

Globalization, Fragmentation and Intra-Firm Trade

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Abstract

What are the theoretical determinants of intra-firm trade between identical countries? This paper focuses on firm and sectorial characteristics to state that this pattern of trade can be associated to low level of intermediate goods trade costs compared with those on final goods and markups imposed by upstream local producers, and multinational firms' technological structure such that scale economies are at the firm-level for downstream sector and plant-level for upstream one.

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1 Introduction

International fragmentation of production is one aspect of globalization of the world economy (Venables(1999)). This vertical disintegration can be associated to the development of outsourcing through inter-firm relations, leading to an increased share of trade in intermediate goods as described empirically by Feenstra (1998) and explained theoretically by Grossman and Helpman (2002) among others. It can also be associated to a spatial fragmentation with activities remaining within a single firm involving multinationality as described by Venables (1999). The latter aspect of fragmentation leads necessarily to the development of intra-firm trade.

Models endogenizing multinational firms (MNFs) in a framework of imperfect competition and scale economies in production predict two types of firms. On the one hand, horizontal MNFs (Markusen (1984), Horstmann and Markusen (1992), Markusen and Venables (1998)) are likely to exist between developed countries : if trade costs are high and firm-specific scale economies are important, firms will replicate the production process at home and abroad, producing the same product and supplying each market from their local plant. On the other hand, vertical multinational firms emerge mainly between countries in different stage of development (Helpman (1984), Zhang and Markusen (1999)). In fact, if countries are different in terms of endowments and income, firms fragment production process in order to take advantage of differences in production costs. Each stage will be undertaken where it is relatively cheaper. These models explain the existence of intra-firm trade in intermediate goods between developed and developing countries.

Also, *Fragmentation may cause the development of 'horizontal' MNCs, in which at least some of the firms' activities are replicated in two places (Venables (1999))*. This strategy may be explained by the knowledge capital one where firms locate their headquarters in one country and produce output in two different locations (Markusen (1997)). In this case,

there will be intra-firm trade only in services and not in goods.

Nevertheless, even if it is difficult to measure intra-firm trade due to its nature and the lack of data, some studies assess its importance regarding total international trade. According to UNCTAD (1996), one third of all international trade occurs within MNEs. In 1993, *the share of intra-firm exports by parent firms based in the country and affiliates of foreign firms located in the country in total exports of the country ranges from 38 per cent in the case of Sweden to 24 per cent in the case of Japan. the corresponding share of intra-firm imports in total country imports ranges from 14 per cent in Japan to 43 per cent in the United States.* Describing French data, Mathieu and Quélenec (1997) found that trade within multinational firms networks represents more than 35% of overall French trade. Moreover, 23% of the intra-group exports of French groups are for use in production. The use of these exports varies from one sector to another. The proportion of parts exported for assembly abroad approaches 25% in the motor vehicle industry and in electronic equipment and components. By country of destination, the larger part of French intra-firm exports to developed countries are resold without further processing : intra-firm exports of finished goods. But, there is a non negligible part of exports of intermediate goods. Moreover, using French data, Soubaya and Zitouna (2001) found a negative effect of differences in income between France and host countries and intra-firm exports of intermediate goods.

The existent theoretical literature on intra-firm trade describes mainly this pattern of trade between developed and developing countries. In fact, Konan (2000) develops a model in which intra-firm trade emerges endogenously for differences in costs motives. Roy and Viæne (1998) explain the existence of intra-firm imports of intermediate goods by vertical multinational firms in a context of variability in exchange rates.

Intra-firm trade in finished goods could be explained between developed countries by a reciprocal FDI dumping (Baldwin and Ottaviano (2001)) where firms produce different varieties of the same product in different countries in order to relax competition between them. Madan (2000) explained the emergence of intra-firm trade - either intermediate and final goods - without cost differences by the existence of different tax rates. The conclusion is that transfer prices can explain the existence of this pattern of trade either in intermediate and finished goods.

