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Partial Collusion and Foreign Direct Investment

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Abstract

We show that the static duopoly model in which firms choose between exporting and foreign direct investment is often a prisoners' dilemma game in which a switch from exporting to foreign direct investment reduces profits. By contrast, we show that when the game is repeated there is a range of parameters for which the firms can partially collude by choosing to export rather than invest. In this range, a reduction in export costs may undermine the partial collusion, causing a switch from export to investment.

Keywords: Foreign Direct Investment; Trade Liberalization; Partial Collusion

JEL Classification: F12, F13, F23.

1. Introduction

A familiar feature of the international economy in recent decades has been the dramatic increase in foreign direct investment (fdi), with investment flows significantly exceeding trade flows, particularly between the developed economies of the OECD. Markusen (1995) details the stylized facts that characterize fdi flows; Markusen (2004) and Navaretti and Venables (2006) review much of the recent literature on fdi.

The characteristics of fdi that are of particular relevance to this paper are first, that there are considerable intra-industry flows of fdi between developed economies – just as there is significant intra-industry trade between the same economies. Secondly, much of the theoretical, game-theoretic literature on fdi treats the choice between exporting and direct investment as being driven by a trade-off between tariff and non-tariff barriers to trade and the set-up costs involved in establishing overseas operations. Thirdly, and in seeming contradiction to our second point, fdi has continued to grow apace in recent years that have been characterized by significant trade liberalization.

One way to "explain" this apparent contradiction is to suggest that much of trade liberalization has been associated with economic integration and the growing tendency for groups of countries to form free-trade areas: the European Union is just one example of many such areas. In terms of the proximity-concentration hypothesis (Brainard, 1997), economic integration strengthens the need to be proximate to – located in – the free trade area while weakening the loss of economies of scale that arise from spreading production over multiple sites.[1] The problem with this suggestion is that, while it might, for example, account for some of the growth of US fdi in Europe, it does not at all

[1] Motta and Norman (1993) and Norman and Motta (1996) provide a theoretical analysis of the potential for economic integration to induce fdi.

explain why we find an almost identical growth of European fdi in the US, as illustrated in Figure 1.

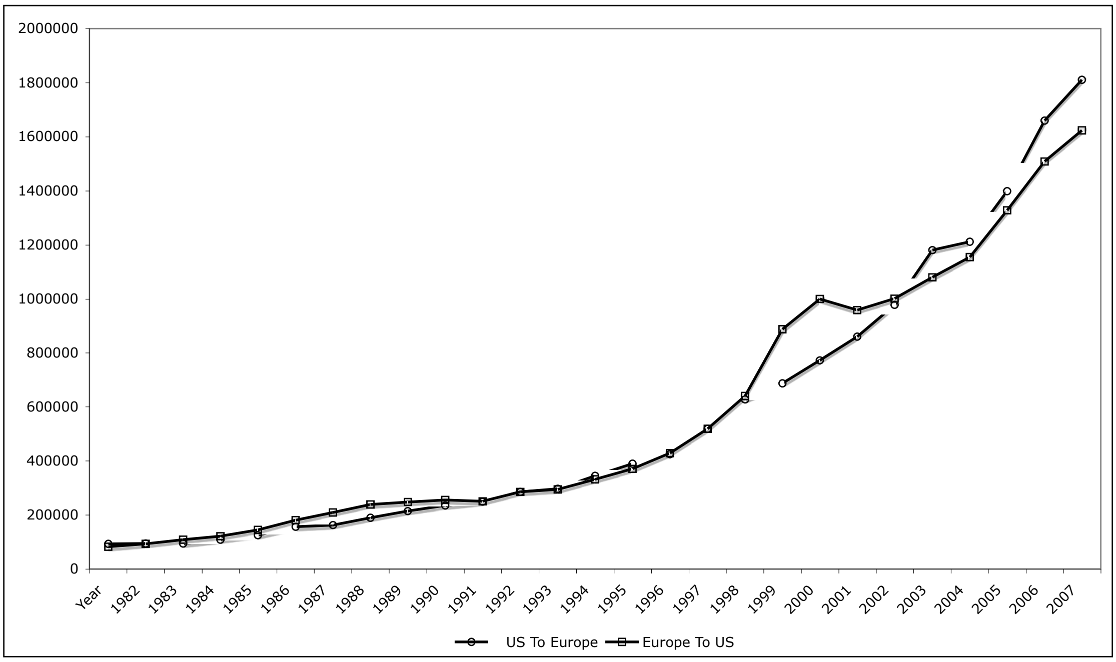

Figure 1: Flows of Foreign Direct Investment – Europe and US
(Source: Bureau of Economic Analysis, U.S.)

Our analysis in this paper investigates a different possible explanation: that firms switch from exporting to fdi in response to a *reduction* in trade costs. This possibility derives from our setting the export/fdi choice in a dynamic, repeated-game framework. A singular characteristic of the strategic literature on fdi, starting with the analysis of Knickerbocker (1973) and continuing through the work of Horstmann and Markusen (1987), Smith (1987), Rowthorn (1992), Motta (1992) and others is that, for not particularly restrictive parameter combinations, the underlying game is a prisoners dilemma game. Firms choose fdi in equilibrium whereas they would be better off choosing to export. It is, of course, well known that cooperation in the prisoners' dilemma game can be sustained and the dilemma resolved provided that the players are "sufficiently patient". What is surprising, and provides the motivation for this paper, is that the implications of this result for the trade/fdi choice have never been investigated. This is all the more surprising given that the typical firms that undertake fdi are large, established firms in repeated interaction with their rivals.

