effects from such a move.

The fact that more open markets may have anti-competitive effects in a repeated game is not new. Most other papers however show this result by reducing barriers to trade such as tariffs or quotas (see for instance Fung (1992), Davidson (1984), Rotemberg and Saloner (1989)). Here, although barriers to trade may be present, we do not vary them when we analyze the switch from market segmentation to market integration.

The implications of these results go beyond a simple theoretical exercise. The switch from market segmentation to market integration has been considered as a useful tool to model the European move toward a unique market (Europe-1992) because it captures the effects of the elimination of the numerous administrative barriers preventing consumers to arbitrage products across markets. Smith and Venables (1988) (with a partial equilibrium model), Burniaux and Waelbroeck (1992), Gasiorek, Smith and Venables (1991), Mercenier (1995) (with general equilibrium models) have evaluated the effects of the Europe-1992 experiment by considering explicitly the switch from market segmentation to market integration. These studies generally find that Europe-1992 has pro-competitive effects, sometimes quite significant ones. All these empirical papers however use a static model of firm's rivalry and thus assume that firms adopt the same behavior before and after integration. Although considerable doubts have been expressed both about the hypothesis itself² and about some of the estimates of the welfare gains from the 1992 experiment,³ it remains a popular tool. It is then especially important to investigate how firm's behavior might be affected by economic integration. In the last part of the paper, we then show that when trade liberalization is understood as lowering barriers to trade followed by the switch from market segmentation to market integration (as in Smith and Venables (1988)), the same qualitative results

² See, in particular, Ben-Zvi and Helpman (1992) and Horn and Shy (1996). The first paper looks at the conditions under which firms can segment markets, while the second paper considers the firm's ability to discriminate between two markets in the presence of consumer's arbitrage. The message of both papers is that the simple switch from market segmentation to market integration exaggerates the effects of economic integration.

³ See Peck (1989) and Winters (1992) for general discussions, and Haaland and Wooton (1992) and Mercenier and Schmitt (1996) for methodological issues.

hold as when market segmentation and market integration is simply compared: at least one country must experience anti-competitive effects and two similar countries always experience anti-competitive effects. Given these results and the importance of this hypothesis for empirical work, it would thus be interesting to incorporate repeated games in an applied general equilibrium model so as to evaluate the welfare cost of tacit collusion.

The paper is organized as follows. In the next section, the basic model is outlined and the equilibrium under market segmentation is derived. In Section 3, the effect of market integration is analyzed and Section 4 compares market segmentation and market integration. Section 5 brings tariff liberalization and market integration together. Section 6 concludes.

2. The Model

The basic model is one of reciprocal dumping (Brander and Krugman (1983)) generalized to allow for a continuum of degrees of product differentiation. The market structure is an international duopoly where firms use quantity as their strategic variable. Following Fung (1991, 1992), Davidson (1984), and Rotemberg and Saloner (1989), we set this basic model into an infinitely repeated game with trigger strategies (Friedman (1971)) to investigate the case of trade liberalization defined as lower bilateral barriers to trade followed by the elimination of the firm's ability to segment markets.

Consider two identical countries (D and F) with one firm in each country producing a single differentiated product. Assume that the barriers to trade between the two countries are low enough so that both firms have a positive share of both markets. Firm X, producing in market D , sells x units domestically and x^* units in market F , while Firm Y, producing in F , sells y^* units domestically and y units in market D . The demand structure in market D is given by

$$p_x = a_x - b(x + \theta y); \quad p_y = a_y - b(y + \theta x), \quad (1)$$

where θ measures the degree of differentiation between the two products (there is no substitution between the products when $\theta = 0$ and they are perfect substitutes when $\theta = 1$). Similarly, the demands in market F have the same parameters as in D and are written with respect to x^* and y^* .

We assume that the marginal cost of production is c_i so that the marginal cost for domestic sales is c_i and the marginal cost for foreign sales is $c_i + t$ ($i = x, y$). We interpret t as being either an additional distribution cost for selling abroad (international transport cost, packaging) or a specific barrier to trade set by governments. By assumption, it is the same in both directions. Firms face no fixed cost of production.

Given these assumptions, the profit function for each firm is

$$\begin{aligned}\Pi_x &= [a_x - c_x - b(x + \theta y)]x + [a_x - c_x - t - b(x^* + \theta y^*)]x^*; \\ &= b[S_x - x - \theta y]x + b[S_x - T - x^* - \theta y^*]y^*,\end{aligned}\tag{2}$$

and

$$\begin{aligned}\Pi_y &= [a_y - c_y - b(y^* + \theta x^*)]y^* + [a_y - c_y - t - b(y + \theta x)]y; \\ &= b[S_y - y^* - \theta x^*]y^* + [S_y - T - y - \theta x]y,\end{aligned}\tag{3}$$

where T is equal to $\frac{t}{b}$ and $S_i = \frac{a_i - c_i}{b}$.