Venables (1999) explained some mechanisms behind the development of horizontal MNCs which fragment internationally production process. Using a model of perfect competition and constant returns, he argued that differences in factor intensities between different stages create incentives for the development of such firms. But, as noted by the author, this model abstracts from much that is important in the theory of MNC, in particular the issue of organisational fragmentation and the boundaries of the firm.

The objective of this paper is to explain theoretically the existence of intra-firm trade in intermediate goods between identical countries. The focus is, then, on firm and sectorial characteristics. MNCs are supposed vertically integrated, they decide whether, (1) to export, (2) to invest only in the downstream sector (buying one proportion of their intermediate inputs from local suppliers at arm's-length and importing the other one from related suppliers at home leading to the emergence of intra-firm trade in intermediate goods), (3) or to invest in downstream and upstream sector, bearing additional fixed costs of settlements and internalizing all the production process.

Results suggest that for a certain level of parameter values, intra-firm trade emerges as a best choice for firms. MNCs will choose to export if trade barriers on finished goods are not important and plant-level scale economies are important regarding firm-specific ones. They will choose to invest in downstream sector and buy intermediate inputs at arm's-length if markups are not important relative to intermediate goods trade costs and their scale economies are mainly

at the firm-level for downstream stage and plant-level in the upstream one. They will prefer to invest in downstream sector and import intermediate goods (intra-firm trade) if trade costs on intermediate goods are not important relative to markups and those on final goods, and their scale economies are mainly at the firm level for downstream stage and plant level in the upstream one. Finally, they will invest in the two sectors if firm-level scale economies are important relative to plant-level ones, and transaction costs and markups are important. Then fragmenting production process by investing only in the final good sector and importing intermediate goods from related upstream producers is the effect of, a difference in scale economies, in trade costs, and markups paid to local upstream producers and the level of competition either on the downstream and upstream sectors. These results are coherent with those of Horstmann and Markusen (1992) where, without fragmentation, MNEs exist when firm-level scale economies are important regarding plant-level ones and trade costs are high. However, by introducing intermediate good market, not only firm specific and plant-level scale economies are important but also upstream-plant scale ones and the difference between trade costs on intermediate and finished goods. Also, This model could explain complementarity between FDI and trade in intermediate goods (Head and Ries (2001)).

The remainder of the paper is organized as follows. Section 2 develops the model. Three different cases of MNEs strategies are analyzed. Section 3 compares between MNEs profits in different cases and discusses the effects of change in each parameter value on the equilibrium outcome. Section 4 concludes.

2 The Model

There are two identical countries, the focus is on two vertically related industries, that of an intermediate good and a final good. In the upstream stage, a homogeneous good is produced

in either country with marginal costs (the same in the two countries) c . There is an oligopoly market structure in the downstream sector in either country. The model chosen is imperfect competition in the vertically related industries which create a successive oligopoly (Greenhut and Ohta (1976)). Upstream producers are assumed to be endowed with market power on the intermediate good market, while downstream firms take the price of the intermediate goods as given. In addition, we suppose that firms can be vertically integrated in order to avoid markups on intermediate inputs. We limit the analysis to one country considering that there is symmetry with the other one. We suppose that foreign firms have the choice between (1) exporting their outputs, (2) investing only in the production of finished good or (3) investing in the two stages of production process. In the first case foreign firms bear a transaction costs t_f on final goods. In the second one, foreign firms have to pay a fixed cost of implementing new facility in the downstream sector abroad, F . In this case, they have to choose the optimal level of their inputs they buy from their related affiliates in their home country (β) : intra-firm trade. For this proportion of their inputs, they do not pay markups but they bear transaction costs which are related to intermediate goods : t_i . However, for the inputs they buy locally, they have to pay markups, μ_j . In the last case, they delocate all their affiliates, producing either intermediate and finished good locally. In this case, they have to pay fixed costs relative to their investment abroad either relative to downstream sector F and upstream one G , but they have not to pay neither markups nor transactional costs, they buy inputs at their costs, c . For all these cases, national downstream firms pay markups to national intermediate good producers. Moreover, intermediate good is a specific input to the final good and is not sold to consumers. Equilibrium on the final good market is resolved such as location configurations are chosen first, then, firms choose prices and quantities produced.