Leahy and Pavelin (2003) is the only article of which we are aware that analyzes fdi in a repeated-game context. However, they concentrate on North-South fdi. Moreover, they analyze cooperation on outputs supplied from South to North. By contrast, our analysis is framed in a North-North setting[2] and we consider cooperation in the export/fdi choice but not in the output or price choice.

The rationale for our approach is straightforward. In our North-North setting, tacit cooperation on outputs or prices typically leads to a decision not to supply the distant market, giving each firm a local monopoly.[3] The risk with this approach, as even the most casual reading of the anti-trust division websites in the US or in Europe indicates, is that it will excite the interest of the anti-trust authorities. When allied with the amnesty policies that these administrations (and others) operate, this significantly increases the probability that such cooperative agreements will be discovered and their members prosecuted. By contrast, partial collusion in which the firms cooperate on the *mode* by which the distant market is to be served but not on *whether and with what quantity* it is to be served is much less likely to excite suspicion and investigation.

[2] It also applies to the growth of South-South intra-industry fdi.

[3] This contrasts with the literature on multi-market contact inspired by the seminal analysis of Bernheim and Whinston (1990). Their approach looks at the strategic use of mergers or other means to *increase* the number of markets in which rivals simultaneously compete in order to facilitate tacit cooperation on output or prices.

Using a general model of the export/fdi choice[4] we first identify the parameter region for which the prisoners' dilemma characterizes the static Nash equilibrium. We then identify the conditions under which the rival firms can sustain a tacitly cooperative agreement to export rather than invest. As might be expected, this region is more extensive the lower is the discount factor that the firms employ. By contrast, we show that a reduction in trade costs can actually undermine tacit cooperation. In other words, in our repeated game setting there are situations in which fdi is actually encouraged by *reduced* rather than increased trade costs.

Our basic model is presented and analyzed in the next section. Section 3 illustrates this analysis using two specific examples: Cournot competition with iso-elastic demand and homogeneous goods, Cournot competition with linear demand and differentiated goods. Some comments on the welfare properties of tacit cooperation are briefly outlined in section 4. Section 5 concludes.

2. Model and Analysis

We develop a model that is standard in the fdi literature. There are two firms, each with established operations in their domestic markets and each considering how to supply the foreign market: firm a (b) is located in country A (B). The supply modes that the firms consider are Export or Invest. If Export is chosen there are export costs of t per unit in supplying the foreign market[5] while if Invest is chosen there are fixed set-up costs

4 The simplifications are that we consider a duopoly game, assume that the rival firms have already established domestic operations and we confine attention to the parameter regions in which Export is feasible.

5 We are agnostic on whether these are transport, tariff or non-tariff barriers to trade and on whether they are linear or "iceberg" costs. We do, however, assume that these costs are independent of the degree of product differentiation.

F to establish the foreign subsidiary. All production costs are constant and identical at c per unit.[6]

2.1 *The Static Game*

Denote by $\pi_K(c_i, c_j)$ $(K = D, F)$ the profit that firm i makes from sales in market K when its marginal costs are c_i and its rival's marginal costs are c_j, where $K = D$ (F) is the domestic (foreign) market for i.[7] This gives the pay-off matrix for the static game in Table 1.

For (Invest, Invest) to be a Nash equilibrium to this game requires:

$$\pi_F(c,c) - F > \pi_F(c+t,c) \Rightarrow F < F_1 = \pi_F(c,c) - \pi_F(c+t,c) \tag{1}$$

The right-hand side of (1) is positive – a firm earns higher profits when it is low-cost than when it is high-cost, given that its rival is low-cost – so that there is a non-empty range of set-up costs for which (Invest, Invest) is a Nash equilibrium. Since $\partial\pi_F(c+t,c)/\partial t < 0$ we have $\partial F_1/\partial t > 0$. This is just the familiar property that the critical value F_1 of set-up costs below which (Invest, Invest) is a Nash equilibrium of the static game is increasing in export costs.

A characteristic of our approach is that each firm's choice of Export or Invest is independent of its rival's choice. This follows directly from the modeling assumption that the two firms are located in different countries. As a result, so long as (1) is satisfied Invest is also a dominant strategy for both firms. This does not limit the generality of our analysis. A different interdependence between the supply modes would apply if we were to assume that the firms were headquartered in the same country (or, equivalently,

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6 Our analysis is qualitatively unaffected but analytically much messier if the firms have different production costs.

7 The profit functions are, of course, derived from the consumer demand functions. We illustrate our general analysis using demand specifications that are quite standard in the oligopoly literature.

were located in A and B but were considering the supply mode for a third country C).[8] In the interests of brevity we do not present this case, particularly since it gives the same qualitative results as the analysis below.

