FDI and International Collusion

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Abstract: We develop a supergame model of collusion between price-setting oligopolists when the trade between countries involves per-unit trade cost and FDI requires a fixed cost of setting up a subsidiary in a foreign country. We demonstrate that cross hauling of FDI may facilitate collusion based on territorial allocation of markets. Whenever FDI is not helpful for sustaining collusion, the collusive arrangement involves no FDI at all. With asymmetric number of home firms or with different sizes of the markets, FDI may facilitate international collusion at lower levels of trade costs and thus our analysis also throws some light on the empirical puzzle regarding the trade liberalisation and FDI flows observed since the 1990s.

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1. Introduction

The firms from different countries form cartel and decide to serve the global market that suits the best interests of the cartel members. International cartels are quite prevalent for more than a century and they take the form of fixing prices, exclusive territorial allocation of markets and also sharing the market based on certain principles such as sales quota and also involving multinational firms.[1] The cartels were often based on *spheres of influence* (SOI) in territorial markets, respecting the "home market principle". Many of the cartels involved more than one firm in each territory.

In view of the empirical findings there are attempts to provide theoretical models to analyse international cartels involving firms from different countries. When the firms have to incur a trade cost to sell in each other's market it is natural that the cartel members should divide the market to avoid the loss associated with the trade costs in such arrangement. How far such division of the market is possible would depend on the parameters of the models in different situations. The possibility of cartel with sphere of influence as the outcome of collusive equilibrium of an infinitely repeated game was established by Pinto (1986) and Bernheim and Whinston (1990). The cartel often adopts a "home market principle" when colluding firms mutually avoid selling in each other's market (Bond and Syropoulos (2008), Byford and Gans (2014)). The existence of collusive equilibrium with the possibility of bilateral trade was established by some papers. For instance, with constant marginal costs, quantity-setting firms might export to each other's markets in a collusive equilibrium if trade costs are low enough (Bond and Syropoulos (2008) and Ashournia et al (2013)) and in case of the price-setting firms producing differentiated products will do trade if trade costs are high enough (Akinbasoye et al, (2012)). If marginal costs are increasing strongly enough, collusive trade is an equilibrium for both price and quantity setting firms (Colombo and Labrecciosa (2007)).[2] In some of these

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[1] A recent study of 81 international cartels detected by European and American competition agencies between 1980 and 2007 found that eighty per cent of them allocated territories or specific customers to their members (Levenstein and Suslow, 2011, p.475). Bhattacharjea and Sinha (2012) have discussed many cartel cases with these features.

[2]Belleflame and Bloch (2008) did not consider per unit trade costs but assumed fixed costs of trade and showed that collusion would take the form of SOI for high levels of fixed costs. Salvo (2010) models SOI with trade costs but assumes that consumers are located Hotelling-style on a line segment between the firms, unlike all the papers cited here.

papers it was also shown that trade liberalisation or economic integration may increase the scope for collusion (Bond and Syropoulos (2008), Lommerud and Sørgard (2001), Akinbasoye et al, (2012), Ashournia et al (2013) etc.). Bhattacharjea and Sinha (2015, 2016) analysed an international cartel with homogenous goods when firms are located in different countries separated by trade costs and the firms would revert to Bertrand price competition in case the collusive arrangement with sphere of influence fails. They established the relation between reduction in trade costs and increase in the collusion sustainability in a more general setting.

Surprisingly, all the above papers took the location of the firms fixed in certain countries and therefore did not analyse the effect of multinational activity on the collusive equilibrium. More specifically, instead of taking the location of a firm being unique and in only one country, we ask what happens if we allow the firm to set up subsidiary operation in another country through foreign direct investment (FDI). The absence of multinational firms from the analysis of international cartels is even more surprising in the current context as it has been observed that since the 1990s the increase in amount of FDI has overtaken the increase in volume of trade by a large margin in the world. Thus, it is natural to extend the analysis and explore the interplay of international cartel, trade and FDI in a single model. This paper aims to fill this gap in the literature.

Brander (1981) showed that duopolistic competition can result in two-way trade in identical products and the idea of "reciprocal dumping" was further strengthened in Brander and Krugman (1983).[3] It was later shown that cross hauling of FDI can occur in a similar non-cooperative set-up (Rowthorn (1992). Using the imperfect competition models the possibility of two-way FDI was also shown by Horstmann and Markusen (1992), Brainard (1993) Markusen and Venables (1998) and others. There are models which highlight the role of vertical linkages for generating two-way FDI in equilibrium (see Glass and Saggi (2005) in the context of intermediate inputs and Zhao (1995) and others using labour union). In essence, these papers have considered the possibility of cross hauling of FDI in the same spirit as the cross hauling of trade since these are alternative modes of serving foreign markets.

However, the global pattern of trade and FDI especially since the 1990s presented a contradictory scenario where the trade liberalisation has been accompanied by dramatic

[3] For a general characterisation of "reciprocal dumping" and the effect of world income growth see Ray Chaudhuri and Sinha (2005).

increase in FDI flows.[4] This empirical observation raised doubt about the standard theory of "proximity- concentration trade-offs" according to which the horizontal FDI flow should fall when the trade costs are reduced. Thus, a branch of literature with the help of vertical FDI flows, export platform FDI, trading block etc. tried to reconcile the growth in FDI flows even when the trade costs were falling in the world (Neary (2008), Mukherjee and Suetrong (2012); Collie (2011) etc.). Baldwin and Ottaviano (2001) showed the existence of two-way FDI with the help of multiproduct multinational firm where different varieties are produced in different countries and thus both FDI and trade can occur simultaneously in their model. Regarding the reduction in trade costs and the incidence of FDI, our model offers a very different perspective. We show even though trade never occurs in equilibrium but FDI occurs only when it facilitates collusion. We also establish that FDI can happen when the trade costs are low rather than when they are high.

Leahy and Pavelin (2003) have analysed how "follow-my-leader FDI" creates a situation for collusion where the domestic rival firms undertake FDI in the same country in order to facilitate collusive behaviour but they serve the domestic country back home. Thus, in their model the FDI is not for serving the foreign country but it replaces the high cost domestic production with the low cost foreign production.[5] Our paper is closely related to Choi and Gerlach (2012) which analysed the international cartel formation with multimarket contact in the presence of multinational firms. They used a similar setting like ours where there are two countries with two global firms having operations in both countries and the firms are engaged in an infinite period repeated game. The firms produce a homogenous product and choose to compete or collude by setting prices in every period. In this setting they focus on the interplay of cartel formation and the incentives for antitrust enforcement both at local and global level and emphasised the role of international antitrust coordination. The starting point of Choi and Gerlach (2012) analysis is that there exist multinational firms having operations in both countries. However, given the setting of the model it is not reasonable to have two firms in each country even for a very small amount of set up costs to begin operations due to the standard Bertrand paradox result in this context. We start off with one firm in each country and first show that firms undertake FDI in each other's market only when FDI facilitates international collusion at a lower levels of common discount factors. Thus, we rationalise the

[4] See UNCTAD (2000) and Markusen (2002, Chapter 1) and others.