Firms are assumed to interact repeatedly and to use quantity as their strategic variable. Friedman (1971) has shown that a collusive outcome can be achieved without communication among players provided that threats are credible. A common punishment strategy in this sort of games is the trigger strategy whereby firms produce a target output as long as others do likewise, and firms revert to Cournot-Nash output forever as soon as one has been observed to deviate from the target level of output. Consequently, we define Π_i^c ($i = x, y$) as firm i 's profit with collusion; Π_i^d as firm i 's profit when it deviates from the target output while its rival firm still produces the target output, and Π_i^n as firm i 's profit in the Cournot-Nash equilibrium. Discounting the flow of future profits over the infinite horizon, firm i then chooses to produce the target output if

$$\frac{1}{1-\delta}\Pi_i^c \geq \Pi_i^d + \frac{\delta}{1-\delta}\Pi_i^n, \quad i = x, y,\tag{4}$$

where $\delta = \frac{1}{1+r}$ is the discount factor as a function of the relevant interest rate. It is easy to check that (4) can be written as

$$r \leq r_i = \frac{\Pi_i^c - \Pi_i^n}{\Pi_i^d - \Pi_i^c} \quad i = x, y,\tag{5}$$

where r_i is the maximum interest rate for firm i consistent with collusion. Since (5) is firm specific and firms produce in separate countries, nothing guarantees that both firms face the same critical rate. Thus, collusion is sustainable if and only if

$$0 \leq r \leq \text{Min}[r_i], \quad i = x, y.$$

$\text{Min}[r_i]$ splits the feasible values for r into two ranges. In the lower range, any value of r is consistent with collusion by both firms and above $\text{Min}[r_i]$, collusion is not sustainable since at least one firm is willing to deviate from the target output.

The effects of trade liberalization can be investigated by asking what happens to $\text{Min}[r_i]$ when trade gets liberalized. If $\text{Min}[r_i]$ falls, tacit collusion becomes more difficult, and if $\text{Min}[r_i]$ increases, tacit collusion becomes easier.⁴ We first derive the critical rates when firms can segment markets.

Suppose firms *segment* markets; that is, suppose they perceive each country as separate entities where separate decisions can be made. Since countries are identical, we concentrate our attention on one country, say, country D . Using (2) and (3), it is straightforward to show that the Cournot-Nash equilibrium quantities are

$$x_n = \frac{2S_x - \theta S_y + \theta T}{4 - \theta^2}; \quad y_n = \frac{2S_y - \theta S_x - 2T}{4 - \theta^2},$$

and the one-period profits in country D are

$$\pi_x^n = bx_n^2; \quad \pi_y^n = by_n^2. \quad (6)$$

Consider now the target outputs. Clearly, they could be any output levels smaller than the Cournot ones. We assume the target outputs correspond to the joint-profit maximization solutions of (2) and (3). In D , they are

$$x_c = \frac{S_x - \theta S_y + \theta T}{2(1 - \theta^2)}; \quad y_c = \frac{S_y - T - \theta S_x}{2(1 - \theta^2)},$$

⁴ Alternatively, we could have computed the highest firm's output between the Cournot and monopoly solutions such that, given r (or δ) and the other parameters of the model, collusion is just sustainable (i.e., the equality holds in (4)). Similar results of comparative statics can be derived with respect to this critical collusive output.

and the target profits in D are

$$\pi_x^c = \frac{bS_x}{2}x_c; \quad \pi_y^c = \frac{b(S_y - T)}{2}y_c. \quad (7)$$

Suppose finally that Firm X, or Firm Y, deviates from the target output while the rival firm continues to produce the target output. The optimal output of the deviating firm (Firm X and Firm Y, respectively) is

$$x_d = \frac{S_x(2 - \theta^2) - \theta S_y + \theta T}{4(1 - \theta^2)}; \quad y_d = \frac{(S_y - T)(2 - \theta^2) - \theta S_x}{4(1 - \theta^2)},$$

and the profit of the deviating firm in D is

$$\pi_x^d = bx_d^2; \quad \pi_y^d = by_d^2. \quad (8)$$

Observe that (7) and (8) imply that tacit collusion is country specific and not over both countries. In other words, each firm's incentive to deviate is separate for each country. Of course, this does not mean that firms cannot collude in both countries, but simply that they do not necessarily collude in D even if they collude in F .⁵

Using (5) to (8), the critical rates in D can be derived. We denote them r_x^S and r_y^S corresponding respectively to Firm X's and Firm Y's critical rate and where superscript S stands for market segmentation. Similarly, r_{x*}^S and r_{y*}^S are the two critical rates in country F corresponding respectively to Firms X and Y.

Lemma 1: $r_x^S \leq r_y^S \Leftrightarrow S_x \leq S_y - T$ and $r_x^S \geq r_y^S \Leftrightarrow S_x \geq S_y - T$ in country D and $r_{x*}^S \geq r_{y*}^S \Leftrightarrow S_x \geq S_y + T$ and $r_{x*}^S \leq r_{y*}^S \Leftrightarrow S_x \leq S_y + T$ in country F .

Proof: Since the present model is a slight generalization of Fung (1992) (we allow for different market sizes), the first part of Lemma 1 is identical to his Proposition 1. The symmetry of the model makes it easy to extend the result to country F . Indeed, observe that the critical rates in F , r_{x*}^S and r_{y*}^S , can be found by simply substituting S_x and S_y in r_y^S and r_x^S , respectively. This implies that $r_{x*}^S = r_{y*}^S$ when $S_y = S_x - T$. Hence, the second part of the Lemma. ■

⁵ This implies that the critical rates in D are not affected by firm's behavior in F since, whether or not firms collude in F , the critical rate (5) can be written as $r_i = \frac{(\pi_i^F + \pi_i^D) - (\pi_i^F + \pi_i^D)}{(\pi_i^F + \pi_i^D) - (\pi_i^F + \pi_i^D)}$, where π_i^F is Firm i 's profit in F irrespective of its behavior there and π_i^D is Firm i 's profit in D depending on its behavior ($k = c, d, n$).