Table 1: Near Here

(Invest, Invest) is a Nash equilibrium of a prisoner's dilemma game if, in addition to (1) we have:

$$\begin{aligned} &\pi_D(c,c)+\pi_F(c,c)-F<\pi_D(c,c+t)+\pi_F(c+t,c)\Rightarrow \\ &F>F_2=\max\big(0,\pi_D(c,c)+\pi_F(c,c)-\big(\pi_D(c,c+t)+\pi_F(c+t,c)\big)\big) \end{aligned} \tag{2}$$

The loss of profit that a firm suffers as a result of its rival investing in its market as opposed to exporting to it must exceed the additional profit that the firm earns from investing in rather than exporting to the rival's market.

For there to be a non-empty range of F for which (Invest, Invest) leads to a prisoner's dilemma requires that $F_2 < F_1$. From (2) and (1) this requires:

$$\pi_D(c,c+t)-\pi_D(c,c)>0 \tag{3}$$

This inequality holds. A low-cost firm always earns more profit when its rival is high-cost than when it is low-cost. (Invest, Invest) as a Nash equilibrium to the static game gives rise to a prisoners' dilemma if set-up costs lie in the non-empty range $[F_2, F_1]$.[9]

Our analysis of the static game can be summarized in the following proposition:

Proposition 1: *In the static duopoly game there is a non-empty range of set-up costs* $F \in [F_2, F_1]$ *for which (Invest, Invest) is a Nash equilibrium of the*

[8] This is, for example, the implicit assumption in Knickerbocker's analysis.

[9] A natural question to ask is whether a similar prisoners' dilemma arises in the parameter region for which (Export, Export) is a Nash equilibrium to the static game. This would require the conditions $F > F_1$ and $F < F_2$, which are contradictory.

static game but in which both firms would be better off with Export. This range is increasing in export costs.

Proof:

From (1) we have $\frac{\partial F_1}{\partial t} = -\underset{(-)}{\frac{\partial \pi_F(c+t,c)}{\partial t}} > 0$. We cannot sign $\partial F_2/\partial t$ unambiguously but

from (2) we have $\frac{\partial F_2}{\partial t} = -\underset{(+)}{\frac{\partial \pi_D(c,c+t)}{\partial t}} - \underset{(-)}{\frac{\partial \pi_F(c+t,c)}{\partial t}} < \frac{\partial F_1}{\partial t}$ ■

2.3 The Repeated Game

As we noted in the introduction, one way in which firms may "escape" a prisoners' dilemma is if the underlying game is repeated indefinitely, an assumption that appears to be perfectly reasonable in the context of firms undertaking fdi.

Consider, therefore, the conditions that have to hold for the prisoner's dilemma to be resolved by partial collusion in a repeated game. By partial collusion in this context, we mean an agreement on the mode by which the foreign market is to be served but not on the quantities to be supplied or the prices to be charged.[10]

Suppose that set-up costs lie in the range [F_2, F_1]. Suppose further that the static game of Table 1 is infinitely repeated. The question that we ask is whether the firms can sustain a tacit agreement to Export, by adopting the standard Nash reversion trigger strategy: "I shall Export in the current period so long as we have both chosen Export in every previous period. If either of us has chosen Invest in any previous period I shall switch to Invest forever." An attractive feature of this type of partial collusion is that deviation is easily and quickly detected. A firm might not be able to monitor its rival's

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[10] We have borrowed this term from Friedman and Thisse (1993).

choice of output or price but it should be able to detect that the rival has established a production facility in the firm's market.

For this strategy to sustain the tacit agreement to Export, standard analysis (Pepall, Richards and Norman, 2008) indicates that the discount factor δ must satisfy:

$$\begin{aligned}\delta > \delta_l &= \frac{\pi_D(c,c+t)+\pi_F(c,c)-F-\pi_D(c,c+t)-\pi_F(c+t,c)}{\pi_D(c,c+t)+\pi_F(c,c)-F-\pi_D(c,c)-\pi_F(c,c)+F} \\ &= \frac{\pi_F(c,c)-\pi_F(c+t,c)-F}{\pi_D(c,c+t)-\pi_D(c,c)}\end{aligned} \tag{6}$$

The numerator is the one-period gain that a firm makes in the foreign market if it cheats on the agreement while the denominator is the per-period loss of profits in the domestic market that results from the collapse of the agreement.

As $F \rightarrow F_1$ we have $\delta \rightarrow 0$ and the tacit agreement can always be sustained. As $F \rightarrow F_2$ we have $\delta \rightarrow 1$ and the tacit agreement is increasingly difficult to sustain. The intuition is straightforward. As $F \rightarrow F_2$ the static game "looks" less and less like a prisoner's dilemma and so there are smaller gains to be had from tacit cooperation. By contrast as $F \rightarrow F_1$ the prisoner's dilemma characteristics of the static game become more pronounced and there are greater gains to be had from cooperation.

For any discount factor $\delta \leq 1$, we can rewrite (6) explicitly in terms of the critical value of set-up costs above which cooperation is sustainable:

$$F > F_3(\delta) = \pi_F(c,c) - \pi_F(c+t,c) - \delta(\pi_D(c,c+t) - \pi_D(c,c)) \tag{7}$$

Note that, from (1) and (2), this can be written:

$$F_3(\delta) = (1-\delta)F_1 + \delta F_2 \tag{8}$$

In other words, $F_3(\delta)$ is a convex combination of F_1 and F_2, confirming that there is always a non-empty parameter region in which partial collusion is sustainable.