[5]In an interesting paper Davies and Liebman (2006) considered the interplay of antidumping duties and collusion under FDI and established why a foreign affiliate might want to have antidumping duties even against its parent firm.

existence of multinational firms with cross hauling of FDI and provide a 'back story' for the Choi and Gerlach (2012) model. We further extend this setting with more number of 'home firms' in each country and anlyse the incentive for international cartel formation. With identical number of firms (more than one) and symmetric demand in each country, we find that multinational firms would never arise in a collusive equilibrium. With asymmetric number of home firms or with different sizes of the markets, FDI occurs as part of collusive arrangement and it facilitates international collusion when trade costs are low rather than when they are high. Thus, contrary to the existing literature, in our model the two-way FDI occurs in equilibrium in anticipation of sustaining collusion between firms from different countries.

The rest of the paper is organised as follows. We set up the basic framework of our analysis in section 2 and begin our analysis with one firm in each country and show how the two-way cross hauling of FDI facilitates international collusion with spheres of influence. Section 3 considers more domestic and foreign firms with at least two home firms in each country and an endogenous process of FDI. This section shows that in a collusive equilibrium FDI never occurs since it cannot enhance the scope for collusion. In section 4, we analyse the effect of asymmetric number of firms and asymmetric market sizes on the prospect of collusion with FDI and re-establish our preliminary result of FDI facilitating international collusion derived in section 2. Section 5 concludes the paper.

2.1. The Basic Framework

We build on the model developed by Bhattacharjea and Sinha (2015, 2016) which presented with varying degrees of generalisation, the basic issue of collusion sustainability between firms from different countries under price competition in a homogenous good.

We assume two countries A and B and there are firms in both countries producing a homogenous good. To begin with we assume that countries have identical demand and they have two identical firms indexed by 1_A and 1_B where firm 1_A is located in country A, and firm 1_B in country B. Both firms have symmetric constant marginal costs *c* per unit of output. Each firm incurs additional trade costs of *t* per unit to sell in the other country, so its delivered cost there is $c^* = c+t$ per unit. Note that the trade cost *t* can be interpreted as transport cost or import tariff (or both taken together) per unit of output. Whichever interpretation we take, it is assumed that *t* is the same in both directions between the two countries. Consider a general downward sloping demand function in country j given by $Q_j = q(P_j)$. Define the monopoly price P^m and the monopoly profit for each country j = A, B:

$$\pi_j^m \equiv (P^m - c)q(P^m) \quad (1)$$

The following first order and second order conditions of monopoly profit maximization ensure the existence of a unique monopoly price $P^m(c)$:

A1. $(P^m - c)q'(P^m) + q(P^m) = 0$

A2: $(P - c)q''(P) + 2q'(P) < 0$.

Given the symmetric trade costs, there exists a limit $\bar{t}$ beyond which the trade costs become prohibitive and both markets become completely segmented. As a result, the firm in each country can charge the monopoly price and the threat of imports from the foreign firm does not exist. The threat of foreign competition remains (weakly) effective when $c+t \leq P^m(c)$. Thus, we assume:

A3: $t \leq P^m(c) - c \equiv \bar{t}$

We consider an infinite period game where the firms in each period choose to collude or compete by setting their prices simultaneously. They have a common per-period discount factor δ, where $0 < \delta \leq 1$. In our model the collusion is achieved as an equilibrium with the help of standard grim trigger strategy where the deviation would be punished by reverting to the Bertrand Nash equilibrium.

The optimal collusion in this environment is to set the monopoly prices in both markets. This would maximize the joint profits of the two firms and based on “home market principle” each firm would serve its home country without any trade in either direction (Bernheim and Whinston (1990) and Bellaflamme and Peitz (2015)). The logic behind this is very easy to see. The monopoly profits in each market would be obtained when the markets are served by home firms and as a result the trade costs are avoided in serving the market. The profits would be π_j^m in each country. On the other hand, if the collusive arrangement entails some exports by at least one firm, q_x, the total profits in the importing country would be $P^m q(P^m) - c.(q(P^m) - q_x) - (c+t).q_x = (P^m - c)q(P^m) - t.q_x < \pi_j^m$. Thus, it is optimal to reduce the export to zero to maximize the profit from each country.

Thus, the collusion must involve the sphere of influence in serving the market along the collusive path of the play and there would not be any cross hauling of trade in equilibrium. What happens in case of deviation? A firm can defect from the collusive path by simply undercutting marginally the monopoly price in the foreign country and becoming the sole seller in that market for one period. For the purpose of closed form solution we assume that the defector can match the monopoly price in the foreign market and make the entire sale there for one period (thus breaking the tie in favour of the defector). From the foreign market say, k, a firm by deviation for one period would get for $k \neq j$:

$$\pi_k^d \equiv (P^m - c^*)q(P^m) \qquad (2)$$

Defection by exporting to the foreign market would trigger punishment, which takes the form of reverting to the Nash equilibrium in each market forever after one period of defection. We assume that it takes only one period for the defection to be detected. The Nash equilibrium after deviation means that each firm would charge the limit price $P = c*$ in their own market (price equal to the marginal delivered cost $c*$ of imports from the foreign country). In every period after the deviation from collusion, along the punishment path each firm therefore earns profits from their respective home market

$$\pi_j^p \equiv (c^* - c)q(c^*),\ j = \text{A, B} \qquad (3)$$

The firms do not earn any profit form the foreign market due to the limit pricing by the rival there.