On the demand side, we assume linear inverted demand function for final goods :

$$p = a - bQ \quad (1)$$

with, $Q = nq_n + mq_m$. n is local final good producers number; q_n their output, m : foreign final good producers number and q_m their output.

Profits of downstream firms are:

$$\Pi_k = (p - c_k)q_k - F_k \quad k = n, m. \quad (2)$$

c_k is marginal cost of production and F_k their fixed costs.

We suppose that marginal costs of intermediate good producers in the two countries are the same (c). In fact, our aim is to explain the existence of fragmentation on production process even though there is no difference in production costs.

We suppose a Cournot-Nash equilibrium with technology such that one unit of intermediate good is used to produce one unit of final good. So, if final good producers and intermediate good ones are vertically integrated, marginal cost of upstream firms, c is the same than for downstream ones - in addition to trade costs if there are -. On the other hand, if they are not integrated, marginal costs of final good producers will be c plus a markup μ .

The resolution of the model is as follows : First, final good producers maximize their profits by equating their marginal revenues to their marginal costs. Their marginal costs can be :

- c : marginal costs of intermediate good producers, if they are integrated and located in the same country.

- $c + t_i$: marginal costs of intermediate good producers plus transaction costs on intermediate goods if upstream-downstream firms are vertically integrated and located in different countries.

- $p_z = c + \mu_z$: price of intermediate good which equals marginal costs of intermediate good

producers plus markups imposed by intermediate good producers if upstream-downstream producers are not vertically integrated.

Since we have technology such that one intermediate good is used to produce one unit of output, from this maximization program we have derived demand of intermediate goods by downstream producers and final good prices depending on upstream prices ($q_n(p_z)$, $q_m(p_z)$ and $p(p_z)$).

From the derived demand described above, we can calculate 'local' derived demand which is the derived demand of local intermediate goods. If MNFs (and national ones) buy $\alpha\%$ of their intermediate inputs locally, local derived demand will equal: $Q_z = nq_n + \alpha m q_m$ which depends on p_z .

This relation can, then be written as: $p_z = A - BQ_z$. Then, upstream firms maximize their profits by equating marginal revenues to their marginal costs, c . Thus, $Q_z^* = \frac{z_n(A-c)}{B(z_n+1)}$. Then, $p_z^* = A - BQ_z^*$, $\mu_z^* = p_z^* - c$. reporting this optimal level of upstream markups, we have q_n^* , q_m^* , p^* , μ_n^* and μ_m^* .

In what follows, we describe the cases and plot the results. Analytical results are in appendix.

- Case one profit maximization :

In this case, foreign firms don't invest neither in final good sector, nor in intermediate good one. So they will compete with local producers with a disadvantage since they have to pay transaction costs on final goods, t_f (transportation costs and trade barriers). However, they do not have to pay markups since they are supposed to be vertically integrated at home which is not the case for national downstream firms.

In this case, national upstream producers impose markups for their sales to national downstream producers only. Moreover, we set fixed costs to zero in this case because we take into account only additional fixed costs associated with implementing new facility in foreign country.

- Case two profit maximization :

In this case ¹, foreign firms invest in the downstream sector (becoming MNFs), they bear fixed costs (F). For their intermediate inputs, they choose an optimal level of imported intermediates from their related affiliates at home, this level (β) indicates intra-firm trade (exports of intermediate goods). For this part of their costs, they pay transactional costs on intermediate goods (t_i). For $1 - \beta$, which is the proportion of their intermediate goods they buy locally, they have to pay markups (μ_z^{2*}). On the other hand, national downstream producers pay markups on all their intermediate goods. As shown in Appendix B, the optimal level of upstream markups are function of competition on the downstream (n and m) and upstream sector (z_n), transaction costs on intermediate goods (t_i) and the market size.

