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Market Segmentation, Market Integration and Tacit Collusion*

Constantin Colonescu
Nicolas Schmitt

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LR: Constantin Colonescu and Nicolas Schmitt

Abstract
Moving from market segmentation to market integration (firms cannot discriminate among markets) is shown to have often anti-competitive effects in an infinitely repeated Cournot game. In particular, market integration between two countries lead both of them to experience anti-competitive effects when product markets are similar. The same conclusion holds when trade liberalization is modeled as a decrease in bilateral trade barriers followed by moving from market segmentation to market integration. The analysis also predicts that a less efficient country (like a country in transition) enjoys pro-competitive effects from market integration.

* Colonescu: EERC, Malaya Pirogovskaya 18, Suite 101, 119435 Moscow, Russia. Tel: 007-95-248-2728, Fax: 007-95-232-3349, E-mail:colonescu@eerc.ru. Schmitt: Department of Economics, Simon Fraser University, Burnaby, BC V5A 1S6, Canada. Tel: 604-291-4582, Fax: 604-291-5944, E-mail: schmitt@sfu.ca. We wish to thank Jean Mercenier and two anonymous referees for very useful comments and suggestions. This paper was written in part when Schmitt was visiting the Center of Economic Studies (CES) at the University of Munich. Its hospitality is gratefully acknowledged. We also thank respectively the 1996 Phare ACE Programme and the Social Sciences and Humanities Research Council of Canada for financial support.

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Address of Contact Author: Schmitt, Department of Economics, Simon Fraser University, Burnaby, BC V5A 1S6, Canada. Tel: 604-291-4582, Fax: 604-291-5944, E-mail: schmitt@sfu.ca.

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 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 pro-competitive effects. The reason is straightforward. 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. It then naturally sets 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 from the fact that a domestic firm has generally a larger share of its home market than the foreign firm. This pro-competitive effect however is based on a static model of competition where firms' rivalry (Cournot, Bertrand, etc) is given.[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. We show below that, in such an environment, moving from market segmentation to market integration is often accompanied by anti-competitive effects since, in several situations, tacit collusion is easier to sustain with market integration than with market segmentation. In particular, we show that switching from market segmentation to market integration between two countries leads both of them to experience anti-competitive effects when product markets are similar. We also show that the same qualitative results hold 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 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 keep them constant when we analyze the switch from market segmentation to market integration. This paper also differs from Pinto (1986) and Lommerud and Sorgard (2001) who consider trade liberalization when the collusive equilibrium is without trade.

This paper provides a better understanding of the circumstances under which anti-competitive behavior may arise as a result of market integration and deregulation. This is important for at least two reasons. First, there exist several examples of such anti-competitive behavior. In 1998, the EU Competition Authority imposed an Ecu70m fine on ABB for playing a key role in organizing the European cartel in the insulated steel pipes used in heating district networks. This cartel emerged as a result of liberalization in the EU procurement market (EIU, 1998). The EU has long exempted car makers from competition rules. Still, in 1998, VW was hit with a large penalty for price fixing after it tried to prevent lower-priced Italian dealers from selling cars to Austrian and German customers, and thus trying to keep the markets segmented (Business Week, 1999). In the airline industry, there are now 579 bilateral partnerships involving 220 airlines across the world, an increase of nearly 50% over the past four years. There is little doubt that these alliances have taken place in response to deregulation in this industry (Economist, 2000). Other recent examples have emerged in the Italian automobile insurance industry and in the book industry in Germany and Austria. Second, the switch from market segmentation to market integration has been a useful tool to evaluate empirically the effects of the European move toward a unique market (Europe-1992) because it captures the effects of eliminating barriers preventing consumers to arbitrage products across markets (see Burniaux and Waelbroeck, 1992; Gasiorek, Smith and Venables, 1991; Mercenier, 1995; Smith and Venables, 1988). These studies generally find that Europe-1992 leads to pro-competitive effects, sometimes quite significant ones. All these papers however use a static model of firms rivalry and thus assume that firms have the same behavior before and after integration. Although considerable doubts have been expressed both about the hypothesis itself [2] and about some of the estimates of the welfare gains from the 1992 experiment,[3] it remains a popular tool. This paper suggests that empirical studies should concentrate their attention on firm's behavior to avoid a possible over-estimation of the pro-competitive effects of market integration.

2. The Model

The basic model is a standard Cournot duopoly model with two countries generalized to allow for a continuum of degrees of product differentiation. Consider two identical countries (D and F) with one firm in each country producing a single differentiated product. The barrier to trade between the two countries is low enough so that both firms have a positive share of both markets and the Cournot equilibrium produces reciprocal dumping (Brander and Krugman, 1983). 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 demands in market D are given by

$$p_x = a_x - (x + \theta y); \qquad p_y = a_y - (y + \theta x), \qquad 0 \le \theta \le 1 \tag{1}$$

where θ measures the degree of differentiation between the two products (there is no substitution between the products when $\theta = 0$ and they become better substitutes as θ increases).[4] 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 unit cost is c_i so that the unit cost for domestic sales is c_i and that 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, distribution) or a specific barrier to trade set by governments (such as a tariff). By assumption, it is the same in both directions. Given these assumptions, the profit function for each firm is

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

and

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

where $S_i = a_i - c_i$ $(i = x, y)$.