Let us try to construct an equilibrium where the firms start with cooperation and continue to do so forever. They earn monopoly profits from their respective home market. Along this equilibrium path the discounted profits for each firm would be $\frac{\pi_j^m}{1-\delta}$. In case of deviation in any period the defector gets the monopoly profit from its home market π_j^m and the deviation profit from the foreign market π_k^d for one period and then this deviation triggers the punishment from the next period, which is to revert to the Nash equilibrium forever leading to a discounted stream of profit $\frac{\delta\pi_j^p}{1-\delta}$. Thus, the incentive compatibility condition (ICC) for collusion with SOI to be a subgame perfect equilibrium for a firm located in country j:

$$\frac{\pi_j^m}{1-\delta} \geq \pi_j^m + \pi_k^d + \frac{\delta\pi_j^p}{1-\delta} \qquad (4)$$

This holds for all $\delta \geq \delta_j^*(1)$, where the critical value of the discount factor for one firm in country j is given by:

$$\delta_j^*(1) = \frac{\pi_k^d}{\pi_j^m + \pi_k^d - \pi_j^p} \quad (5)$$

The behavior of $\delta_j^*(1)$ defined in (5) is fully characterized in Proposition 2 and Lemma 1 in Bhattacharjea and Sinha (2015) and based on which they derive the trade cost collusion paradox in their paper. For our purpose we simply borrow from their paper and note that at t = 0, $\pi_k^d = \pi_j^m$ and $\pi_j^p = 0$, from the definitions given in (1), (2) and (3) and therefore $\delta_j^*(1) = \frac{1}{2}$.[6] On the other hand at the limit $t = \bar{t}$, $\pi_k^d = 0$ and $\pi_j^m = \pi_j^p$ and the expression becomes $\frac{0}{0}$ and then by L'Hôpital's rule, using the derivative expressions evaluated in the limit we get $\delta_j^*(1) = 1$. For our purpose we note that $\delta_j^*(1)$ is an increasing function with respect to t and for any $0 \leq t < \bar{t}$, $1 \geq \delta_j^* \geq \frac{1}{2}$. Thus, for symmetric market sizes with one firm in each country, the collusion with exclusive sphere of influence would be sustainable for

$$\delta \geq \delta_A^*(1) = \delta_B^*(1).$$

Now we consider more number of firms in each country. More generally suppose there are $n_j \geq 2$ firms in country *j (*where *j=A, B) . The firms are identical and have the same marginal costs c.* The collusion with more firms in each country would take the shape of equally sharing monopoly profits in their home market and staying out of the foreign market. The collusive trade would still not arise in equilibrium. A deviating firm can slightly undercut the collusive price and snatch the entire demand in both markets for one period. The defection will be punished by reversion to the Bertrand-Nash equilibrium in each country thus resulting into zero profits in both home and foreign markets. The ICC for a representative firm in country j is now:

$$\frac{\pi_j^m/n_j}{1-\delta} \geq \pi_j^m + \pi_k^d \qquad \text{for any } 0 \leq t \leq \bar{t}, \quad (6)$$

which yields the critical discount factor $\delta_j^*(n_j)$ as a function of number of firms in country $j(n_j \geq 2)$:

[6] Note that at t = 0 the markets are integrated and the firms can continue to divide the integrated market equally and sustain collusion for $\delta \geq \delta_j^*(1) = \frac{1}{2}$.

$$\delta_j^*(n_j) = \frac{(n_j-1)\pi_j^m + n_j\pi_k^d}{n_j[\pi_j^m + \pi_k^d]} = \frac{\frac{(n_j-1)}{n_j}\pi_j^m + \pi_k^d}{[\pi_j^m + \pi_k^d]} \tag{7}$$

Lemma 1: *$\delta_j^*(n_j)$ is an increasing function of number of firms $n_j \geq 2$. Also for any given n_j, $\delta_j^*(n_j)$ is a decreasing function with respect to the trade cost $t \in [0, \bar{t}]$ which starts from $\frac{(2n_j-1)}{2n_j}$ at $t = 0$ and falls to $\frac{(n_j-1)}{n_j}$ at $t = \bar{t}$.*

Proof: Note that $\delta_j^*(n_j)$ can be written as $\delta_j^*(n_j) = \frac{(n_j-1)\pi_j^m + n_j\pi_k^d}{n_j[\pi_j^m + \pi_k^d]} = 1 - \frac{\pi_j^m}{n_j[\pi_j^m + \pi_k^d]}$, which is an increasing function of n_j and the lowest value is realized when $n_j = 2$ [since $n_j \geq 2$ by assumption]. Now for any given $n_j \geq 2$, π_k^d is a decreasing function of t, so $\delta_j^*(n_j)$ also decreases with respect to the trade cost $t \in [0, \bar{t}]$, within the permissible range of t. At $t = 0$, $\pi_k^d = \pi_j^m$ and therefore $\delta_j^*(n_j) = \frac{(2n_j-1)}{2n_j}$. And at the limit $t = \bar{t}$, $\pi_k^d = 0$ and therefore $\delta_j^*(n_j) = \frac{(n_j-1)}{n_j}$. Also in particular for $n_j = 2$, $\delta_j^*(2)$ starts from $\frac{3}{4}$ at t = 0 and falls to $\frac{1}{2}$ at $t = \bar{t}$. ■

The following figure depicts the behavior of critical discount factors $\delta^*(1)$ and $\delta^*(n)$ for n = 2, 3, 4 and so on in (t, δ) space.

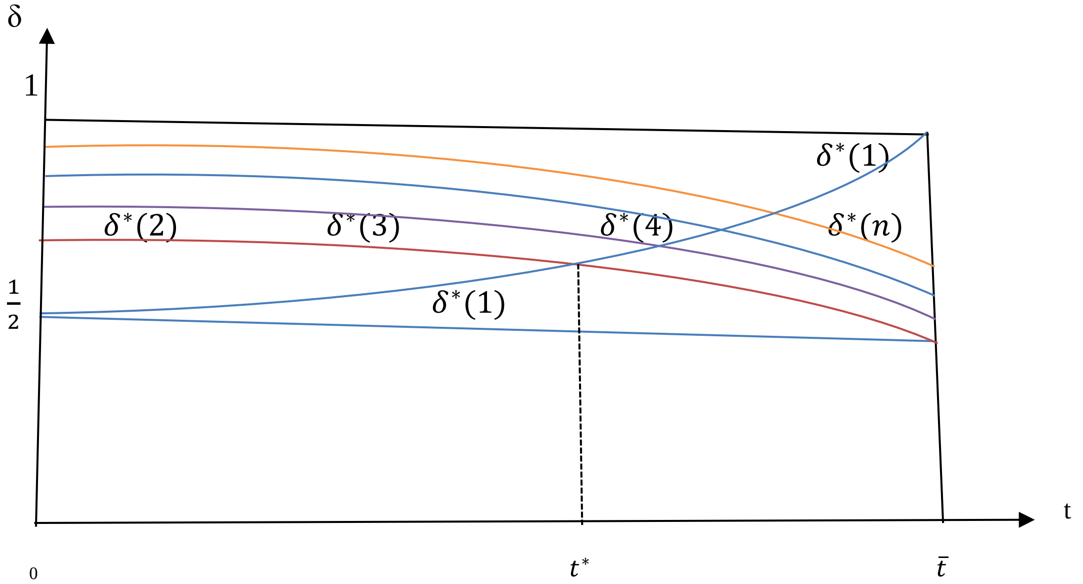

Figure 1: critical discount factors [for $n = 1$, $\delta^*(1)$ is increasing and $\delta^*(n)$ for n≥ 2 are decreasing curves]

It is clear from the profit expressions in (7) that $\delta_j^*(n_j)$ is independent of the number of firms in the other country, and it involves only monopoly quantity, price and c^*. Since $\delta_j^*(n_j)$ is an increasing function of n_j, the scope for collusion gets reduced as the number of firms is increased beyond two. The sole reason for this is that under collusion the profits have to be shared between more firms while the gains from defection remain unchanged for each firm. Thus, for our model with two countries A and B, the range of common δ for which the collusion would be sustained in case of $n_A,\ n_B\ \geq 2$ is $\delta \geq max\{\delta_A^*(n_A), \delta_B^*(n_B)\}$ and it would be binding by the critical discount factor of the country with more firms.[7]

Based on the above preliminary analysis we now move on to show how the multinational activity in the form of FDI affects the prospect of collusion in both countries.