Markups are illustrated in figure (1)². The relation between markups and intra-firm level is not monotone. Higher intra-firm proportion of input procurement raises markups up to a point, at which the latter declines if β rises. In fact, there are two opposite effects at work. An increase in β means that MNFs buy more intermediate goods from their related affiliate, so demand for local intermediate goods declines and markups rise. Whereas, β rises means that final good producers mean marginal costs decline, which results in an increase in final goods output thus an increase in the derived demand of intermediate goods and a decrease in markups. The latter effect becomes dominant the more intra-firm level important is. But at the same time, this decrease in markups does not affect MNFs since a high β means a low proportion of inputs concerned with these markups.

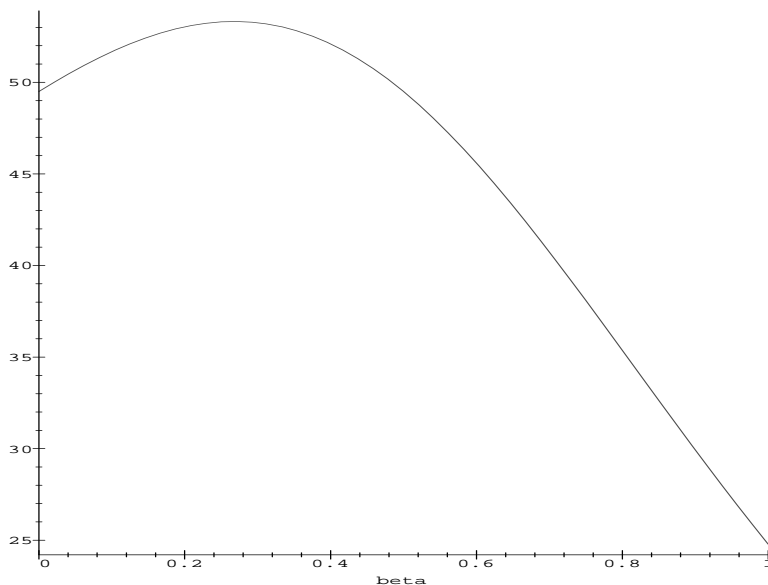
Consumer prices, MNFs' costs, their markups, their market shares and their production value are represented in figure (2)³ for the case of one MNF in this market. We note that final prices and costs are decreasing function of the intra firm level, β . It means that the more the foreign firm buys intermediate inputs from its related affiliate in its home country, the less is

¹This case works like in Belderbos and Sleuwaegen (1997) except that we introduce trade costs on intermediate goods, t_i and our interest is mainly on MNFs and not local upstream and downstream firms.

²parameters values used in simulations are: $m = 1$, $z_n = 1$; $t_i = 0.1$; $c=1$; $n=1$; $a=100$; $b=2$; $F=3$

³parameters values used in simulations are: $m = 1$; $z_n = 5$; $t_i = 0.1$; $c=1$; $n=5$; $a=100$; $b=2$; $F=3$