Firms are assumed to play an infinitely repeated game.[5] Friedman (1971) shows that a collusive outcome can be achieved without communication among players provided that threats are credible. A common and simple 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 (see Section 5 for a discussion on this point). 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. Firm i chooses to produce the target output if its one-period gain from deviating is smaller than its future discounted punishment; that is, if

$$(\Pi_i^d - \Pi_i^c) - \frac{(\Pi_i^c - \Pi_i^n)}{r} \leq 0, \qquad i = x, y, \tag{4}$$

where r is the relevant discount rate. It is easy to check that (4) can be written as

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

where r_i is firm i maximum discount rate 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 $0 \leq r \leq \text{Min}[r_i]$ $(i = x, y)$. This lowest critical rate splits the feasible values for r in 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.[6] These critical rates change because, for every firm, market integration changes the balance between deviating and colluding. Importantly, this balance is affected differently for a domestic and for a foreign firm in a given country. The contribution of this paper is thus to investigate how market integration affects this balance. To do so we start by deriving the critical rates when firms can segment (or discriminate between) countries. We concentrate our attention on country D.

Using (2) and (3), it is easy to show that the Cournot-Nash equilibrium quantities are

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

and the one-period profits in country D are

$$\pi_x^n = x_n^2; \qquad \pi_y^n = y_n^2. \tag{6}$$

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

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

and the target profits in D are

$$\pi_x^c = \frac{S_x}{2} x_c; \qquad \pi_y^c = \frac{(S_y - t)}{2} y_c. \tag{7}$$

Suppose finally that one firm deviates from the target output while the rival firm does not. The optimal output of the deviating firm (Firm X and Firm Y, respectively) is

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

and the profit of the deviating firm in D is

$$\pi_x^d = x_d^2; \qquad \pi_y^d = y_d^2. \tag{8}$$

The traditional definition of market segmentation is that each firm perceives both countries as separate entities where separate decisions can be made. If this works well in a static model, collusion can be over one or both markets in a dynamic game. In particular, as Bernheim and Whinston (1990) shows, international trade may increase the scope for tacit collusion since punishment may be carried out in several markets. In this paper, we therefore assume that, when markets are segmented, both firms understand this possibility and act accordingly in one or in both countries in order to do the best they can. It turns out that firms will take advantage of trade to enforce international collusion but will enforce country-specific collusion when international collusion is not feasible.

To see this, suppose first that collusion is country specific. Using (5) to (8), the critical rates in D can be derived. We denote them as r_x^S and r_y^S corresponding respectively to Firm X's and Firm Y's critical rate (superscript S stands for market segmentation).[7] Similarly, $r_{x^*}^S$ and $r_{y^*}^S$ are the two critical rates in country F corresponding respectively to Firms X and Y.[8] Suppose now that firms consider collusion over both markets so that when they deviate or punish their rival, they do so in both markets. To find the relevant critical rates in this case, production in both countries under collusion, Cournot-Nash and deviation must be taken into account. Thus, there is now just one critical rate per firm. To find it for Firm X, use (5) with $\Pi_x^c = x_c(S_x/2) + x_c^*(S_x - t)/2$, $\Pi_x^n = x_n^2 + (x_n^*)^2$ and $\Pi_x^d = x_d^2 + (x_d^*)^2$ and with the quantities found above (similarly for Firm Y). We denote these two critical rates consistent with international collusion in market segmentation as $\bar{r}_x^S$ and $\bar{r}_y^S$. Since collusion occurs below the lowest critical rate, Lemma 1 compares these rates in market segmentation when collusion is country specific and when it is international.

Lemma 1:
(i) Given country-specific collusion, Firm X's critical rate in country D (r_x^S) is lower or equal to Firm Y's critical rate (r_y^S) when $S_x \leq S_y - t$ and it is greater when $S_x > S_y - t$. Firm X's critical rate in country F ($r_{x^*}^S$) is greater or equal to Firm Y's critical rate ($r_{y^*}^S$) when $S_x \geq S_y + t$ and it is lower when $S_x < S_y + t$.
(ii) Given international collusion, Firm X's critical rate ($\bar{r}_x^S$) is lower or equal to Firm Y's critical rate ($\bar{r}_y^S$) when $S_x \leq S_y$ and it is higher when $S_x > S_y$.
(iii) If country-specific collusion is sustainable in both countries, international collusion is also sustainable. However, unless $t = 0$, the reverse is not necessarily true.

Proof: (i) Since the model is a generalization of Fung (1992) (allowing for different product market sizes), the first part of (i) is identical to his Proposition 1. By symmetry, the result extends to country F as 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 $S_y = S_x - t$. (ii) The only difference with respect to (i) is that firms are symmetric for $S_x = S_y$ since they now make decisions with respect to both countries and firms are identical when $S_x = S_y$. (iii) See Appendix 1. QED

Lemma 1 indicates that, when the demands for both goods are identical ($a_x = a_y$), the relevant critical rate determining collusion is the rate associated with the high-cost firm whether collusion is national or international. Indeed, $S_x \geq S_y - t$ implies $c_x \leq c_y + t$ in which case r_y^S, corresponding to the foreign firm, is the binding rate below which collusion is feasible. Similarly, if firms face the same cost of production ($c_x = c_y$), the relevant critical rate is associated with the firm facing the smaller residual demand ($S_x \geq S_y - t$ implies $a_x \geq a_y - t$). Trade costs are not relevant under international collusion since firms, always acting with respect to both markets, are identical when $S_x = S_y$. The last part of Lemma 1 shows that multi-market contacts improve the scope for tacit collusion. Using (5), Figure 1 illustrates Lemma 1 in (S_x, r_i^j) space for given values of S_y, θ and t. These curves exhibit two important features: with Lemma 1 (i), $r_y^S = r_x^S$ at $S_x = S_y - t$ (point Q) and with Lemma 1(ii), $\bar{r}_y^S = \bar{r}_x^S$ at $S_x = S_y$ (point T).