Lemma 1 indicates that the relevant critical rate which determines collusion between the two firms is the one associated with the high-cost firm inclusive of the trade cost when the demands for both goods are identical ($a_x = a_y$). In effect, $S_x \geq S_y - T$ implies $c_x \leq c_y + t$. Since, in this case, $r_y^S = \min[r_i^S]$ ($i = x, y$), the binding rate below which collusion is feasible is determined by the high selling cost foreign firm. If firms have the same cost of production ($c_x = c_y$), the relevant critical rate is associated with the firm facing the smaller residual demand since $S_x \geq S_y - T$ implies $a_x \geq a_y - t$.

We now consider the equilibrium under market integration and derive the critical rates.

3. Market Integration

With market integration, each firm is constrained to choose a single price for both countries since arbitrage prevents them to do otherwise. Thus, with market integration, the price of a given product differs by the barrier to trade t between the two countries. Unlike in the segmented case, the firm's decision about collusion now depends on the overall profit earned in both countries. Formally, Firm X maximizes (2) by choosing x subject to the arbitrage constraint $p_x = p_x^* - t$. Similarly, Firm Y maximizes (3) with respect to y subject to the constraint $p_y - t = p_y^*$. Using the demands faced by both firms in each country, the constraints for Firm X and Y can be written, respectively, as

$$x_k^* = x_k - T + \theta(y_k - y_k^*) \quad \text{and} \quad y_k^* = y_k + T - \theta(x_k^* - x_k), \quad (9)$$

where $T = \frac{t}{b}$ and $k = c, d, n$ for collusion, deviation and Cournot-Nash, respectively.

These constraints play a key role. In particular, they imply that, in market integration, collusion must take place over both countries. To see this, consider Firm X's incentive to deviate in one country only, say D . It would choose x_d maximizing $\Pi_x(x_d; x_c^*, y_c, y_c^*)$. Since market integration implies $x_k = x_k^* + T - \theta(y_c - y_c^*)$ and none of the elements on the right-hand side changes with deviation, then, necessarily, $x_k = x_d = x_c$ when the constraint is binding. In other words, in an integrated market, Firm X has no incentive to deviate in one country alone. This is, of course, true for both firms irrespective of the country in which they consider deviating. Firm X can find, however, x_d and x_d^* such that $\Pi_x(x_d, x_d^*; y_c, y_c^*)$ is maximized under the constraint $x_d = x_d^* + T - \theta(y_c - y_c^*)$. Hence, Firm X's incentive to

deviate, if it exists, is necessarily over both countries. This is how tacit collusion is modeled in this section.

Using the same infinitely repeated game as in the previous section, the Cournot-Nash equilibrium in D is now characterized by⁶

$$x_n = \frac{2(1-\theta)(2S_x - \theta S_y) + (1+2\theta)(2-\theta)T}{2(4-\theta^2)(1-\theta)}; \quad y_n = \frac{2(1-\theta)(2S_y - \theta S_x) - 3(2-\theta)T}{2(4-\theta^2)(1-\theta)}.$$

The one-period profit of each firm in the Cournot-Nash equilibrium is

$$\Pi_x^n = \frac{b}{2}(x_n + x_n^*)^2; \quad \Pi_y^n = \frac{b}{2}(y_n + y_n^*)^2. \quad (10)$$

If both firms collude tacitly by producing the output consistent with joint-profit maximization while making sure that the price difference for each product across border is equal to t , (i.e., they maximize joint profit with respect to x and y under the constraints (9)), they produce the following quantities in market D :⁷

$$x_c = \frac{2S_x - 2\theta S_y + (1+3\theta)T}{4(1-\theta^2)} \quad y_c = \frac{2S_y - 2\theta S_x - (3+\theta)T}{4(1-\theta^2)}.$$

The firm's profits are then

$$\Pi_x^c = \frac{b}{4}(2S_x - T)(x_c + x_c^*); \quad \Pi_y^c = \frac{b}{4}(2S_y - T)(y_c + y_c^*). \quad (11)$$

Finally, a deviating firm maximizes its individual profit subject to its pricing constraint. When Firm X deviates over both countries, its optimal outputs are⁸

$$x_d = \frac{2(2-\theta^2)S_x - 2\theta S_y + (\theta^2 + 5\theta + 2)T}{8(1-\theta^2)}; \quad x_d^* = \frac{2(2-\theta^2)S_x - 2\theta S_y - (6+3\theta-\theta^2)T}{8(1-\theta^2)}.$$

Firm's profits when deviating are:

$$\Pi_x^d = \frac{b}{2}(x_d + x_d^*)^2; \quad \Pi_y^d = \frac{b}{2}(y_d + y_d^*)^2. \quad (12)$$

⁶ The quantities sold in F are x_n^* and y_n^* ; they are found by substituting S_x and S_y in y_n and x_n respectively.

⁷ To find x_c^* and y_c^* , substitute S_x and S_y in y_c and x_c , respectively.

⁸ Firm Y 's deviating outputs y_d and y_d^* are found by substituting S_x and S_y in x_d^* and x_d , respectively.

Like in the segmented case, one can define two critical rates, r_x^I and r_y^I for Firm X and Firm Y, respectively, in market integration. They are found by substituting (10), (11) and (12) in (5). Collusion is then sustainable under market integration whenever $r \leq \min[r_x^I, r_y^I]$. Note that, unlike in the segmented market case, these critical rates are valid for both countries.