2.2. FDI and collusion with one firm in each country: $(n_A = n_B = 1)$

So far we have been concerned with the analysis of cartels where the activity of the firms in equilibrium was limited to their home markets. We now explore the possibility of multinational activity and its interplay with the collusion. In particular, we analyse how the prospect of collusion may be brightened due to two-way foreign direct investment (FDI) by the firms. To use the spirit of subgame perfection we assume that firms anticipate the stream of payoffs when they take decisions regarding FDI. We assume that setting up an overseas affiliate is a once for all decision and requires a fixed set up cost F. We also assume that the affiliates are wholly owned by the parent firm, but once set up they are delegated managerial autonomy so that they behave like independent firms in their respective territories, subject to a restriction that they do not sell in the parent firm's home market. Correspondingly, the parent firm confines itself to its home market.

To introduce the idea in the simplest possible way, first we consider a situation with one home firm in each country and no other entrant in any country due to lack of production technology or other constraints. Additionally, we assume that the net payoff from a subsidiary operation under FDI, which shares market j with a home firm in an SOI cartel is strictly positive; otherwise, an affiliate would never be set up even in anticipation of a cartel. Thus, in case of one firm in each country we need to assume:

[7] It is important to note that based on the behaviour of the functions $\delta_j^*(n_j)$ in case of one and more firms $n_j \geq 2$ with respect to the trade cost Bhattacharjea and Sinha (2015) developed the idea of 'competition paradox' where "an increase in the number of firms might lead to greater scope for collusion".

(A4). $\frac{\pi_j^m(c)}{2(1-\delta)} - F > 0.$

Suppose, the common discount factor of the firms δ is such that $\delta_j^*(1) > \delta > \delta_j^*(2) > \frac{1}{2}$ for j = A and B . This is possible for $t \geq t^*$ (in Figure 1). Note that given the value of δ, no SOI cartel is sustainable. But the two firms having the same technology may choose to set up affiliates in each other's market, a situation we call as cross hauling of FDI in the same spirit as cross hauling of trade.[8] The question is when collusion cannot be sustained with one firm in each country, can it be sustained by cross hauling of FDI? To explore this further we introduce a one-shot game played by the two firms in the beginning regarding whether to undertake FDI or not, before they choose to collude in subsequent periods.

If both firms undertake FDI, then the SOI cartel is sustainable because both parents and affiliates function with the understanding of not selling into each other's market. The payoff along the cartel path is the discounted value of half the monopoly profit in each market, less the set up cost *F*, and such a cartel will be sustainable for $\delta \geq \frac{1}{2}$. If both firms decide not to undertake FDI in each other's market then no international cartel is possible since $\delta < \delta_j^*(1)$ and then at best they will limit price and sell in their own market, earning $\pi_j^p(c)$ in every period from their respective home market. These payoffs are entered in the cells on the diagonal of Table 1.

Table 1: Payoff matrix under one shot FDI Game

Country A Firm \ Country B Firm	FDI	No FDI
FDI	$\frac{\pi_A^m(c)}{1-\delta} - F, \frac{\pi_B^m(c)}{1-\delta} - F$	$\frac{\pi_A^m(c)+\pi_B^m(c)/2}{1-\delta} - F, \frac{\pi_B^m(c)}{2(1-\delta)}$
No FDI	$\frac{\pi_A^m(c)}{2(1-\delta)}, \frac{\pi_B^m(c)+\pi_A^m(c)/2}{1-\delta} - F$	$\frac{\pi_A^p(c)}{1-\delta}, \frac{\pi_B^p(c)}{1-\delta}$

[8] In the present setup, cross-hauling of trade does not occur both in one shot Nash equilibrium and in the collusive equilibrium in an infinite period game.

As for the off-diagonal payoffs, we examine the case where the firm based in country B undertakes FDI in country A, while the firm based in country A does not undertake FDI (see (No FDI, FDI) payoffs). However, the payoffs for the opposite case will simply require interchange of subscripts. The multinational firm from country B has given up the possibility of defection by setting up its foreign affiliate, so the only ICC that needs to be satisfied is for the home firm in country A. For $\delta \geq \delta_j^*(2)$ as assumed, a cartel with SOI and monopoly pricing in both markets can be sustained. Given A4, the payoff matrix in Table 1 then gives (FDI, FDI) as a dominant strategy Nash equilibrium. Thus, cross hauling of FDI which is the outcome of the first stage game facilitates subsequent product market collusion. With monopoly pricing in both markets under collusion, the possibility of arbitrage constraining pricing does not arise.

With a slightly more complicated analysis, cross-hauling of FDI to facilitate collusion can also be supported as a subgame perfect Nash equilibrium (SPNE) for a wider range of discount factors. Let us now consider the range $\delta_j^*(2) > \delta \geq \frac{1}{2}$ with one firm in each country. In the one shot FDI game the payoffs in the diagonal cells of Table 1 remain unchanged, but those in the off-diagonal cells need modifications because one-way FDI can no longer support a cartel with SOI. We again focus on the case where the firm in country B undertakes FDI in country A. In country B, there is one domestic firm which has to charge the limit price $c^* = c + t$ because of the threat of imports from its rival in country A. Consequently, $\pi_B^p(c)$ will replace $\pi_B^m(c)$ in its payoff in the lower left cell of Table 1, with a symmetric change for the country A firm's payoff in the top right cell. However, the possibility of arbitrage now imposes a further constraint on pricing in country A where FDI occurs. The parent firm in B will not sell its product in A, but it is charging a price of c^* in its home market, so independent arbitrageurs would ensure that the price in A has to be less than or equal to $c^* + t \equiv c + 2t$. This constrains the price that the home firm and the foreign affiliate in country A can charge if they collude in a domestic cartel in country A with $\delta \geq \frac{1}{2}$. Two possible cases arise: (i) $p^m \leq c^* + t$; (ii) $p^m > c^* + t$.