When collusion is country specific, it is sustainable in both markets for $r < \text{Min}[r_i^S, r_{i*}^S]$ $(i = x, y)$ corresponding to the triangle with Z as its top and the S_x-axis as its base. When collusion is international, it is sustainable for $r < \text{Min}[\bar{r}_x^S, \bar{r}_y^S]$ corresponding to the triangle with T as its top and the S_x-axis as its base. Since this last area contains the first, multi-market contacts always improve the scope for international collusion with respect to country-specific collusion.[9] When tacit collusion over both countries is not sustainable, there is still scope for collusion in a single country as long as barriers to trade are positive. Firms clearly prefers such outcome rather than no collusion at all. Areas with country-specific collusion are the two cross-hatched areas (in country D below Q and in country F below Q'). Outside these areas, collusion is not sustainable as there is always at least one firm prefering to deviate in each market. We now consider the equilibrium under market integration.

3. Market Integration

With market integration, each firm chooses a quantity allocation between the two countries preventing arbitrage, and thus a quantity allocation generating a price difference in the two countries equal to the barrier to trade t. Formally, Firm X maximizes (2) by choosing x and x^* subject to the arbitrage constraint $p_x(x, y) = p_x^*(x^*, y^*) - t$. Similarly, Firm Y maximizes (3) with respect to y and y^* subject to the constraint $p_y(x, y) - t = p_y^*(x^*, y^*)$. Using the demands faced by both firms in each country, the arbitrage constraints for Firm X and Y can be written, respectively, as

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

where $k = c, d, n$ stands for collusion, deviation and Cournot-Nash, respectively.

These constraints are important since they imply that collusion only takes place over both countries with market integration. To see this, suppose it is not the case. Suppose in particular that Firm X deviates in market D only. It does so by choosing x_d maximizing its profit $\Pi_x(x_d; x_c^*, y_c, y_c^*)$. But market integration imposes a constraint on the quantities chosen by Firm X. Indeed, with collusion, market integration imposes $x_c = x_c^* + t - \theta(y_c - y_c^*)$ (see (9)). Since none of the elements on the right-hand side of this constraint changes when

Firm X deviates in D only, necessarily $x_d = x_c$: Firm X's deviating output in D alone is the same as when it colludes. In an integrated market, Firm X has thus no incentive to deviate in one country alone when its arbitrage constraint is binding. It has, however, an incentive to deviate in both markets since it can find 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 in both markets. Since the same is true concerning punishment, collusion always takes place over both markets when they are integrated.

Using the same infinitely repeated game as in the previous section, the Cournot-Nash equilibrium in D is now characterized by[10]

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

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

$$\Pi_x^n = \frac{1}{2}(x_n + x_n^*)^2; \qquad \Pi_y^n = \frac{1}{2}(y_n + y_n^*)^2. \tag{10}$$

If both firms maximize joint profit with respect to x and y under the constraints (9), they produce in market D:

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

The firm's profits are then

$$\Pi_x^c = \frac{1}{4}(2S_x - t)(x_c + x_c^*); \qquad \Pi_y^c = \frac{1}{4}(2S_y - t)(y_c + y_c^*). \tag{11}$$

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

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

Firm's profits when deviating are:

$$\Pi_x^d = \frac{1}{2}(x_d + x_d^*)^2; \qquad \Pi_y^d = \frac{1}{2}(y_d + y_d^*)^2. \tag{12}$$

One can define two critical rates in market integration, r_x^I and r_y^I for Firm X and Firm Y, respectively. They are found by substituting (10), (11) and (12) in (5).

Observe that (10), (11) and (12) are not valid for all parameter values. In particular, each firm may choose to sell in its domestic market only especially if t is high. This may be the case as market integration imposes a constraint on the choice of outputs lowering profit with respect to market segmentation. A firm can avoid this constraint by selling in its most profitable market only. In the sequel, we assume that t is always low enough for bilateral trade to occur whether or not firms collude. In addition, we require outputs to be non-negative as well as $t \leq 2S_x$ and $t \leq 2S_y$ (see (11)).

Since tacit collusion with market integration requires $r \leq \text{Min}[r_x^I, r_y^I]$, our task is to determine which rate is lower under which circumstances. Comparing r_x^I and r_y^I,

Lemma 2: *Given market integration, Firm X's critical rate (r_x^I) is greater or equal to Firm Y's critical rate (r_y^I) when $S_x \geq S_y$ and it is lower when $S_x < S_y$.*

Proof: See Appendix 2.

The fact that $r_x^I = r_y^I$ when $S_x = S_y$ (point P in Figure 1) is not surprising: the two critical rates must be the same when the firms (or the demands) are identical (barriers to trade do not matter as firms always act with respect to both markets). Importantly, when $S_x = S_y$, the critical rate is $4(1+\theta)/(2+\theta)^2$ which is independent of S_y and t and is equal to the critical rate when firms are symmetric under market segmentation and market-specific collusion (point Q and Q'). Since $S_i = a_i - c_i$, Lemma 2 says that the high-cost firm (when $a_x = a_y$) is again the relevant firm determining the range over which collusion is sustainable in the integrated market. Alternatively, when $c_x = c_y$, the firm facing the smaller market also determines the range over which collusion is sustainable.

The proof of Lemma 2 provides clues for the interpretation of our results. Since the sign of $((\Pi_x^c - \Pi_x^n) - (\Pi_y^c - \Pi_y^n))$ is the same as the sign of $S_x - S_y$, the high-cost firm (or 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 $((\Pi_x^d - \Pi_x^c) - (\Pi_y^d - \Pi_y^c))$ is the negative of the sign of $S_x - S_y$, the gain from deviating is always higher for the high-cost firm. This is why the high-cost firm (or the firm with the smaller product market) is always the critical one determining tacit collusion.