Observe also that (10), (11) and (12) are not valid for all values of the parameters. First, we require the various outputs to be positive and, from (11), $T < 2S_x$ and $T < 2S_y$. Second, each firm in the integrated market is free to decide to sell in one country only. In particular, in this model, the incentive for each firm to stop exporting and to sell only in the country of production (domestic market) increases with T . This is the case as the equilibrium under market integration averages out the elasticities of the demands faced by each firm in each country and, in a segmented equilibrium, the domestic market elasticity is lower than the foreign one. In the remainder of this paper, we will use only the first set of constraints on the parameters as the effects of market integration can be made clear without the second set of constraints. In other words, we assume that T is low enough for bilateral trade to occur whether or not firms collude.

Since tacit collusion with market integration is sustainable when $r \leq \min[r_x^I, r_y^I]$, our task is now to determine which rate is lower under which circumstances. Comparing r_x^I and r_y^I :

Lemma 2: $r_y^I < r_x^I \Leftrightarrow S_x > S_y$ and $r_y^I > r_x^I \Leftrightarrow S_x < S_y$.

Proof: Lemma 2 requires showing that $(r_x^I - r_y^I)$ has the same sign as $(S_x - S_y)$. Using (5),

$$r_x^I - r_y^I = \left(\frac{\Pi_x^c - \Pi_x^n}{\Pi_x^d - \Pi_x^c} \right) - \left(\frac{\Pi_y^c - \Pi_y^n}{\Pi_y^d - \Pi_y^c} \right). \quad (13)$$

Since, in equilibrium, $\Pi_i^c - \Pi_i^n > 0$ and $\Pi_i^d - \Pi_i^c > 0$ ($i = x, y$), consider the difference between the two numerators in (13):

$$(\Pi_x^c - \Pi_x^n) - (\Pi_y^c - \Pi_y^n) = \frac{3(S_x - S_y)(S_x + S_y - T)\theta^2}{2(4 - 5\theta^2 + \theta^4)}. \quad (14)$$

Observe from (11) that $2S_x - T > 0$ and $2S_y - T > 0$ which imply $S_x + S_y - T > 0$. In addition, $(4 - 5\theta^2 + \theta^4) \geq 0$ for $\theta \in [0, 1]$. Hence, the difference between the two numerators

has the same sign as $(S_x - S_y)$. Consider now the difference between the two denominators in (13):

$$(\Pi_x^d - \Pi_x^c) - (\Pi_y^d - \Pi_y^c) = -\frac{(S_x - S_y)(S_x + S_y - T)}{8(1 - \theta^2)}. \quad (15)$$

Clearly, this expression has the opposite sign of $(S_x - S_y)$. Since $\Pi_i^c - \Pi_i^n > 0$ and $\Pi_i^d - \Pi_i^c > 0$ ($i = x, y$), (14) and (15) imply that $\left(\frac{\Pi_x^c - \Pi_x^n}{\Pi_x^d - \Pi_x^c}\right) > \left(\frac{\Pi_y^c - \Pi_y^n}{\Pi_y^d - \Pi_y^c}\right)$ for $S_x > S_y$, while the opposite holds when $S_x < S_y$. ■

The fact that $r_x^I = r_y^I$ when $S_x = S_y$ should not be surprising. In market integration, the two critical rates must be the same when the firms and the demands for the two products are identical. Since $S_i = \frac{a_i - c_i}{b}$, Lemma 2 also says that the high production cost firm (when $a_x = a_y$) is the relevant firm which determines the range over which collusion is sustainable in the integrated market. Alternatively, when $c_x = c_y$, the firm facing the smaller market determines the range over which collusion is sustainable. Observe however that, unlike with market segmentation, the condition includes only the production costs, not the trade costs.

The proof of Lemma 2 shows important results for the interpretation of the main conclusion of this paper. Since the sign of (14) is the same as the sign of $S_x - S_y$, the high-cost firm (alternatively, the firm with the smaller market) always captures a smaller additional share of the gain from collusion than its rival. Similarly, since the sign of (15) is the negative of the sign of $S_x - S_y$, the gain from deviating is always higher for the high-cost firm. It is then not surprising that the high-cost firm (alternatively, the firm with the smaller product market) is the critical one determining tacit collusion.

To know the effect of a discrete change from market segmentation to market integration, we must determine how the lowest critical rate under market integration compares with the lowest rate under market segmentation. This is what we do in the next Section.

4. Market Segmentation versus Market Integration

The effects of market integration is relative to the equilibrium with market segmentation. Since the incentive to collude in market segmentation is country specific, we analyze in detail the effects of integration from the point of view of country D and we extend the results to country F . We compare r_i^I and r_i^S ($i = x, y$) in three steps (Lemmas 3 to 5):

Lemma 3: $r_x^I < r_y^S \Leftrightarrow S_x^A \leq S_x < S_y - \frac{T}{2}$ and $r_x^I > r_y^S \Leftrightarrow S_y - \frac{T}{2} < S_x \leq S_x^B$, where S_x^A and S_x^B are the limits of the feasible range of S_x in country D, corresponding respectively to $r_x^I = 0$ and $r_y^S = 0$.