Clearly $\partial F_3(\delta)/\partial\delta < 0$. The critical value of the set-up costs above which the agreement to export is sustainable is decreasing in the discount factor. Intuitively, an increase in the discount factor increases the value of cooperation as opposed to defection and so increases the range of set-up costs for which cooperation is sustainable. We can put this another way. From (6), $\partial\delta_l/\partial F < 0$. As set-up costs increase, the gains from cheating on the agreement are weaker whereas the gains from adhering to the agreement are unchanged. The tacit agreement is, therefore, easier to sustain. We can summarize this part of the analysis as follows:

Proposition 2: *If the duopoly game is infinitely repeated a tacit agreement by both firms to Export is sustainable by a Nash reversion trigger strategy for set-up costs in the range* $F \in [F_3(\delta), F_1] \subseteq [F_2, F_1]$. *This range is increasing in the discount factor* δ.

Now consider the impact of a change in export costs. We can state:

Proposition 3: *The range of set-up costs* $[F_3(\delta), F_1]$ *over which a tacit agreement to Export is sustainable by a Nash reversion trigger strategy is smaller when export costs are lower.*

Proof: From (1) and (7) we have:

$$\frac{\partial F_3(\delta)}{\partial t} = \frac{\partial F_1}{\partial t} - \delta \underset{(+)}{\frac{\partial \pi_D(c, c+t)}{\partial t}} < \frac{\partial F_1}{\partial t} \qquad \blacksquare$$

Proposition 3 of itself does not suggest that a reduction in export costs will have a non-intuitive impact on the export/fdi choice.[11] However, from (7) we also have:

$$\frac{\partial F_3(\delta)}{\partial t} = -\underset{(-)}{\frac{\partial \pi_F(c+t, c)}{\partial t}} - \delta \underset{(+)}{\frac{\partial \pi_D(c, c+t)}{\partial t}} \tag{9}$$

The sign of $\partial F_3(\delta)/\partial t$ is ambiguous. It is certainly positive when $\delta = 0$ but may be negative as $\delta \to 1$. This is important since $\partial F_3(\delta)/\partial t < 0$ gives the apparently perverse result that a decrease in export costs may actually cause a switch from exporting to foreign direct investment. Intuitively, a decrease in export costs increases *both* the per-period loss of profits that are suffered if the agreement collapses *and* the one-off increase in profits that cheating generates. The higher is the discount factor the more weight a firm places on the one-off gain.

We can state the following:

Proposition 4: *If the duopoly game is infinitely repeated, a sufficient condition for there to be a discount factor δ_t < 1 above which $\partial F_3(\delta)/\partial t < 0$ is that $\left|\partial \pi_F(c+t, c)/\partial t\right| < \partial \pi_D(c, c+t)/\partial t$. If this condition is satisfied a decrease in trade costs may cause a switch from exporting to FDI.*

In other words, $\partial F_3(\delta)/\partial t < 0$ if the impact of an increase in export costs on overseas profit is less than its impact on domestic profit.

[11] Suppose, however, that the set-up cost F is drawn from a uniform distribution $[0, F^u]$ with $F^u > F_1$. Proposition 3 suggests that the probability that a tacit agreement to Export can be sustained is lower when export costs are lower.

It is tempting to conjecture that this condition is more likely to be satisfied when exports costs are high since then overseas profit is low while domestic profit is high. Suppose that export costs are linear at t per unit exported. We can state the following:

Proposition 5: *Denote by* $\hat{t}$ *the export cost above which exports are not feasible. Then there exists an export cost* t_l *above which* $\partial F_3(\delta)/\partial t < 0$.

Proof: Profit from exporting can be written $\pi_F = \left(P(Q_F, Q_D) - c - t\right)Q_F$.

Differentiate with respect to t to give

$$\frac{\partial \pi_F}{\partial t} = \left(P(Q_F, Q_D) - c - t\right)\frac{\partial Q_F}{\partial t} + Q_F\left(\frac{\partial P(Q_F, Q_D)}{\partial Q_F}\frac{\partial Q_F}{\partial t} + \frac{\partial P(Q_F, Q_D)}{\partial Q_D}\frac{\partial Q_D}{\partial t}\right) - Q_F$$

As $t \to \hat{t}$ we have $Q_F \to 0$ and $\left(P(Q_F, Q_D) - c - t\right) \to 0$. As a result as $t \to \hat{t}$ we have

$\dfrac{\partial \pi_F}{\partial t} \to 0$. By contrast $\dfrac{\partial \pi_D}{\partial t} > 0 \;\forall\; t$. ■

3. Examples

3.1 Cournot Competition with Identical Products and Iso-Elastic Demand

Assume that consumer demand is iso-elastic, $Q = P^{-\eta}$, or in inverse form:

$$P = (Q_1 + Q_2)^{-\frac{1}{\eta}} \qquad (\eta > 1) \tag{10}$$

where η is the elasticity of demand. Further assume that export costs are linear at t per unit exported.