4. Market Segmentation versus Market Integration

We now compare market segmentation and market integration while keeping barriers to trade constant. We first consider the market segmentation case with tacit collusion over both countries and we ask whether moving to market integration increases or decreases the scope for such collusion. We then ask the same question when market segmentation only allows tacit collusion in a single country.

To assess 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. When collusion is international, the comparison is straightforward. The result is summarized in Proposition 1.

Proposition 1: *When product markets are similar (i.e., when $S_x^M < S_x < S_x^N$), moving from market segmentation to market integration under international tacit collusion has anti-competitive effects in both countries. When product markets are sufficiently different (i.e., $S_x < S_x^M$ or $S_x > S_x^N$), moving from market segmentation to market integration under international tacit collusion has pro-competitive effects in both countries.*

Proof: First, from Lemma 1 (ii), $\bar{r}_x^S$ is the minimum critical rate for $S_x < S_y$ under market segmentation and international collusion and, from Lemma 2, r_x^I is the minimum rate over the same range under market integration. Second, for $S_x = S_y$, $\bar{r}_x^S < r_x^I$ when $t > 0$ so that the same inequality holds for arbitrary small differences between S_x and S_y. Third, $r_x^I = \bar{r}_x^S = 4(1-\theta)/(2-\theta)^2$ for $S_x = S_x^M$ (point M in Figure 1) and there can only be one intersection between the two schedules. Hence, r_x^I necessarily crosses r_x^S from above as S_x decreases implying that $r_x^I \leq \bar{r}_x^S$ for $S_x \leq S_x^M$ and $r_x^I > \bar{r}_x^S$ for $S_x^M < S_x \leq S_y$. A similar reasoning holds for the range $S_x > S_y$. QED

Thus, when tacit collusion under market segmentation can be enforced over both countries, either both countries have pro-competitive effects from moving to market integration or they both face anti-competitive effects from such a move. The fact that, when product markets are identical ($S_x = S_y$), collusion under market integration can be supported over a wider range of discount rates comes from the fact that the constraint associated with market integration limits the incentive to deviate of the foreign firm who, as we saw above, is usually the one determining the scope for collusion. When firms (or markets) are sufficiently different, the ability to deviate and to punish in both countries under market segmentation sufficiently enhances the ability to collude so as to make the move to market integration a pro-competitive experience for both countries.

We have established in the previous Section that, when tacit collusion cannot be enforced over both countries under market segmentation, firms may still have an incentive to collude in a single country. We thus need to investigate the effects of moving to market integration when collusion is initially feasible in country D only. We first establish a partial result. Define S_x^A and S_x^B as the limits of the feasible range of S_x in country D corresponding respectively to $r_x^I = 0$ and $r_y^S = 0$.[11]

Lemma 3:
(i) Firm X's critical rate in market integration (r_x^I) is lower than Firm Y's critical rate in market segmentation (r_y^S) when $S_x^A \leq S_x < S_y - \frac{t}{2}$. Firm X's critical rate in market integration (r_x^I) is greater than Firm Y's critical rate in market segmentation (r_y^S) when $S_y - \frac{t}{2} < S_x \leq S_x^B$;
(ii) Firm Y's critical rate in market integration (r_y^I) is greater than its critical rate in market segmentation (r_y^S) when $S_x > S_y - \frac{t}{2}$. Similarly, Firm X's critical rate in market segmentation (r_x^S) is greater than its critical rate in market integration (r_x^I) when $S_x < S_y - \frac{t}{2}$.

Proof: See Appendix 3 and 4.

Using Lemmas 1, 2 and 3, we can now determine the relevant lowest critical rates r_i^j ($i = x, y$; $j = S, I$) over the entire feasible range of S_x and thus whether market integration is pro- or anti-competitive.

Proposition 2: *When tacit collusion with market segmentation is feasible in country D only, 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 $S_x > S_y - \frac{t}{2}$.*

Proof: The feasible range can be divided into two critical 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(i)) and $r_x^I < r_x^S$ (Lemma 3(ii)). Hence, $r_x^I = \text{Min}[r_x^S, r_y^S, r_x^I, r_y^I]$ over this range.
(ii) $S_y - \frac{t}{2} \leq S_x \leq S_x^B$: we know $r_y^S < r_x^S$ (Lemma 1(i)), $r_y^S < r_x^I$ (Lemma 3(i)) and $r_y^S < r_y^I$ (Lemma 3(ii)). Hence, $r_y^S = \text{Min}[r_x^S, r_y^S, r_x^I, r_y^I]$ over this range. QED

All these results can be checked with Figure 1. The first part of Proposition 2 holds because, when $S_x < S_y - \frac{t}{2}$, r_x^I is the relevant critical rate with market integration as this rate is lower than any other relevant critical rates in D. Hence, the range of relevant rates over which tacit collusion is a subgame perfect equilibrium must shrink when market integration is introduced implying less scope to sustain collusion in D. 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. Given the definition of S_i, $S_x < S_y - \frac{t}{2}$ indicates either that Firm X (the domestic firm) is a high-cost firm with respect to Firm Y (the foreign firm), that the market for X is smaller than the market for Y, or a combination of both. When $S_x > S_y - \frac{t}{2}$, it is Firm Y which is the high-cost firm or which faces the smaller market.