Proof: Direct calculations show that

$$r_x^I - r_y^S = \frac{8(S_x + S_y - T)(S_x - S_y + \frac{T}{2})(1 + \theta)(\theta - 1)H(S_x; S_y, \theta, T)}{(\theta - 2)^2(2 + \theta)^2(-2S_y + T + 2\theta S_x - \theta T)^2(S_x - \theta S_y + \theta T)^2}, \quad (16)$$

where $H(S_x; S_y, \theta, T)$ is a quadratic function in S_x for given values of S_y, θ and T . It is easy to see from (16) that $r_x^I - r_y^S = 0$ holds for $S_x = S_y - \frac{T}{2}$. In Appendix 1, we show that $H < 0$ over the interval $S_x^A \leq S_x \leq S_x^B$. Since the denominator in (16) is always positive and $\theta < 1$, it follows that the sign of $r_x^I - r_y^S$ is the same as the sign of $(S_x - S_y + \frac{T}{2})$, hence the Lemma. ■

We also need to compare r_y^I and r_y^S , as well as r_x^S and r_x^I for part of the overall interval.

Lemma 4: $r_y^I > r_y^S \Leftrightarrow S_x > S_y - \frac{T}{2}$ and $r_x^S > r_x^I \Leftrightarrow S_x < S_y - \frac{T}{2}$.

Proof: See Appendix 2.

The last step is to use Lemmas 1 to 4 to determine the relevant critical rates r_i^j ($i = x, y$; $j = S, I$) over the entire feasible range for S_x .

Lemma 5: $r_x^I = \text{Min}[r_i^j]$ when $S_x^A \leq S_x < S_y - \frac{T}{2}$ and $r_y^S = \text{Min}[r_i^j]$ when $S_y - \frac{T}{2} \leq S_x \leq S_x^B$ ($i = x, y$; $j = S, I$).

Proof: The feasible range can be divided into two intervals:

- (i) $S_x^A \leq S_x < S_y - \frac{T}{2}$: we know $r_x^I < r_y^I$ (Lemma 2), $r_x^I < r_y^S$ (Lemma 3) and $r_x^I < r_x^S$ (Lemma 4);
- (ii) $S_y - \frac{T}{2} \leq S_x \leq S_x^B$: we know $r_y^S < r_x^S$ (Lemma 1), $r_y^S < r_x^I$ (Lemma 3) and $r_y^S < r_y^I$ (Lemma 4).

Hence, r_x^I , respectively r_y^S , is the lowest critical rate over the first, respectively the second, interval. ■

Figure 1 illustrates the critical rates in the (S_x, r_i^j) space for given values of S_y, θ and T . To derive Figure 1, we have used equation (5) with the relevant equilibrium profits in

market segmentation and in market integration. Point A shows the lower end of the feasible range for S_x (S_x^A) and point B its upper end (S_x^B). There are two important points to note about these curves. First, with Lemma 1, $r_y^S = r_x^S$ at $S_x = S_y - T$ (point Q) and, with Lemma 2, $r_x^I = r_y^I$ at $S_x = S_y$ (point P). Second, these two intersections occur for the same critical rate $\frac{4(1+\theta)}{(2+\theta)^2}$ which is independent of S_y and T . It is also easy to check that r_y^S , r_x^S , r_y^I and r_x^I are consistent with Lemmas 1 to 5.

[Insert Figure 1 about here]

Using Lemma 5 and Figure 1, the effect of introducing market integration only (i.e., firms are unable to discriminate between the two countries) is now immediate.

Proposition 1: *Within the feasible range for S_x , moving from market segmentation to market integration has a pro-competitive effect in country D when $S_x < S_y - \frac{T}{2}$ and an anti-competitive effect when $S_x > S_y - \frac{T}{2}$.*

The first part of Proposition 1 holds because, when $S_x < S_y - \frac{T}{2}$, r_x^I is the relevant critical rate with market integration and this rate is lower than any other critical rates. Hence, the range of relevant rates over which tacit collusion is a subgame perfect equilibrium must decrease when market integration is introduced implying that collusion becomes more difficult to sustain. When $S_x > S_y - \frac{T}{2}$, the relevant minimum critical rate with integration is higher than r_y^S , so that the opposite conclusion holds over this interval.

Recall now the definition of S_i . It is equal to $\frac{a_i - c_i}{b}$ ($i = x, y$) where a_i is a measure of demand size for product i and c_i is the firm's unit cost of production. Thus, $S_x < S_y - \frac{T}{2}$ indicates either that Firm X is a high-cost firm with respect to Firm Y, that the market for product X is smaller than the market for product Y, or a combination of both. With identical demands for both products, collusion is more difficult with integration when $c_x > c_y + \frac{t}{2}$ and thus when Firm X is a sufficiently high-cost firm with respect to Firm Y. Similarly, when $c_x = c_y$, collusion is more difficult when, despite trade costs, the demand for Y is sufficiently large with respect to the demand for X.

Figure 1 shows that similar conclusions hold for country F. In this Figure, r_x^S and r_y^S represent the critical rates for country F with market segmentation. As Section 3 made clear, they are equal at $S_x = S_y + T$. As already mentioned, all the results for country D extends to country F by simply substituting S_x and S_y . Inspection of Figure 1 reveals:

Proposition 2: *Within the feasible range for S_x , moving from market segmentation to market integration has a pro-competitive effect in country F when $S_x > S_y + \frac{T}{2}$ and an anti-competitive effect when $S_x < S_y + \frac{T}{2}$.*

Remarkably, Propositions 1 and 2 indicate that market integration cannot simultaneously have pro-competitive effects in both in the ranges over which pro-competitive effects prevail in each country are mutually exclusive. They also indicate that two identical countries necessarily both experience anti-competitive effects from market integration. Indeed, in Figure 1, the movement from market segmentation to market integration for two identical countries corresponds to the movement from Z to P.