Table 2 details the relevant profit functions for the two models ignoring the set-up costs and also identifies the range of export costs for which Export is feasible.[12]

Table 2: Near Here

[12] Detailed calculations are omitted in the interests of brevity. They can be obtained from the authors on request.

Substituting these in (1) and (2) gives:

$$F_1 = \frac{(2\eta-1)^{\eta-1}}{\eta^{\eta}}\left(\frac{c^2}{(2c)^{\eta+1}} - \frac{(t\eta-c-t)^2}{(2c+t)^{\eta+1}}\right) \tag{11a}$$

$$F_2 = \frac{(2\eta-1)^{\eta-1}}{\eta^{\eta}}\left(\frac{2c^2}{\left((2c)^{\eta+1}\right)} - \frac{(t\eta-c-t)^2}{(2c+t)^{\eta+1}} - \frac{(c+t\eta)^2}{(2c+t)^{\eta+1}}\right) \tag{11b}$$

and $F_3(\delta)$ is given by (8).

This example is illustrated in Figure 1 for η = 2 and two values of the discount factor, and in Figure 2 for δ = 0.5 and two values of the price elasticity.[13] The shaded areas are areas where we have a prisoners' dilemma and the darker shaded area is where partial collusion to Export is sustainable.

δ = 0.5; η = 2 δ = 0.7; η = 2

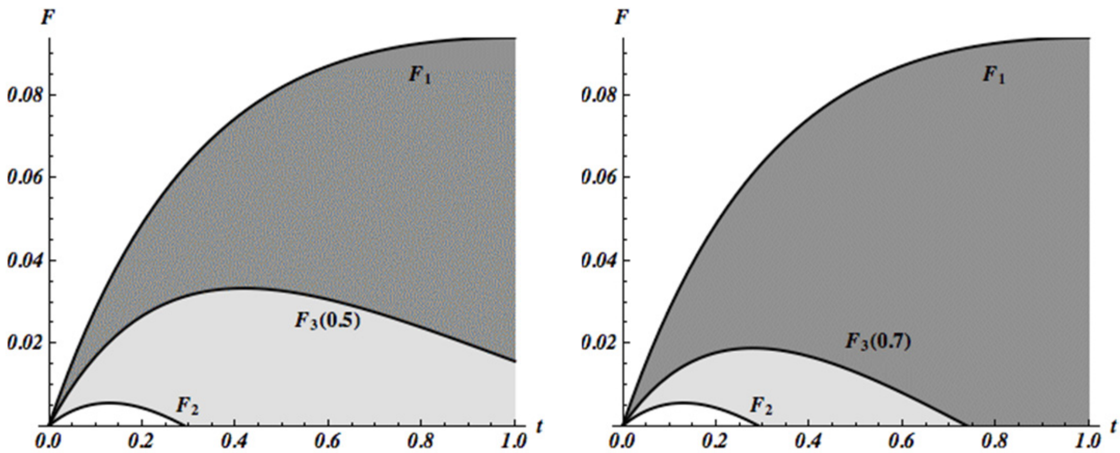


Figure 1: Iso-Elastic Demand and the Discount Factor

δ = 0.5

13 In Figure 2 we restrict the *t* axis to the range of values for *t* over which exports are feasible when η = 2.5.

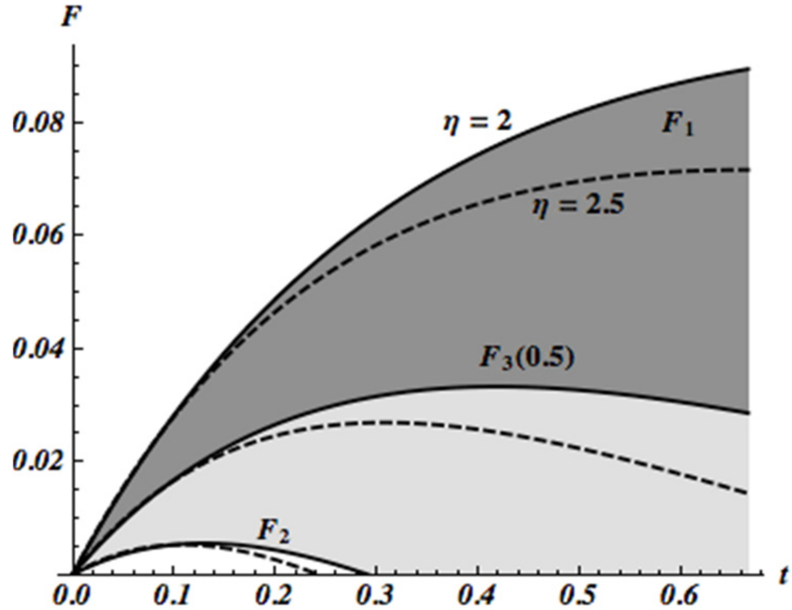


Figure 2: Iso-Elastic Demand and the Elasticity of Demand

Provided that export costs are not "very low", the critical value of set-up costs F_1 below which (Invest, Invest) is the one-shot equilibrium is lower when demand elasticity is higher. Intuitively, a high price elasticity intensifies competition when firms are located in the same market. Admittedly a high price elasticity also adversely affects profits from exporting, but as $t \rightarrow \hat{t}$ exports tend to zero and the impact of price elasticity on exports also tends to zero. By exactly the same argument, the critical value of set-up costs $F_3(\delta)$ above which partial collusion is sustainable in the repeated game is also lower when the demand elasticity is higher.