Similar conclusions hold for country F. Indeed, all the results for country D extends to country F by simply substituting S_x and S_y. Hence,

Proposition 3: *When tacit collusion with market segmentation is feasible in country F only, 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 $S_x < S_y + \frac{t}{2}$.*

It is apparent that the results are essentially the same as when market segmentation involves international collusion since similarity of product markets favors anti-competitive effects. With market segmentation, the foreign firm, by absorbing 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 since it pushes firms to be more specialized across markets. In a given country, this makes the foreign firm's incentive to deviate stronger than the domestic firm's. Integration, by forcing collusion to be over both countries, places the two firms on the same level playing field since each firm gets an equal share of the overall profit generated on both markets. Thus, the incentive to deviate decreases, especially for the foreign firm making collusion easier to enforce in two integrated markets than in two segmented markets.

Two additional remarks are in order. First, when tacit collusion is feasible in a single country under market segmentation, moving to market integration may involve only pro-competitive effects for this country. For this to occur, it suffices that $S_x^M \geq S_y - \frac{t}{2}$ in country D ($S_x^N \leq S_y + \frac{t}{2}$ in country F). Second, Propositions 2 and 3 imply that, moving from market segmentation to market integration can lead to anti-competitive effects in both countries but cannot lead to pro-competitive effects in both countries. Indeed we have just established that the country with tacit collusion under market segmentation either faces pro- or anti-competitive effects from market integration. The other country, however, always faces anti-competitive effects from market integration since market integration involves some tacit collusion while market segmentation does not.

This simple model produces a rich set of outcomes since moving from market segmentation to market integration can produce pro- or anti-competitive effects in one or in both countries depending on whether collusion in the initial equilibrium is national or international.

5. Trade Liberalization

Since trade liberalization has often been modeled as the cumulative effect of lowering barriers to trade and switching from market segmentation to market integration, we now consider this case.[12] The case of a *marginal change* in barriers to trade followed by market integration is easy to analyze. In this case, Propositions 1 to 3 necessarily extend to trade liberalization since the discrete effect of switching from market segmentation to market integration always dominates any marginal effect from lowering t. A discrete change in t is thus more interesting and more realistic. Suppose then that t decreases from a 'high' (t_h) to a 'low' (t_l) level.

Irrespective of the type of collusion in market segmentation, a lower barrier to trade decreases the difference between the critical rates under market segmentation and under market integration. This means that a lower barrier always decreases the size of the pro- and the anti-competitive effects associated with market integration. Indeed, as t converges to zero, the critical rates under market segmentation converge to those under market integration. We now show the following Proposition:

Proposition 4:
Whether collusion under market segmentation is national or international, trade liberalization increases the range of S_x within which anti-competitive effects arise with respect to market integration alone.

Proof: Consider international collusion first. From Proposition 1, the lower limit of S_x separating pro- and anti-competitive effects for a given t is determined by $\bar{r}_x^S = r_x^I$ and it occurs at $S_x^M = (2S_y(8+8\theta-3\theta^2-4\theta^3)+t\theta^3(1-\theta))/(16+16\theta-6\theta^2+6\theta^3+2\theta^4)$. S_x^M is decreasing with t so that $S_x^M(t_l) < S_x^M(t_h)$. With trade liberalization, the lower limit of S_x separating pro- and anti-competitive effects is determined by $\bar{r}_x^S(t_h) = r_x^I(t_l)$ denoted $h(S_y, t_h, t_l)$. Since lower t shifts up the relevant schedules and they are all increasing in S_x (see Figure 1), $h(S_y, t_h, t_l) < S_x^M(t_l) < S_x^M(t_h)$. The same reasoning shows that the upper limit, denoted $g(S_y, t_h, t_l)$, is such that $g(S_y, t_h, t_l) > S_x^N(t_l) > S_x^N(t_h)$. Consider now national collusion. The lower value of S_x separating pro- and anti-competitive effects is denoted $H(S_y, t_l, t_h)$ and is such that $r_y^S(t_h) = r_x^I(t_l)$, while the upper limit is denoted $G(S_y, t_l, t_h)$ such that $r_{x^*}^S(t_h) = r_{y^*}^I(t_l)$. Using (5) and the relevant equilibrium profits, $H(S_y, t_l, t_h) = \frac{1}{4}[t_l + (16S_y^2 - 16S_y t_h - 8S_y t_l + 8t_h t_l + t_l^2)^{\frac{1}{2}}] \leq S_y - \frac{t}{2}$ for $t_h \geq t_l$. Similarly, $G(S_y, t_l, t_h) = \frac{1}{4}[2t_h + t_l + (16S_y^2 - 8S_y t_l + (t_l - 2t_h)^2)^{\frac{1}{2}}] \geq S_y + \frac{t}{2}$ for $t_h \geq t_l$. QED

Proposition 4 indicates that, even when barriers to trade decrease significantly, the combination of tariff liberalization and market integration increases the scope for collusion in two similar countries. In this regard, it is interesting to note that antitrust authorities in Europe have recently been much tougher with cartels and other firm's anti-competitive behavior especially with those taking advantage of market integration. The cases of ABB and of VW mentioned in Introduction illustrate this point. They also indicate that antitrust authorities are today more vigilant precisely because they do not want the potential gains from trade liberalization and market integration to be captured by firms through enhanced anti-competitive behavior as predicted by this proposition. Our results can also be used to predict the effects of economic integration on imperfectly competitive industries for countries in transition (such as Eastern Europe). In this model, this can be captured by one of two elements: the demand for the foreign good (i.e., the EU good or good Y) is higher than the demand for the domestic product ($a_y > a_x$),[13] or the domestic firm producing good X has a higher unit cost than the foreign firm ($c_x > c_y$). Either assumption leads to the inequality $S_y > S_x$. If the difference is sufficiently large, our results indicate that market integration is pro-competitive in the country in transition (Country D), while it has the same or the opposite effect in the EU (Country F).