In case (i) arbitrage does not prevent a cartel in country A from charging the monopoly price, so the payoffs remain as in Table 1, with the modifications discussed above for the payoffs in country B where FDI does not occur and thus the net payoff of multinational firm of country B is $\frac{\pi_B^p(c)+\pi_A^m(c)/2}{1-\delta} - F$. Symmetrically there will be a change of payoff in the top right cell for country A firm. The game will still have one Nash equilibrium (FDI, FDI) in dominant strategies. This outcome occurs for all values of F satisfying our assumption (A4).

In case (ii), where $p^m > c^* + t$, in the country where FDI occurs both the home firm and the foreign affiliate would be constrained to charge $\bar{p} = c* + t$. Let us define $\bar{\pi}_j \equiv (c^* + t - c)q(c^* + t) \equiv 2t.q(c + 2t)$. Then the firms earn profits $\bar{\pi}_j/2$ in each period in the country where FDI occurs. Payoffs are now as given in Table 2, where two possibilities arise. First, suppose $\frac{\bar{\pi}_j}{2(1-\delta)} - F > 0$. Given A4, this can hold for some higher values of t where $c* + t$ is close to but lower than the monopoly price. In such a case, we would still have only one Nash equilibrium involving FDI by both firms. However, if $\frac{\bar{\pi}_j}{2(1-\delta)} - F < 0$ at lower values of t, FDI by one firm even if there is domestic cartel is not profitable. Then, the payoffs of firms A and B in all cells of the matrix will be $\frac{\pi_A^p(c)}{1-\delta}$, $\frac{\pi_B^p(c)}{1-\delta}$ respectively except for the payoffs associated with (FDI, FDI) choice of the firms. Then the payoff matrix gives us a coordination game with two Nash equilibria (FDI, FDI) and (No FDI, No FDI). Now the two firms can coordinate on which one to play depending on the payoffs. By comparing payoffs from two equilibria we find that the (FDI, FDI) equilibrium would Pareto dominate (No FDI, No FDI) when $F < \frac{\pi_j^m(c) - \pi_j^p(c)}{1-\delta}$. Thus, two firms can collude to play the Pareto dominant equilibrium by cross hauling of FDI to facilitate their product market collusion.

Table 2: Payoff matrix under one shot FDI Game for case (ii): $p^m > c^* + t$.

Country A Firm \ Country B Firm	FDI	No FDI
FDI	$\frac{\pi_A^m(c)}{1-\delta} - F$, $\frac{\pi_B^m(c)}{1-\delta} - F$	$\frac{\pi_A^p(c) + \bar{\pi}_B/2}{1-\delta} - F$, $\frac{\bar{\pi}_B}{2(1-\delta)}$
No FDI	$\frac{\bar{\pi}_A}{2(1-\delta)}$, $\frac{\pi_B^p(c) + \bar{\pi}_A/2}{1-\delta} - F$	$\frac{\pi_A^p(c)}{1-\delta}$, $\frac{\pi_B^p(c)}{1-\delta}$

Note: We have defined $\bar{\pi}_j \equiv (c^* + t - c)q(c^* + t)$. Subscript j indicates the country where the profits are earned.

Thus, starting from one firm in each country, there are circumstances where an international cartel with SOI can only be formed when there is cross hauling of FDI. For low values of set up cost of affiliates the cross hauling of FDI is a natural outcome in anticipation of a cartel. Our analysis demonstrates a new way in which collusion can be facilitated, and also provides a new theory of cross hauling of FDI when there is a possibility of collusion. This reasoning is different from the traditional “tariff jumping” argument for choosing FDI as a mode of entry into a foreign market which is to avoid trade costs. Thus,

Proposition 1. *Under certain parametric configuration, starting from one home firm in each country, the cross-hauling of FDI by increasing the market participants from one to two in each market can facilitate the collusion with SOI.*

Let us elaborate the above result with the help of Figure 1. Note that FDI would occur as part of a collusive arrangement for $t > t^*$ and $\delta_j^*(1) > \delta > \delta_j^*(2)$ and for this range of discount factors collusion with SOI would not be possible without the option of FDI. The collusion with FDI is even possible under some restrictive conditions discussed above for all values of t and δ such that $Min.\{\delta_j^*(1), \delta_j^*(2)\} > \delta \geq \frac{1}{2}$. Thus, cross hauling of FDI might occur for all values of t to facilitate international collusion with SOI. However, for all values of $\delta \geq \delta_j^*(1)$, the international collusion with SOI is possible without FDI and therefore the firms would not have FDI in collusive equilibrium and stick to serving their home market.

3. FDI with symmetric number of home firms in each country: $\mathbf{n_A = n_B \geq 2}$

Let us consider the problem more generally with identical number of home firms, say $n = n_A = n_B \geq \mathbf{2}$ in each country. Now depending on the value of F we would have two cases to consider: Case A: with small F and Case B: with relatively large F. They are analysed below. To focus on the process of endogenous entry through FDI, we assume identical market size in both countries and symmetric n number of home firms.

3.1. Case A: FDI with small F

Under the assumption of small set up cost F, all firms can set up a new plant in the foreign country resulting in $2n$ number of firms in each country when they anticipate that by doing FDI international collusion is sustainable. This happens when the following condition holds,

$$(A4')\ \frac{\pi_j^m(c)}{2n(1-\delta)} - F > 0.$$

First note that the condition of collusion under **no FDI** is given by equation (7), which is restated here with $n_j = n$ as (8)

$$\delta \geq \delta_j^*(n) = \frac{\frac{(n-1)}{n}\pi_j^m + \pi_k^d}{\left[\pi_j^m + \pi_k^d\right]} \qquad (8)$$

However, under FDI the total number of firms in each country is $2n$. On the equilibrium path each parent firm would get equal share of its monopoly profit from the foreign market. In case of deviation by any firm and given each firm operates in both countries the defection means that both operations of the parent firm (home and affiliate) would deviate and get the monopoly profit in each country for one period and then in subsequent period the Bertrand-Nash competition will happen. Thus the incentive compatibility for collusion under FDI would be

$$\frac{\pi_j^m/2n}{1-\delta} + \frac{\pi_k^m/2n}{1-\delta} \geq \pi_j^m + \pi_k^m \qquad [\text{where } j \neq k \text{ and } j,k = A,B] \qquad (9)$$

Given the assumption of identical market size and symmetric number of firms in each country, by putting $\pi_j^m = \pi_k^m$ we get the conditions for collusion under FDI by each firm to the foreign market.