As can be seen, there is, indeed, a critical value of exports costs t_l above which $\partial F_3(\delta)/\partial t < 0$. Moreover, t_l is lower when the discount factor is higher and when demand elasticity is higher. An increase in either the discount factor or the price elasticity, by reducing $F_3(\delta)$, makes partial collusion on Export sustainable where it otherwise would not be, but also expands the range of export costs for which trade liberalization leads to a breakdown in partial collusion and a switch to fdi.

3.2 Cournot Competition with Differentiated Products and Linear Demand

Assume, as in Singh and Vives (1984) (hereafter SV) that inverse demand for firm *i* (*i = a, b*) is $p_i = V - \beta q_i - \gamma q_j \ (i = a,b; i \neq j)$.[14] In this model $\gamma \leq \beta$ is an inverse measure of product differentiation. Assume also that transport costs are linear at *t* per unit. One potential problem with this model is that there are several parameters, making comparative static analysis problematic. We can show, however, that the model reduces to a three-parameter model in *f*, *g* and τ using the normalization:[15]

$$\tau = t/V; g = \gamma/\beta; f = F\beta/V^2 \tag{12}$$

Intuition is aided if we substitute $s = 1 - g$ ($s \in [0, 1]$) as a direct measure of the degree of product differentiation.

Table 3 details the relevant profit functions for this model ignoring the set-up costs. Substituting these in equations (1) and (2) gives:

$$f_1 = \frac{4\tau(1+s-\tau)}{\left(3+2s-s^2\right)^2}; f_2 = \max\left(0, \frac{\tau\left(2-5\tau+2s(2+\tau)+s^2(2-\tau)\right)}{\left(3+2s-s^2\right)^2}\right) \tag{13}$$

while $f_3(s, \delta, \tau)$ is given by (8). These functions are illustrated in Figures 2(a) and (b) respectively.

It is simple to confirm that in the SV model $\partial f_1/\partial s > 0$, $\partial f_2/\partial s > 0$ and $\partial f_2/\partial s > \partial f_1/\partial s$. The range of set-up costs for which (Invest, Invest) is a Nash

[14] The consumer utility function is $U(q_1, q_2) = V(q_1 + q_2) - \left(\beta\left(q_1^2 + q_2^2\right) + 2\gamma q_1 q_2\right)/2$.

[15] Details are available from the author on request.

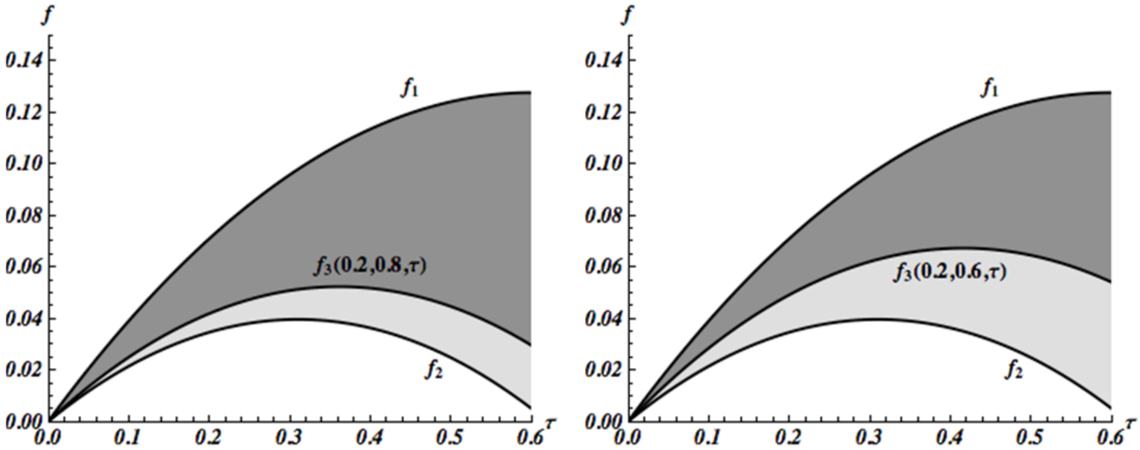
equilibrium increases with the degree of product differentiation but the range over which there is a prisoners' dilemma decreases.

Table 3: Near Here

From Table 3 and equation (8) we obtain:

$$f_3(s,\delta,\tau)=\frac{4(1+s-\tau)\tau}{(3-s)^2(1+s)^2}-\frac{\delta(1-s)\big(\tau(1-s)+2(1+s)\big)\tau}{(3-s)^2(1+s)^2} \tag{14}$$

This example is illustrated in Figure 3 for δ = 0.6 and δ = 0.8 and in Figure 4 for two values of s – the degree of product differentiation.