We conclude this Section by briefly discussing extensions and the normative aspect of our results. Adding tacit collusion into the picture implies that trade liberalization has three distinct (partial equilibrium) welfare effects. The first effect is the standard positive welfare effect of lowering barriers to trade. The second one is due to the (static) switch from market segmentation to market integration with given firm's behavior. As shown by Anderson, Schmitt and Thisse (1995) in an equivalent context, this welfare effect is negative in the case of two identical firms when t is a tariff and positive when t is a resource cost (see also Haaland and Wooton (1992)). Tacit collusion adds a third effect which is negative in the case of two identical firms in so far as the enhanced ability to collude found in Proposition 1 implies a more restrictive output (the standard deadweight loss). The net effect can, of course, be positive or negative.

The analysis can be extended in several directions. We have used a quantity game. It can be seen as a game in the choice of scale that determines the firm's cost function and thus the conditions of price competition (see Tirole, 1988). One of its main characteristics is to have a negative cross-partial derivative of a firm's profit with respect to the actions of that firm and its rival (strategic substitutes). This arises in several situations including price games in the presence of capacity constraints (Kreps and Scheinkman, 1983), or in the presence of cost-reducing investments. Although a complete analysis of the Bertrand case is beyond the scope of this paper, Anderson, Schmitt and Thisse (1995) shows that the comparison between international market segmentation and the absence of such segmentation leads to the same qualitative outcome in a Bertrand and in a Cournot game. This is not very surprising as a Bertrand game affects the sensitivity of the firm's profit to changes in barriers to trade and market integration with respect to a Cournot game but not the direction in which the firm's profit changes. One could also relax the assumption about constant marginal costs. Fung (1992) shows that increasing marginal costs change the condition under which the pro- and anti-competitive effects operate but does not affect the main intuition about his results.

Finally, we consider briefly a different punishment strategy. In particular, we consider the case of Abreu (1986)'s maximal punishment where the punishment strategy, instead of lasting forever as in the above analysis, lasts for a limited number of periods. In this case, each firm faces two incentive constraints, one for the collusive phase and the other for the punishment phase of the game as punishment also requires an implicit agreement. Although, in general, this makes the analysis more cumbersome (there is now an additional critical rate for each firm and, in the case of market segmentation with specific-market collusion, for each market), we consider the simple case where the punishment phase lasts for a single period (unless firms deviate during this phase) and where punishment entails outputs such that firm's profit is zero.[14] In this case, Propositions 1 to 3 hold as well whether collusion in market segmentation is market specific or multi-market. Interestingly, the binding critical rates are always those associated with the punishment phase. This implies that, ignoring the level of the critical rates, Figure 1 remains essentially valid with this type of punishment provided that, for country D, r_y^S, r_y^I, r_x^S, r_x^I, $\bar{r}_x^S$ and $\bar{r}_y^S$ are re-labeled respectively as r_x^{Sp}, r_x^{Ip}, r_y^{Sp}, r_y^{Ip}, $\bar{r}_y^{Sp}$ and $\bar{r}_x^{Sp}$.[15] Of course, this does not prove the robustness of our results but that they hold for at least one alternative punishment strategy.

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, market integration has anti-competitive effects in both markets when they are similar whether collusion is national or international in the initial equilibrium. It is only when product markets (or firms) are sufficiently different that market integration has pro-competitive effects in one or in both markets. 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 for some participants 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 necessarily ought to have strong pro-competitive effects. Competition policy should indeed be stronger, not weaker, with market integration, especially when countries are similar.

These theoretical results are especially interesting given recent examples of anti-competitive behavior sanctioned by the EU Commission which for many of them seem to be associated with European integration and deregulation. The fact that antitrust authorities are more active in Europe today suggests that they may be aware of the anti-competitive effects of market integration found in this paper. These results are also interesting given the widespread use of the market integration assumption in empirical studies. They suggest that if dynamic games were an integral part of an empirical model of trade liberalization, there would be a social cost to collusion especially when countries are similar. Of course, this does not imply that, with dynamic games, trade liberalization has overall negative welfare effects. Still, this suggests that it would be important to develop models of endogenous market structure, not only to be able to evaluate the possible social cost of tacit collusion associated with trade liberalization but to be able to decompose the effects of trade liberalization into the firm's entry/exit effect and the firm's behavior effect.

Appendix

1. Proof of Lemma 1(iii): $\bar{r}_y^S - r_y^S = \frac{4t(1-\theta^2)(S_x+S_y-t)N(S_x,S_y)}{(4-\theta^2)^2(S_x-\theta S_y+t\theta)^2 n(S_x,S_y)}$ with $N(S_x, S_y) = S_x^2\theta(-16+7\theta^2) + S_y^2\theta(-16+6\theta^2+\theta^4) - tS_y(8-16\theta+5\theta^2+6\theta^3-4\theta^4+\theta^5) + tS_x(-8+16\theta-5\theta^2-7\theta^3+4\theta^4) + S_xS_y(16+10\theta^2-8\theta^4) + t^2(8+5\theta^2-4\theta^4)$ and $n(S_x, S_y) = 2(S_x^2+\theta^2S_y^2) - 4S_xS_y\theta + 2t(1-\theta)(\theta S_y - S_x) + t^2(1+\theta^2)$. Over the relevant range ($S_x \geq S_y$), we want to show that $\bar{r}_y^S - r_y^S > 0$ when $t > 0$ for multimarket contacts to help sustaining collusion: 1) it is easy to check that every term of $(\bar{r}_y^S - r_y^S)$ is positive for $S_x = S_y$ so that T is above Z as illustrated in Figure 1. 2) It is possible but cumbersome to show that $\bar{r}_y^S > 0$ at $S_x > S_y$ such that $r_y^S = 0$. 3) The solution to the polynomial n has no real solution and is always positive, while the solution to N shows there can only be one intersection between $\bar{r}_y^S$ and r_y^S for $S_x \geq S_y$. Because of 2), this intersection cannot be within the relevant range. Similarly for the relevant range $S_x \leq S_y$. QED