$$\delta \geq \delta_{FDI}^*(2n) = \frac{2n-1}{2n} \qquad (10)$$

Comparing this with the no FDI case from (8), we find that at t = 0, $\pi_j^m = \pi_k^d$ and we get

$$\delta_j^*(n) = \frac{2n-1}{2n} \qquad (11)$$

Thus, the two critical discount factors are equal when t = 0. Now for any t > 0, $\pi_j^m > \pi_k^d$ and π_k^d is a decreasing function of t and it reaches 0 when $= \bar{t}$, we find that $\delta_j^*(n) \leq \delta_{FDI}^*(2n)$ for all $t \in [0, \bar{t}]$. In Figure 2 (t, δ) space, this situation can be viewed as CE representing $\delta_j^*(n)$ and CD representing $\delta_{FDI}^*(2n)$. It is clear that collusion is more difficult to sustain if all firms undertake FDI rather than none doing it. Thus, when the firms collude, they will collectively decide not to undertake FDI and would make no FDI as a part of collusive agreement. In case of deviation by any firm the punishment would occur in terms reversion to the Bertrand Nash equilibrium, leading to zero profits for all.

The intuition behind this result is easy to see. When all firms have an affiliate in foreign country then the deviation would mean that both the home firm and its foreign affiliate make the deviation simultaneously and reap the monopoly profits in each country for one period and revert to the Bertrand Nash equilibrium leading to zero profit forever. Here the trade cost has no role as each firm has its presence in both countries leading to a horizontal line δ^*_{FDI} representing the critical discount factor above which collusion is sustainable with FDI. However, without FDI each firm is located in the home country and deviation from collusion would mean monopoly profit from home country and monopoly profit net of trade cost from the foreign country for one period and then for all subsequent periods the Bertrand Nash equilibrium post deviation would lead to zero profit for all firms. Thus, the collusion without FDI involves a lower profit from the foreign market due to the presence of positive trade cost and hence it is easier to sustain collusion without FDI than with FDI. And given the behavior of the one period deviation profit from foreign country with respect to the trade cost we have downward sloping critical discount factor above which the collusion with SOI is sustainable. The situation would become identical only when the trade cost is exactly equal to zero and in that case the value of critical discount factor would be the same.

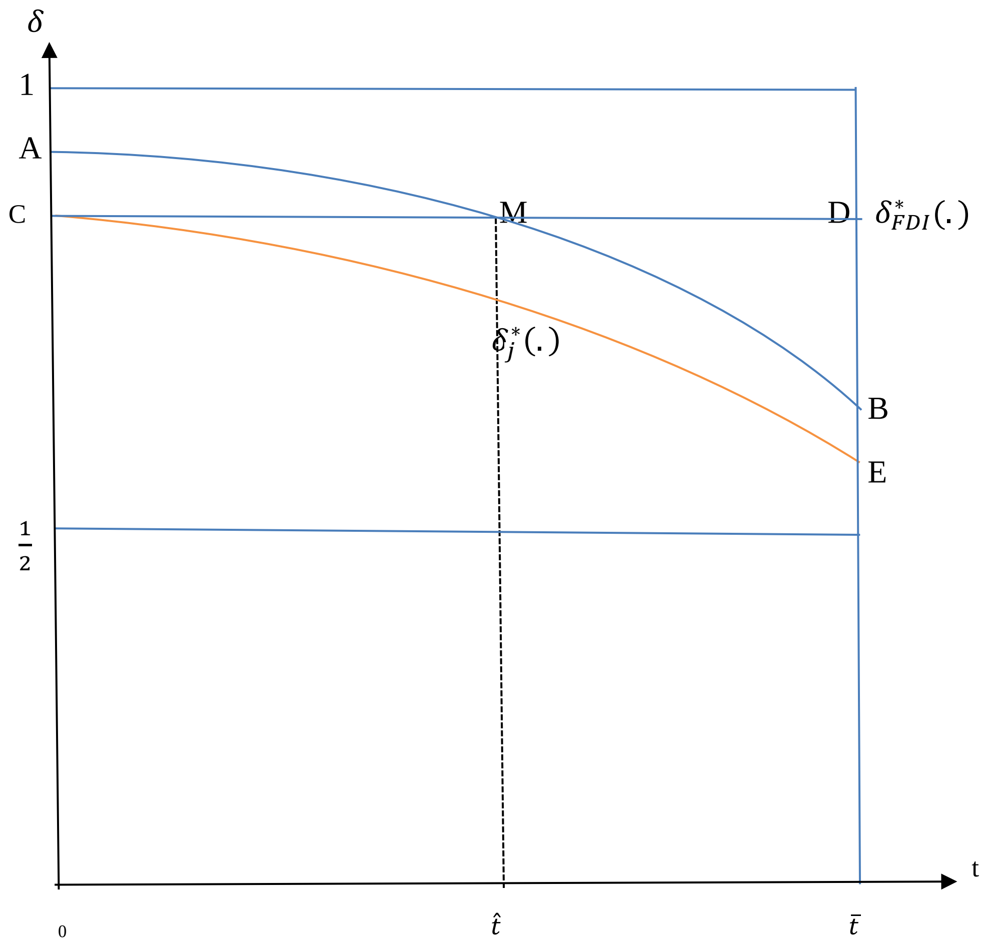

Figure 2: Critical discount factors for $n_A = n_B \geq 2$ with and without FDI.

3.2. Case B: FDI with relatively large F

We have just discussed above the effect of FDI on collusion with symmetric number of firms in each country and with small set up cost of FDI so that every firm can undertake FDI in the foreign country when they anticipate collusion. Now suppose the value of F is such that only a subset of firms from each country can undertake FDI. Assume that in case of collusion with SOI only m firms can undertake FDI profitably and not more, where $m < n$. So with FDI, total number of firms in each country would be $(n + m)$ who will share the profits in each country under collusion. This happens under the assumption

(A5). $\frac{\pi_j^m(c)}{(n+m)(1-\delta)} > F > \frac{\pi_j^m(c)}{(n+m+1)(1-\delta)}$

Under this assumption exactly m number of firms undertake FDI under collusion. Now the question is, does the incidence of FDI facilitate international collusion when only a subset of firms can become multinational?

For the multinational firms the incentive compatibility constraint for collusion with SOI cartel with total number of firms in each country being $N = n + m$ under endogenous entry through FDI is (by (9))

$$\delta \geq \delta_E^*(N) = \frac{N-1}{N} \tag{11}$$

Now for the non FDI firms the incentive compatibility is given by

$$\frac{\pi_j^m/N}{1-\delta} \geq \pi_j^m + \pi_k^d$$

i.e.,

$$\delta \geq \delta_j^*(N) = \frac{\frac{(N-1)}{N}\pi_j^m + \pi_k^d}{\left[\pi_j^m + \pi_k^d\right]} \tag{12}$$

At t=0 the above critical values $\delta_E^*(N) < \delta_j^*(N)$ and since $\delta_j^*(N)$ is a decreasing function, for the collusion to sustain we must have the common discount factor $\delta \geq Max\{\delta_E^*(N), \delta_j^*(N)\}$. In Figure 2, assuming $\delta_E^*(N)$ is represented by CD line and $\delta_j^*(N)$ is represented by AB curve then for the collusion to sustain the common discount faction δ must lie in the upper envelope of the two curves (above AMD).