δ = 0.8 δ = 0.6

Figure 3: Differentiated Product and the Discount Factor

After some manipulation we have:

$$\frac{\partial f_3(s,\delta,\tau)}{\partial\tau}<0 \Leftrightarrow \tau>\tau_{SV}(s,\delta)=\frac{(1+s)(2-\delta(1-s))}{4+\delta(1-s)^2} \tag{15}$$

Since $\tau_{SV}(s,\delta) < (1+s)/2$ (the upper limits on τ for which Export is feasible – see Table 3) – there is a non-empty range of export costs for which $\partial f_3(s,\delta,\tau)/\partial\tau<0$. Moreover, as we should expect, this range is more extensive the higher is the discount factor:

$\partial\tau_{SV}(s,\delta)/\partial\delta < 0$. By contrast, $\partial\tau_{SV}(s,\delta)/\partial s > 0$. A greater degree of product differentiation, by softening competition, ameliorates to at least some degree the prisoners' dilemma "problem" and so reduces the range of export costs for which trade liberalization leads to a breakdown in partial collusion and a switch to fdi.

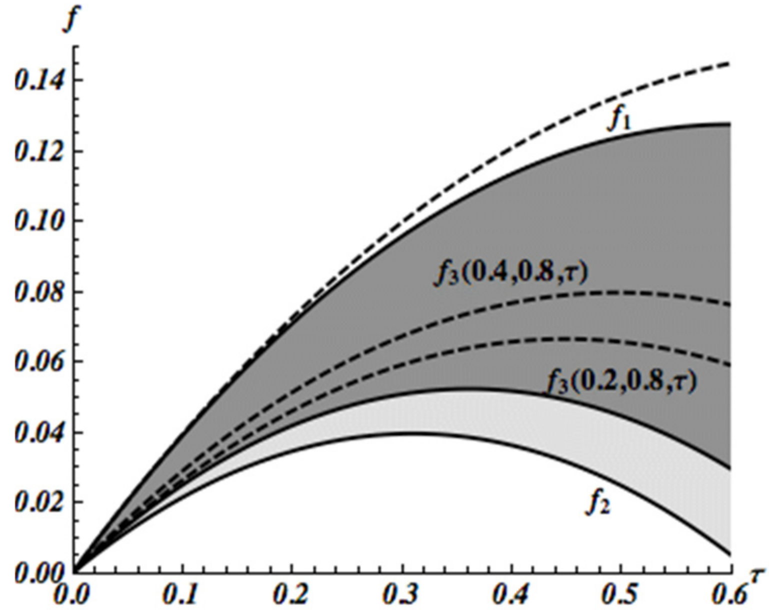


Figure 4: Differentiated Product and the Degree of Product Differentiation

4. Some (Very) Brief Welfare Comments

Making welfare comparisons in these types of models is always complicated by the question of how to treat export costs and profits earned in the non-domestic market. As a result we shall confine ourselves in this section to some very brief comments.

Note first that a decrease in export costs that leaves the supply mode (Export, Export) unchanged need not increase a firm's profits. In the SV case, for example, if the firms export aggregate profit falls as τ is reduced so long as $\tau > \frac{(1+s)^2}{s^2 - 2s + 5}$.[16] The reason for this is simple to explain. A reduction in export costs increases export profits by making exports less expensive in the foreign market but decreases domestic profits by weakening import protection. When export costs are high export quantity is low and the import protection effect dominates.

By contrast, consumers always gain from a reduction in export costs since this toughens competition in their domestic market – the only market with which they are concerned.

Now suppose that we are in the parameter region $[0, F_3(\delta)]$, so that the tacit agreement to Export is unsustainable. Further suppose that the decrease in exports costs results in a switch to [Export, Export] in the repeated game. The firms benefit since they are able to escape the prisoners' dilemma but consumers lose. Suppose, by contrast that we are in the parameter region $[F_3(\delta), F_1]$. Further suppose that the decrease in export costs causes a breakdown in the tacit agreement to Export. The firms lose but consumers gain.

It is, of course, possible in either of these cases that total consumer and producer surplus is greater with [Export, Export] than [Invest, Invest]. However, is this really convincing as a justification for advocating a reduction in export costs that facilitates tacit collusion or rejecting a reduction in export costs because it undermines tacit collusion? This is the kind of justification that has been advanced by those who believe that cartels should be investigated on the basis a rule of reason but which has been rejected in favor of a *per se* rule by most anti-trust authorities.

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16 It is straightforward to check that this lies within the feasible range of τ.

5. Conclusions

A standard result in the literature on the export/fdi choice is that an increase in export costs may cause firms to switch from exporting to direct investment. One puzzle with this result is that it seems to conflict with the rapid increase in fdi in a period when there has been significant trade liberalization. It has, of course, been suggested that there is a simple explanation for this puzzle: the growing importance of free trade areas. The problem with this, however, is that while it might, for example, be consistent with the growth of US investment in Europe, it cannot explain the almost parallel growth of European investment in the US.

We suggest a different rationale in this paper. A switch from exporting to direct investment in response to an increase in export costs does not mean that the firms gain from such a switch. We have shown that in a static duopoly game there is always a non-empty range of set-up costs for which [Invest, Invest] is the Nash equilibrium of a prisoners' dilemma game: the duopolists are both better off with Export. This range is greater the higher are export costs. Moreover, if export costs are "close" to the margin between export and fdi a small increase in transport costs that results in a switch to fdi always reduces the firms' profits.