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

$$r_x^I - r_y^I = \left(\frac{\Pi_x^c - \Pi_x^n}{\Pi_x^d - \Pi_x^c}\right) - \left(\frac{\Pi_y^c - \Pi_y^n}{\Pi_y^d - \Pi_y^c}\right). \tag{A.1}$$

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 (A.1):

$$(\Pi_x^c - \Pi_x^n) - (\Pi_y^c - \Pi_y^n) = \frac{3(S_x - S_y)(S_x + S_y - t)\theta^2}{2(4 - 5\theta^2 + \theta^4)}. \tag{A.2}$$

(A.2) has the same sign as $(S_x - S_y)$ since $2S_x - t > 0$ and $2S_y - t > 0$ (see (11)) which imply $S_x + S_y - t > 0$, and $(4 - 5\theta^2 + \theta^4) \geq 0$ for $\theta \in [0, 1]$. The difference between the two denominators in (A.1),

$$(\Pi_x^d - \Pi_x^c) - (\Pi_y^d - \Pi_y^c) = -\frac{(S_x - S_y)(S_x + S_y - t)}{8(1 - \theta^2)}, \tag{A.3}$$

has clearly the opposite sign of $(S_x - S_y)$. Thus, since $\Pi_i^c - \Pi_i^n > 0$ and $\Pi_i^d - \Pi_i^c > 0$ $(i = x, y)$, $\left(\frac{\Pi_x^c - \Pi_x^n}{\Pi_x^d - \Pi_x^c}\right) > \left(\frac{\Pi_y^c - \Pi_y^n}{\Pi_y^d - \Pi_y^c}\right)$ for $S_x > S_y$, while the opposite holds when $S_x < S_y$. QED

3. Proof of Lemma 3 (i): Direct calculations show that

$$r_x^I - r_y^S = \frac{8(S_x + S_y - t)(S_x - S_y + \frac{t}{2})(1+\theta)(\theta - 1)E(S_x; S_y, \theta, t)}{(\theta - 2)^2(2+\theta)^2(-2S_y + t + 2\theta S_x - \theta t)^2(S_x - \theta S_y + \theta t)^2}, \tag{A.4}$$

where $E(S_x; S_y, \theta, t)$ is a quadratic function in S_x for given values of S_y, θ and t. From (A.4), $r_x^I - r_y^S = 0$ for $S_x = S_y - \frac{t}{2}$. Since the denominator of (A.4) is always positive and $\theta < 1$, the sign of $r_x^I - r_y^S$ is the same as the sign of $(S_x - S_y + \frac{t}{2})$ provided $E < 0$ over the interval $S_x^A \leq S_x \leq S_x^B$.

$E(S_x; S_y, \theta, t)$ is a second-degree polynomial concave in S_x equal to $E = (-16 - 10\theta^2 + 8\theta^4)(S_x^2 + S_y^2) + (64\theta - 26\theta^3 - 2\theta^5)S_x S_y + (8 - 48\theta + 5\theta^2 + 19\theta^3 - 4\theta^4 + 2\theta^5)S_x t + (24 - 16\theta + 15\theta^2 + 6\theta^3 - 12\theta^4 + \theta^5)S_y t + (-8 + 16\theta - 5\theta^2 - 6\theta^3 + 4\theta^4 - \theta^5)t^2$. We want to show that its maximum is negative over $S_x^A \leq S_x \leq S_x^B$ (where S_x^A (S_x^B) solves $r_x^I = 0$ ($r_y^S = 0$)). We first find the feasible roots

$$S_x^A = \frac{2S_y\theta - t(\theta - 2)}{4} + \frac{(4 - \theta^2)(2S_y - t)}{4(8 + \theta^2)^{\frac{1}{2}}}; \ S_x^B = \frac{(S_y - t)[\theta(8 + \theta^2) - (4 - \theta^2)(8 + \theta^2)^{\frac{1}{2}}]}{8(\theta^2 - 1)}, \tag{A.5}$$

and then solve $S_x^B - S_x^A = 0$ for S_y. The unique feasible root is

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

Since $S_x^B - S_x^A$ is increasing in S_y, $S_x^B - S_x^A > 0$ for $S_y > \hat{S}_y$.

Second, we determine the values of S_x corresponding to Argmax$\{E\}$. We find $S_x^E = \frac{S_y\theta(-32+13\theta^2+\theta^4)+t(8-48\theta+5\theta^2+19\theta^3-4\theta^4+2\theta^5)}{2(-8-5\theta^2+4\theta^4)}$ with the corresponding value of E equal to $E^M = \frac{(1+\theta)^2}{8(8+5\theta^2-4\theta^4)}M$, where $M = S_y t(1536 - 3072\theta + 384\theta^2 + 2272\theta^3 - 936\theta^4 - 388\theta^5 + 212\theta^6 - 8\theta^8) + S_y^2(-1024 + 2048\theta - 256\theta^2 - 1536\theta^3 + 634\theta^4 + 288\theta^5 - 140\theta^6 - 8\theta^7 + 4\theta^8) + t^2(-488 + 1152\theta - 112\theta^2 - 848\theta^3 + 257\theta^4 + 124\theta^5 - 56\theta^6 + 8\theta^7 + 4\theta^8)$. Clearly, the sign of E^M is the same as the sign of M. Since the coefficient of S_y^2 in M is negative, solving $M = 0$ with respect to S_y implies that M and thus E are negative for any value of S_y outside its two roots. The only positive root to $M = 0$ is $\tilde{S}_y = \frac{t}{D}[(8 - 8\theta - 3\theta^2 + 3\theta^3)(128 + 32\theta^2 - 8\theta^3 - 94\theta^4 - 5\theta^5 + 24\theta^6 + 4\theta^7)^{\frac{1}{2}} - (1536 - 3072\theta + 384\theta^2 + 2272\theta^3 - 936\theta^4 - 388\theta^5 + 212\theta^6 - 8\theta^8)]$, where $D = 256 - 512\theta + 64\theta^2 + 384\theta^3 - 156\theta^4 - 72\theta^5 + 35\theta^6 + 2\theta^7 - \theta^8$. Hence, $E < 0$ for $S_y > \tilde{S}_y$.