The economic intuition about the effect of market integration is the following. Consider two identical countries ($S_x = S_y$). In market segmentation, collusion is market specific so that the foreign firm, even if it absorbs part of the barrier to trade, earns a smaller share of the profit generated on this market than the domestic firm. Collusion enhances this difference. This always makes the foreign firm's incentive to deviate stronger than the domestic firm's. Integration, by forcing collusion to be over both countries, makes the two firms on the same level playing field since each firm gets an equal share of the overall profit generated in both markets. As a consequence, the incentive to deviate decreases, especially for the foreign firm. Hence, with two identical countries, collusion is easier to enforce in two integrated markets than when these markets are segmented.

5. Trade Liberalization

Since trade liberalization has often been modelled as the cumulative effect of lowering the barriers to trade t and switching from market segmentation to market integration, we close this paper by considering this particular form of trade liberalization.

Consider first the case of a *marginal change* in barriers to trade followed by market integration. In this case, Propositions 1 and 2 are easily extended since the discrete effect of switching from market segmentation to market integration necessarily dominates any effect from lowering t . Hence,

Proposition 3: *In country D, trade liberalization has a locally pro-competitive effect when $S_x < S_y - \frac{T}{2}$ and a locally anti-competitive effect when $S_x > S_y - \frac{T}{2}$. In country F, trade*

liberalization has a locally pro-competitive effect when $S_x > S_y + \frac{T}{2}$ and a locally anti-competitive effect when $S_x < S_y + \frac{T}{2}$.

A discrete change in t is more interesting and more realistic. To see the effects of such a change, suppose t decreases from a high to a low level. In terms of T (recall $T = \frac{t}{b}$), this change corresponds to a decrease from T_h to T_l . Figure 2 illustrates the case for country D .

[Insert Figure 2 about here]

As in Figure 1, $r_x^S(T_l)$ and $r_y^S(T_l)$ are equal when $S_x = S_y - T_l$ (point Q), while $r_x^I(T_l)$ intersects $r_y^I(T_l)$ at $S_x = S_y$ (point P). Since $T_h > T_l$, $r_y^S(T_h) = r_x^S(T_h)$ is found to the left of Q (point Q'). Moreover, points Q', Q, and P are on the same horizontal line given by the critical rate $\frac{4(1+\theta)}{(2+\theta)^2}$ since it is independent of T . Lower barriers to trade followed by market integration has now two distinct effects on the critical rates. These effects may go in opposite or in the same direction depending on the value of S_x .⁹ To see this, define $F(S_y, T_l, T_h)$ as the value of S_x such that $r_y^S(T_h) = r_x^I(T_l)$ (corresponding to S_x at point L in Figure 2) and $G(S_y, T_l, T_h)$ as the value of S_x such that $r_x^S(T_h) = r_y^I(T_l)$ (not represented in Figure 2). Proposition 4 summarizes the net effect for both countries:

Proposition 4: *In country D, trade liberalization has a pro-competitive effect when $S_x < F(S_y, T_l, T_h)$ and an anti-competitive effect when $S_x > F(S_y, T_l, T_h)$. In country F, trade liberalization has a pro-competitive effect when $S_x > G(S_y, T_l, T_h)$ and an anti-competitive effect when $S_x < G(S_y, T_l, T_h)$. Since $F(S_y, T_l, T_h) < G(S_y, T_l, T_h)$, at least one country will necessarily experience anti-competitive effects from trade liberalization and two similar countries (such that $F(\cdot) < S_x < G(\cdot)$) experience anti-competitive effects from trade liberalization.*

Proof: Using (5) and the relevant equilibrium profits, $F(S_y, T_l, T_h) = \frac{1}{4}[T_l + (16S_y^2 - 16S_yT_h - 8S_yT_l + 8T_hT_l + T_l^2)^{\frac{1}{2}}]$. Similarly, $G(S_y, T_l, T_h) = \frac{1}{4}[2T_h + T_l + (16S_y^2 - 8S_yT_l + (T_l - 2T_h)^2)^{\frac{1}{2}}]$.¹⁰ Since $r_x^I(T_l)$ is the lowest critical rate when $S_x < F(S_y, T_l, T_h)$, trade liberalization has a pro-competitive effect for low values of S_x . When $S_x > F(S_y, T_l, T_h)$, $r_y^S(T_h)$ is the lowest critical rate so that trade liberalization necessarily has an anti-competitive effect as $r_x^I(T_l) > r_y^S(T_h)$. Similarly for $G(\cdot)$ with respect to country F. To show that $F(\cdot) < G(\cdot)$, consider two identical

⁹ See Fung (1992) for an analysis of the effects of marginal and discrete changes in tariff alone on the firm's incentive to collude in a segmented market.

¹⁰ Note that, as expected, when $T = T_l = T_h$, $F = S_y - \frac{T}{2}$ and $G = S_y + \frac{T}{2}$.

countries ($S_x = S_y$). Observe first that $F(.) < S_y$ simplifies to $8T_h(T_l - 2S_y) < 0$ which is always the case. Similarly $G(.) > S_y$ holds if $-2S_yT_h + T_l(1 + S_y) < 0$ which holds since $T_h > T_l$ and $S_y > T_l$. Hence, two similar countries (i.e., such that $F(.) < S_x < G(.)$) must both experience anti-competitive effects from trade liberalization. ■

Proposition 6 indicates that even when the barriers to trade decrease significantly, the combination of tariff liberalization and market integration produces anti-competitive effects to two identical countries. The intuition is the same as before: as long as the firms become more similar with trade liberalization, collusion tends to be easier to sustain. It is only when one firm has a much higher production cost than the other, or when the demand for one product is much smaller than the demand for the other product that trade liberalization has a pro-competitive effect in one country.