Alternative to this, if all the firms can agree as part of the cartel arrangement not to undertake FDI then the collusion is sustainable for

$$\delta \geq \delta_j^*(n) = \frac{\frac{(n-1)}{n}\pi_j^m + \pi_k^d}{\left[\pi_j^m + \pi_k^d\right]} \quad (13)$$

Note that by comparing (11), (12) and (13) we find $\delta_j^*(n) < Max\{\delta_E^*(N), \delta_j^*(N)\}$. Hence, the scope for collusion is better under no FDI than with partial FDI by few firms. In other words, FDI by few firms make the collusion less likely. Therefore, collusive arrangement would involve no FDI by firms and international cartel will be sustained with SOI whenever $\delta \geq \delta_j^*(n)$. Thus, with small F when all firms can do FDI (Case A) and with relatively large F when only a subset of firms can do FDI (Case B) in anticipation of an international cartel we summarize the result of this section below.

Proposition 2: *With identical market size and symmetric number of home firms* $n \geq 2$ *in each country, an endogenous occurrence of FDI in anticipation of international collusion either by all firms (with small F) or by a subset of firms (with relatively large F) would raise the critical discount factor making the collusion with SOI under FDI more difficult to sustain. Therefore, FDI will not occur under the international collusion.*

It is worth noting that FDI is costly and in case the very fact of FDI does not help to reach collusion from a situation of non-collusion, then FDI would not occur in our model. This is because if there is no cartel either domestic or international then the firms will get zero profit due to Bertrand competition and in that case there is no incentive for any firm to undertake FDI by incurring a fixed set up cost leading to a negative payoff from FDI operation itself. If the collusion is sustainable even without FDI then it is in collective interest not to undertake FDI as part of collusive agreement since it involves wastage in the form of fixed cost F from the overall collusive profits in both countries. So it is clear from the above Proposition 2 that whenever FDI does not facilitate collusion, the FDI would not occur in collusive equilibrium.

4. FDI facilitates international collusion

Now we move on to analyse the following two possibilities: (i) when the countries have asymmetric number of home firms; and (ii) when the countries have asymmetric sizes of their markets. We would show that under these two scenarios discussed below, FDI would occur in our model only when it actually enhances the prospect of collusion for some parameter configuration given the common discount factor and therefore the players would be willing to cooperate on keeping FDI as part of the collusive arrangement.

4.1. Asymmetric number of home firms $\mathbf{n_A \neq n_B \geq 2}$

We consider asymmetric number of home firms in two countries and without loss of generality we assume that country A has more home firms than country B, i.e., $n_A > n_B$. In case of FDI by all firms the total number of firms including home and affiliate in each country would be $N = n_A + n_B$. We assume that the set up cost F for an affiliate is small (but positive) so that all the firms can undertake FDI if they anticipate a collusion. We need to assume

(A6). $\frac{\pi_j^m(c)}{N(1-\delta)} - F > 0$.

Now the collusion under FDI with N players in each country would be sustainable (from (10)) if

$$\delta \geq \delta_{FDI}^*(N) = \frac{N-1}{N} \quad (14)$$

In case no firm undertakes FDI but they decide to collude with SOI, then the discount factors for which the collusion would be sustainable is given by $\delta \geq max[\delta_A^*(n_A), \delta_B^*(n_B)]$. Given $n_A > n_B$, $\delta_A^*(n_A)$ would bind and thus the collusion with SOI but without FDI would be sustainable for $\delta \geq \delta_A^*(n_A) = \frac{\frac{(n_A-1)}{n_A}\pi_A^m + \pi_B^d}{[\pi_A^m + \pi_B^d]}$.

At $t = 0, \pi_A^m = \pi_B^d$ and therefore $\delta_A^*(n_A) = \frac{2n_A-1}{2n_A}$. Now since $N = n_A + n_B$ and $n_A > n_B$ we have $N < 2n_A$. Therefore, t = 0, $\delta_A^*(n_A) > \delta_{FDI}^*(N)$. Also from Lemma 1, recall the behavior of $\delta_A^*(n_A)$, which is a decreasing function of t. Thus, for small values of t, we have a situation $\delta_A^*(n_A) > \delta_{FDI}^*(N)$ and therefore the incidence of FDI facilitates collusion if the common discount factor of the firms δ is such that $\delta_A^*(n_A) > \delta > \delta_{FDI}^*(N)$. However, for large values of t the incidence of FDI does not facilitate the collusion. Therefore, FDI will not take place. In Figure 2, this situation can be viewed as AB representing $\delta_A^*(n_A)$ and CD representing δ_{FDI}^* and the FDI facilitates collusion for the values of the discount factors belonging to the region AMC. Thus,

Proposition 3. *With asymmetric number of home firms $n_A > n_B \geq 2$, collusion becomes easier to sustain for smaller trade costs when all firms undertake FDI in the foreign country. The opposite happens when the trade costs are larger and as a result FDI will not take place. Thus, whenever FDI occurs, it must be pro-collusive.*

4.2. Asymmetric market size: market B is larger than market A

So far we have assumed that the size of the markets in two countries are equal. Now we allow for variations in market size by a scalar multiplication of $q(P)$, so that the quantity demand for each level of price is higher in foreign country by a scale factor say $\beta > 1$. This is equivalent to assuming that demand variation arises from replication of identical consumers which leaves the optimal monopoly price P^m unaffected as the first-order optimality condition (A2) is not influenced by the scalar β. Thus, even with different market sizes it is possible to maintain the collusion at the same monopoly price level in both countries and cross-market arbitrage cannot constrain this monopoly pricing based on SOI. With no change in P^m and $c*$, the changes in market size in country B only changes the profit expressions defined in (1), (2) and (3) also by the scale factor β as compared to the similar expression in Country A. Now to focus on the effect of asymmetric market size and its interaction with FDI we assume the same number of home firms in each country, which is n.