The last step is to compare $\hat{S}_y$ and $\tilde{S}_y$. It is easy but cumbersome to show that $\hat{S}_y - \tilde{S}_y > 0$. Since $S_x^B - S_x^A > 0$ for $S_y > \hat{S}_y$ and $E < 0$ for $S_y > \tilde{S}_y$, then $E < 0$ for $S_x^A < S_x < S_x^B$. QED

4. Proof of Lemma 3 (ii): We prove $r_y^I > r_y^S \;\Leftrightarrow\; S_x > S_y - \frac{t}{2}$ only.[16] Define $D \equiv \{S_x : S_y - \frac{t}{2} \leq S_x \leq S_x^B\}$, where S_x^B corresponds to $r_y^S = 0$. By direct calculations,

$$r_y^I - r_y^S \equiv H(S_x; S_y, t, \theta) = \frac{4t(1-\theta^2)(S_x + S_y - t)N(S_x; S_y, t, \theta)}{(2S_x - t - 2\theta S_y + \theta t)^2 (S_x - \theta S_y + \theta t)^2 (4-\theta^2)^2}, \tag{A.6}$$

where

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

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

$$\begin{aligned} N(S_y - \frac{t}{2}) = {} & 4(1-\theta)^2(16-6\theta^2+\theta^3)S_y^2 - 6(\theta-1)^2(16-6\theta^2+\theta^3)tS_y \\ & + (40-64\theta+25\theta^2+26\theta^3-20\theta^4+2\theta^5)t^2. \end{aligned} \tag{A.8}$$

The discriminant of (A.8) 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.5), 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 $a(\theta) + b(\theta) = 2(\theta-1)(1+\theta)^2\,[32 + 48\theta - 36\theta^2 - 34\theta^3 + 13\theta^4 + 4\theta^5 + (8+\theta^2)^{\frac{1}{2}}(-16 - 8\theta + 14\theta^2 + 5\theta^3 - 4\theta^4)] > 0$ 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.7), $\frac{\partial^2 N(S_x)}{\partial S_x^2} = -64\theta + 28\theta^3$ 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 $N(.)$, and thus $H(.)$, must be positive over the domain D. QED

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Notes:

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.

2. See especially 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 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.

4. These linear demands can of course be generated from a quadratic utility function (see Dixit (1988) for a derivation with differentiated products). Our specific assumption about the slope of the demand functions has no effect on the results of this paper.

5. Other papers using infinitely repeated games in international trade include Fung (1991, 1992), Davidson (1984), and Rotenberg and Saloner (1989).

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

7. Country-specific collusion implies that the critical rates in D are not affected by firm's behavior in F since the critical rate (5) is $r_i = [(\pi_i^c + \pi_i^*) - (\pi_i^n + \pi_i^*)]/[(\pi_i^d + \pi_i^*) - (\pi_i^c + \pi_i^*)]$, where π_i^* is Firm i's profit in F irrespective of its behavior there and π_i^k is Firm i's profit in D depending on its behavior ($k = c, d, n$).

8. Outputs x_n^*, y_n^*, x_c^*, y_c^*, x_d^* in F and y_d^* are found by substituting S_x and S_y in y_n, x_c, y_c, y_d and x_d, respectively.

9. Also, consistent with Bernheim and Whinston's Proposition 1, the gains from multi-market contacts are smaller when product markets are more alike. Gains from multi-market

contacts exist for $S_y = S_x$ since $t > 0$ still creates an asymmetry between firms in each country.

10. The quantities sold in F under market integration, x_n^* and y_n^*, are found by substituting S_x and S_y in y_n and x_n respectively. The same is true below for x_c^*, y_c^*, y_d and y_d^* with respect to y_c, x_c, x_d^* and x_d.

11. This range implies that, in D, some tacit collusion is always feasible under both market segmentation and market integration.

12. 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 single segmented market.

13. This might be due to a difference in quality making consumers in both countries having a higher demand for the good produced in the EU with respect to the good produced in the country in transition.

14. Hence, for collusion to be sustainable, $r_i \leq (2\pi_i^c - \pi_i^d)/(\pi_i^d - \pi_i^c)$ in the collusion phase and $r_i^p \leq \pi_i^c/\pi_i^{dp} - 1$ in the punishment phase (π_i^{dp} is i's deviation profit during the punishment phase). See Fung (1992) for a change in t given market segmentation in the same context.

15. Two points are worth making: first, because we deal with the punishment phase, Firm X's (Firm Y) critical rate schedules have now a negative (positive) slopes in (r_i^j, S_x) space. Second, the value of the slope of these schedules is different (in absolute terms) than with trigger strategies. Still, Proposition 1, for instance, still holds because r_y^{Ip} is the lowest critical rate for $S_x < S_y - \frac{t}{2}$ and r_x^{Sp} is the lowest critical rate for $S_x > S_y - \frac{t}{2}$.

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

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