6. Conclusion

Market integration has been modeled as the law of one price, so that price differences reflect only barriers to trade. In this framework, it has been shown that market integration has pro-competitive effects in one market when the foreign firm is a low-cost firm with respect to the domestic one and anti-competitive effects when it is a high-cost firm. Alternatively, if the firms face the same unit cost, market integration decreases the willingness to collude when the demand for the foreign good is large with respect to the demand for the domestic good and it increases it in the opposite case. We have seen that this result occurs because differences in cost makes the low-cost firm increase its share of profit relative to the high-cost firm in the collusive equilibrium and decrease its relative gain from deviation. Hence, the allocation of profit between the two firms in the different regimes is key for our result to hold. Combined with the effects of a change in barriers to trade, our results indicate that, in a dynamic game, trade liberalization may easily have anti-competitive effects in at least one country and it always does in both countries when they are similar. These results cast doubts on the widely held view that market integration and trade liberalization ought to have strong pro-competitive effects.

These theoretical results are interesting in their own right but they are especially so given the widespread use of market integration in empirical studies. Our results suggest that

if dynamic games were imbedded in applied general equilibrium models of trade liberalization, there would be a social cost to collusion especially when countries are similar. Still,

this does not imply that, with dynamic games, trade liberalization has necessarily negative welfare effects since we have insisted only on the market structure effects of trade liberalization. However, it is uncertain whether these effects would significantly affect the welfare estimates of a trade liberalization exercise. Hence, this paper suggests that it would be important to have models of endogenous market structure, not only to be able to evaluate the social cost of tacit collusion but, more generally, to be able to decompose the effects of trade liberalization in imperfectly competitive environments into the traditional firm's entry/exit effect and firm's behavior effect.

Appendix

1. Proof of Lemma 3: $H(S_x; S_y, \theta, T)$ in (16) takes the following form:

$$\begin{aligned} H = & (-16 - 10\theta^2 + 8\theta^4)(S_x^2 + S_y^2) + (64\theta - 26\theta^3 - 2\theta^5)S_x S_y \\ & + (8 - 48\theta + 5\theta^2 + 19\theta^3 - 4\theta^4 + 2\theta^5)S_x T \\ & + (24 - 16\theta + 15\theta^2 + 6\theta^3 - 12\theta^4 + \theta^5)S_y T \\ & + (-8 + 16\theta - 5\theta^2 - 6\theta^3 + 4\theta^4 - \theta^5)T^2. \end{aligned}$$

It is easy to see that H is a second-degree polynomial which is concave in S_x . We want to show that the maximum of H is negative in the interval $S_x^A \leq S_x \leq S_x^B$ where S_x^A and S_x^B are the solutions to $r_x^I = 0$ and $r_y^S = 0$ respectively. The feasible solutions are

$$\begin{aligned} S_x^A &= \frac{2S_y\theta - T(\theta - 2)}{4} + \frac{(4 - \theta^2)(2S_y - T)}{4(8 + \theta^2)^{\frac{1}{2}}}; \\ S_x^B &= \frac{(S_y - T)[\theta(8 + \theta^2) - (4 - \theta^2)(8 + \theta^2)^{\frac{1}{2}}]}{8(\theta^2 - 1)}. \end{aligned} \tag{A.1}$$

To make sure that $S_x^A < S_x^B$, we compute the difference $S_x^B - S_x^A$. Solving for S_y such that $S_x^B - S_x^A = 0$, the unique root is

$$\hat{S}_y = -T \left[\frac{32 - 80\theta - 28\theta^2 - 2\theta^3 - 4\theta^4 + \theta^5 + 3(8 + \theta^2)^{\frac{1}{2}}(8 - \theta^4 + 2\theta^2)}{(4 - \theta^2)(24\theta + 3\theta^3 - (8 + \theta^2)^{\frac{1}{2}}(4 + 5\theta^2))} \right].$$

It can be checked that the polynomial $S_x^B - S_x^A$ is linearly increasing in S_y , so that $S_x^B - S_x^A > 0$ for $S_y > \hat{S}_y$.

Next, we want to determine the values of S_y corresponding to the maximum of H . Maximizing H with respect to S_x , we find $S_x^M = \frac{S_y\theta(-32+13\theta^2+\theta^4)+T(8-48\theta+5\theta^2+19\theta^3-4\theta^4+2\theta^5)}{2(-8-5\theta^2+4\theta^4)}$. The corresponding value of H is $H^M = \frac{(1+\theta)^2}{8(8+5\theta^2-4\theta^4)}G$, where

$$\begin{aligned} G = & S_y T(1536 - 3072\theta + 384\theta^2 + 2272\theta^3 - 936\theta^4 - 388\theta^5 + 212\theta^6 - 8\theta^8) \\ & + S_y^2(-1024 + 2048\theta - 256\theta^2 - 1536\theta^3 + 634\theta^4 + 288\theta^5 - 140\theta^6 - 8\theta^7 + 4\theta^8) \\ & + T^2(-488 + 1152\theta - 112\theta^2 - 848\theta^3 + 257\theta^4 + 124\theta^5 - 56\theta^6 + 8\theta^7 + 4\theta^8). \end{aligned}$$

It is apparent that the sign of H is the same as the sign of G . The coefficient of S_y^2 in G can be shown to be negative. Thus, solving $G = 0$ with respect to S_y , G is negative for any value of S_y outside its two roots. The only positive root to $G = 0$ is

$$\tilde{S}_y = -\frac{T}{D} \left[(8 - 8\theta - 3\theta^2 + 3\theta^3)(128 + 32\theta^2 - 8\theta^3 - 94\theta^4 - 5\theta^5 + 24\theta^6 + 4\theta^7)^{\frac{1}{2}} - (1536 - 3072\theta + 384\theta^2 + 2272\theta^3 - 936\theta^4 - 388\theta^5 + 212\theta^6 - 8\theta^8) \right]$$

where $D = -256 + 512\theta - 64\theta^2 - 384\theta^3 + 156\theta^4 + 72\theta^5 - 35\theta^6 - 2\theta^7 + \theta^8$.