Given the same number of firms ($n > 2$) in each country and with country B assumed larger than country A, the collusion with SOI cartel is sustainable under no FDI if $\delta \geq max[\delta_A^*(n), \delta_B^*(n)]$. From (7) we can write the critical discount factors for country A and country B firms for sustaining collusion with SOI.

$$\delta_A^*(n) = \frac{(n-1)\pi_A^m + n\pi_B^d}{n[\pi_A^m + \pi_B^d]} = \frac{(n-1)\pi_A^m + n\beta\pi_A^d}{n[\pi_A^m + \beta\pi_A^d]} \tag{15}$$

and $\delta_B^*(n) = \frac{(n-1)\pi_B^m + n\pi_A^d}{n[\pi_B^m + \pi_B^d]} = \frac{(n-1)\beta\pi_A^m + n\pi_A^d}{n[\beta\pi_A^m + \pi_A^d]}$ (16)

Note with $\beta = 1$, i.e., with symmetric market sizes, the two critical discount factors are equal. As we increase β from 1 to a larger value we find that $\delta_A^*(n)$ will go up and the value of $\delta_B^*(n)$ will go down. When the market B is larger than market A, for each firm in country A the temptation to deviate from the SOI cartel and invade market B is larger and to balance the incentive the critical value of $\delta_A^*(n)$ has to be larger. On the other hand, for firms in country B, they enjoy a greater profit under collusion in market B and the deviation is less attractive as the market A is relatively small in size leading to a decrease in critical value of $\delta_B^* (n)$. However, for collusion to be sustainable with asymmetric market size, we need $\delta \geq max[\delta_A^*(n), \delta_B^* (n)] = \delta_A^* (n)$,when market B is larger.

Now consider the possibility that all firms are involved in FDI and as a result there are $2n$ firms in each country with equal number of domestic and foreign firms. The feasibility of FDI in anticipation of collusion is guaranteed under assumption that it is feasible for smaller Country A and given by

$(A7).\ \frac{\pi_A^m(c)}{2n(1-\delta)} - F > 0$

The international cartel with FDI will be sustainable (by condition (9)) if,

$\delta \ \geq \delta_{FDI}^*(2n) = \frac{2n-1}{2n}$.

Now comparing $\delta_A^* (n)$ and $\delta_{FDI}^*(2n)$ we find that at t=0, $\pi_A^m = \pi_A^d$ and therefore $\delta_A^*(n) = \frac{(n-1)+n\beta}{n[1+\beta]} > \frac{2n-1}{2n} = \delta_{FDI}^*(2n)$ for $\beta > 1$. However, for $t = \bar{t}$, $\pi_B^d = 0$ and hence $\delta_A^*(n) = \frac{(n-1)}{n} < \frac{2n-1}{2n} = \delta_{FDI}^*(2n)$.

Given the downward sloping nature of $\delta_A^*(n)$ with respect to t, it is clear that there exists a value of $t = \hat{t}$ (say) such that

for $0 \leq t \leq \hat{t}$, $\delta_A^*(n) \geq \delta_{FDI}^*(2n)$

and for $\hat{t} < t \leq \bar{t}$, $\delta_A^*(n) < \delta_{FDI}^*(2n)$.

In Figure 2, this situation can be viewed as AB representing $\delta_A^* (n)$ and CD representing δ_{FDI}^*. The range of parameters in (t, δ) for which FDI facilitates international collusion is given by AMC. On the other hand, the collusion without FDI is sustainable for all values of (t, δ) above the curve AB. Thus, for low levels of trade cost, FDI facilitates collusion which would not be possible otherwise.

Proposition 4. *As the size of the two markets becomes more unequal, then without FDI the critical discount factor goes up and this reduces the scope for collusion. However, FDI by all firms facilitates collusion for lower values of trade cost and hence FDI would occur in collusive equilibrium.*

Both this result and the previous one (in Proposition 3) are associated with the occurrence of FDI facilitating collusion at a lower levels of trade costs and interestingly these results are quite contrary to the tariff-jumping theories of FDI. Usually the tariff-jumping occurs at higher levels of tariff (trade cost) but propositions 4 and 5 demonstrate the opposite. These results also provide a partial rationalization of the empirically observed phenomenon that with trade liberalization the incidence of FDI have also gone up substantially in the world. Our collusion story throws some insight into this issue and provide an explanation for such observation.

5. Conclusion

There are many theories, both strategic and non-strategic, to rationalize the incidence of foreign direct investment and there is plenty of literature demonstrating the positive effects of FDI for the host economy. One common understanding is that the entry of foreign firms almost always increases the competition in the host market as the number of firms increases with FDI. This paper provides a new theory of FDI where the FDI occurs not as the outcome of saving the trade costs (associated with export trade) but as an instrument to facilitate an international cartel with spheres of influence. In this paper there is no incentive for undertaking FDI in our setting based on static tradeoff theory. However, due to the dynamic consideration of collusion that is sustainable with FDI, we would observe FDI in collusive equilibrium.

There is a recent literature on international cartels with spheres of influence to rationalize some of the empirical observations. Surprisingly, in that literature location of firms is assumed to be fixed and no serious attempt has been made to analyse the effect of multinational activity on the prospect of such international cartels. In this paper we built on the model developed by Bhattacharjea and Sinha (2015, 2016) which presented with varying degrees of generalisation, the basic issue of collusion sustainability between firms from different countries under price competition in homogenous good, but here we further added the option of foreign direct investment (FDI) which involves a fixed set up cost to be incurred at the beginning of the operation. Thus, in our model we have developed the story of collusion between price setting oligopolists with the trade-off that the trade between countries involves per unit trade costs and FDI requires a fixed cost of setting up an operation in a foreign country. We showed that the FDI may facilitate collusion and we also establish that cross hauling of FDI may indeed help an international cartel with sphere of influence based on the location of firms. With asymmetric number of firms or with different sizes of the markets, cross hauling of FDI facilitates international collusion whereas trade never occurs between countries. Thus, the papers by

Bhattacharjea and Sinha (2015, 2016) showed that apparently competition enhancing policies of trade liberalisation and domestic entry could paradoxically decrease competition by facilitating collusion while we show in this paper that the foreign entry through FDI can also reduce competition by facilitating collusion. However, given the significance of our results, we emphasise the role of antitrust authorities both at a local and global level in the presence of multinational firms and international antitrust policy coordination to deal with FDI at a global scale is extremely important.

The paper also provides important insights into the empirical observation that the trade liberalisation was accompanied by greater incidence of FDI since the 1990s. There are some theories to justify such behaviour. In our model, both with asymmetric market sizes or with asymmetric number of firms in each country, we find that the cross hauling of FDI facilitates collusion for lower values of trade costs. Thus, we also provide a rationalization of the empirically observed phenomenon that with trade liberalization, the incidence of FDI might go up. Our collusion story throws some insight into this issue and provides an answer to such observation that FDI and lower trade costs can be consistent when FDI helps to achieve international collusion based on spheres of influence in the world.

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