Suppose that we are in this prisoners' dilemma region. If, by contrast, the firms are involved in an indefinitely repeated game – a not unrealistic scenario – it seems reasonable to suggest that they will seek to adopt a tacit agreement to Export, sustained by a simple Nash reversion trigger strategy.

We have shown that there is, indeed, a non-empty range of set-up costs for which such a tacit agreement is sustainable. This range is increasing in the discount factor but is smaller when export costs are lower. Of more direct relevance to our puzzle above, we have shown that the lower bound on this region, $F_3(\delta)$ may be non-monotonic in export costs and is more likely to be decreasing in export costs if the discount factor δ is “high”. This suggests that we may see a switch from export to fdi in response to a *reduction* in export costs, if this reduction results in the tacit agreement to export being unsustainable. Note also that this result implies that we should see a switch from intra-industry trade to intra-industry (two-way) fdi in response to trade liberalization, an outcome that is at least consistent with the recent evidence on foreign direct investment.

References

Bernheim, B.D. and Whinston, M.D. (1990) “Multimarket contact and collusive behavior”, *RAND Journal of Economics*, 21: 1-26.

Brainard, S.L. (1997), “An empirical assessment of the proximity-concentration trade-off between multinational sales and trade”, *American Economic review*, 87: 520-544.

Horstmann, I.J. and Markusen, J.R. (1987) “Strategic investments and the development of multinational”, *International Economic Review*, 28: 109-121.

Knickerbocker, F.T. (1973) *Oligopolistic Reaction and Multinational Enterprise*, Harvard University Press, Cambridge, Mass.

Leahy, D. and Pavelin, S. (2003) “Follow-my-leader and tacit collusion”, *International Journal of Industrial Organization*, 21: 439-453.

Markusen, J.R. (1995) “The boundaries of multinational firms and the theory of international trade”, *Journal of Economic Perspectives*, 9: 169-189

Markusen, J.R. (2004) *Multinational Firms and the Theory of International Trade*, MIT Press, Cambridge, Mass.

Motta, M. (1992) “Multinational firms and the tariff-jumping argument”, *European Economic Review*, 36: 1557-1571.

Motta, M. and Norman, G. (1996) “Does economic integration cause foreign direct investment?”, *International Economic Review*, 4: 757-783

Navaretti, G.B. and Venables, A.J. (2006) *Multinational Firms in the World Economy*, Princeton University Press, Princeton, NJ.

Norman, G. and Motta, M. (1993) “Eastern European economic integration and foreign direct investment”, *Journal of Economics and Management Strategy*, 2: 483-507.

Pepall, L., Richards, D. and Norman, G. (2008) *Industrial Organization: contemporary theory and empirical applications*, Blackwell Publishing, Oxford.

Rowthorn, R.E. (1992) “Intra-industry trade and investment under oligopoly: the role of market size”, *Economic Journal*, 102: 402-414.

Singh, N. and Vives, X. (1984) “Price and quantity competition in a differentiated oligopoly”, *RAND Journal of Economics*, 15: 546-554.

Smith, A. (1987) “Strategic investment, multinational corporations, and trade policy”, *European Economic Review*, 31: 89-96.

		Firm b	
		Export	Invest
Firm a	Export	$\pi_D(c,c+t)+\pi_F(c+t,c);$ $\pi_D(c,c+t)+\pi_F(c+t,c)$	$\pi_D(c,c)+\pi_F(c+t,c)$ $\pi_D(c,c+t)+\pi_F(c,c)-F$
	Invest	$\pi_D(c,c+t)+\pi_F(c,c)-F$ $\pi_D(c,c)+\pi_F(c+t,c)$	$\pi_D(c,c)+\pi_F(c,c)-F$ $\pi_D(c,c)+\pi_F(c,c)-F$

Table 1: Pay-Off Matrix for the Static Game

π_D(c, c); π_F(c, c)	$\dfrac{(2\eta-1)^{\eta-1}}{(2c)^{\eta+1}\eta^{\eta}}c^2$
$\pi_F(c+t, c)$	$\dfrac{(2\eta-1)^{\eta-1}}{(2c+t)^{\eta+1}\eta^{\eta}}(t\eta-c-t)^2$
$\pi_D(c, c+t)$	$\dfrac{(2\eta-1)^{\eta-1}}{(2c+t)^{\eta+1}\eta^{\eta}}(c+t\eta)^2$
$\hat{t}$	$c/(\eta - 1)$

Table 2: Cournot with Iso-Elastic Demand and Homogeneous Goods

$\pi_D(s\text{: }0, 0)$; $\pi_F(s\text{: }0, 0)$	$\dfrac{1}{(3-s)^2}$
$\pi_F(s\text{: }t, 0)$; $\pi_F(s\text{: }\tau, 0)$	$\dfrac{(1+s-2\tau)^2}{(3-s)^2(1+s)^2}$
$\pi_D(s\text{: }0, t)$; $\pi_D(s\text{: }0, \tau)$	$\dfrac{(1+s+\tau(1-s))^2}{(3-s)^2(1+s)^2}$
Range of t or τ	$[0, (1+s)/2]$

Table 3: Profit Equations for the SV Model