The last step is to compare $\hat{S}_y$ and $\tilde{S}_y$. Computing $\hat{S}_y - \tilde{S}_y$, it is easy but cumbersome to show that the coefficient in T is always positive. Hence, $\hat{S}_y - \tilde{S}_y > 0$. Since S_y must be greater than $\hat{S}_y$ for all feasible values of S_y ($S_x^A < S_x^B$) and $H < 0$ for $S_y > \tilde{S}_y$, then $H < 0$ for $S_x^A < S_x < S_x^B$.

2. Proof of Lemma 4: We prove here $r_y^I > r_y^S \Leftrightarrow S_x > S_y - \frac{T}{2}$ only.¹¹ Denote by D the subset of the feasible values of S_x , such that $D \equiv \{S_x : S_y - \frac{T}{2} \leq S_x \leq S_x^B\}$, where S_x^B corresponds to $r_y^S = 0$. By direct calculations,

$$r_y^I - r_y^S \equiv F(S_x; S_y, T, \theta) = \frac{4T(1 - \theta^2)(S_x + S_y - T)N(S_x; S_y, T, \theta)}{(2S_x - T - 2\theta S_y + \theta T)^2(S_x - \theta S_y + \theta T)^2(4 - \theta^2)^2}, \quad (A.2)$$

where

$$\begin{aligned} N(S_x; S_y, T, \theta) = & (-32\theta + 14\theta^3)S_x^2 - 2\theta(2 - \theta^2)(8 + \theta^2)S_y^2 + 4(8 + 5\theta^2 - 4\theta^4)S_xS_y \\ & (-24 + 16\theta - 15\theta^2 - 7\theta^3 + 12\theta^4)TS_x \\ & + (-8 + 48\theta - 5\theta^2 - 18\theta^3 + 4\theta^4 - 3\theta^5)TS_y \\ & + (8 - 16\theta + 5\theta^2 + 6\theta^3 - 4\theta^4 - \theta^5)T^2. \end{aligned} \quad (A.3)$$

Since the sign of F is the same as the sign of N , we want to show that $N > 0$ over the domain D . To determine the sign of N , we show first $N > 0$ at $S_x = S_y - \frac{T}{2}$:

$$\begin{aligned} N(S_y - \frac{T}{2}) = & (64 - 128\theta + 40\theta^2 + 52\theta^3 - 32\theta^4 + 4\theta^5)S_y^2 \\ & + (-96 + 192\theta - 60\theta^2 - 78\theta^3 + 48\theta^4 - 6\theta^5)TS_y \\ & + (40 - 64\theta + 25\theta^2 + 26\theta^3 - 20\theta^4 + 2\theta^5)T^2. \end{aligned} \quad (A.4)$$

¹¹ The proof of the second part is available upon request from the authors.

The discriminant of (A.4) is equal to $T^2(1-\theta^2)^2(-256+192\theta^2-36\theta^4+\theta^6)$, which is negative for $0 < \theta < 1$. Hence, $N(S_y - \frac{T}{2})$ has always the same sign as the coefficient of S_y^2 , which can easily be shown to be positive.

Next, we show that $N > 0$ at $S_x = S_x^B$. Evaluating $N(S_x^B)$ using (A.1), it is a first-degree polynomial in S_y of the form $N(S_x^B) = a(\theta)S_y + b(\theta)T$, where $a(\theta) = -1024\theta + 512\theta^2 + 576\theta^3 - 288\theta^4 - 24\theta^5 + 12\theta^6 - 14\theta^7 + 7\theta^8 + (8+\theta^2)^{\frac{1}{2}}(128-64\theta+208\theta^2-104\theta^3-224\theta^4+112\theta^5+50\theta^6-25\theta^7) > 0$ for $0 \leq \theta \leq 1$. Since $S_y > T$ and $a(\theta) > 0$, $N(S_x^B) > (a(\theta) + b(\theta))T$. This last expression is positive since $a(\theta) + b(\theta) = 2(\theta-1)(1+\theta)^2[32+48\theta-36\theta^2-34\theta^3+13\theta^4+4\theta^5+(8+\theta)^{\frac{1}{2}}(-16-8\theta+14\theta^2+5\theta^3-4\theta^4)] > 0$ for $0 \leq \theta \leq 1$.

The last step is to show that $\frac{\partial^2 N(S_x)}{\partial S_x^2} < 0$ over the interval D . Using (A.3), $\frac{\partial^2 N(S_x)}{\partial S_x^2} = -64\theta + 28\theta^3$ which is always negative over D . Since $N > 0$ at the two extreme points of the domain D and it is concave over D , we conclude that $N(\cdot)$, and thus $F(\cdot)$, must be positive over the domain D .

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Figure 1: Critical Rates, and Market Integration

Figure 2: Critical Rates and Trade Liberalization

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