Figure 1: μ^{2*}



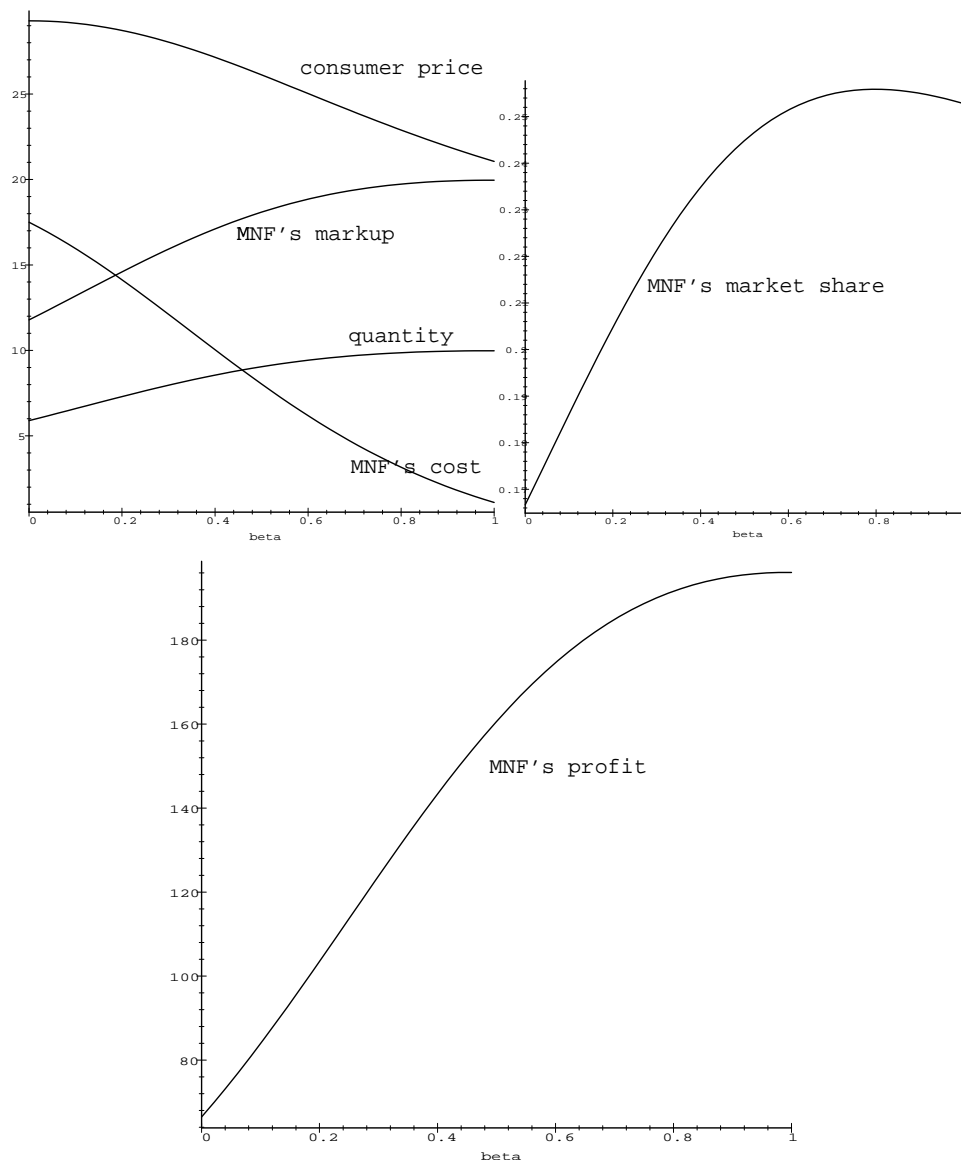
its costs since it avoids markups imposed by local upstream produces. So, more competition is created in the final good market which explains the decrease in prices. The decrease in costs is more important than the decrease in prices which explains the fact that markups are increasing. Quantities produced are also increasing in β . This is due to the fact that MNF's market share is increasing in β . Finally MNF profits are always an increasing function of intra-firm level suggesting that, if MNF is the only foreign firm in this market, it is optimal to buy all its intermediate inputs from its affiliates in intra-firm trade ($\beta = 1$).

What about the effects of an increase in m ?

As illustrated in figure (3)⁴ where MNFs number is set to 10, the increased competition between MNFs results in the same curve form for consumer prices and costs. The only difference is that for high values of β , prices decrease more than costs which results in a decrease in MNFs' markups. This decrease affects production negatively and it is due to the decrease in market shares. All these effects affect negatively MNFs profits. Comparing the third part of figure (2)

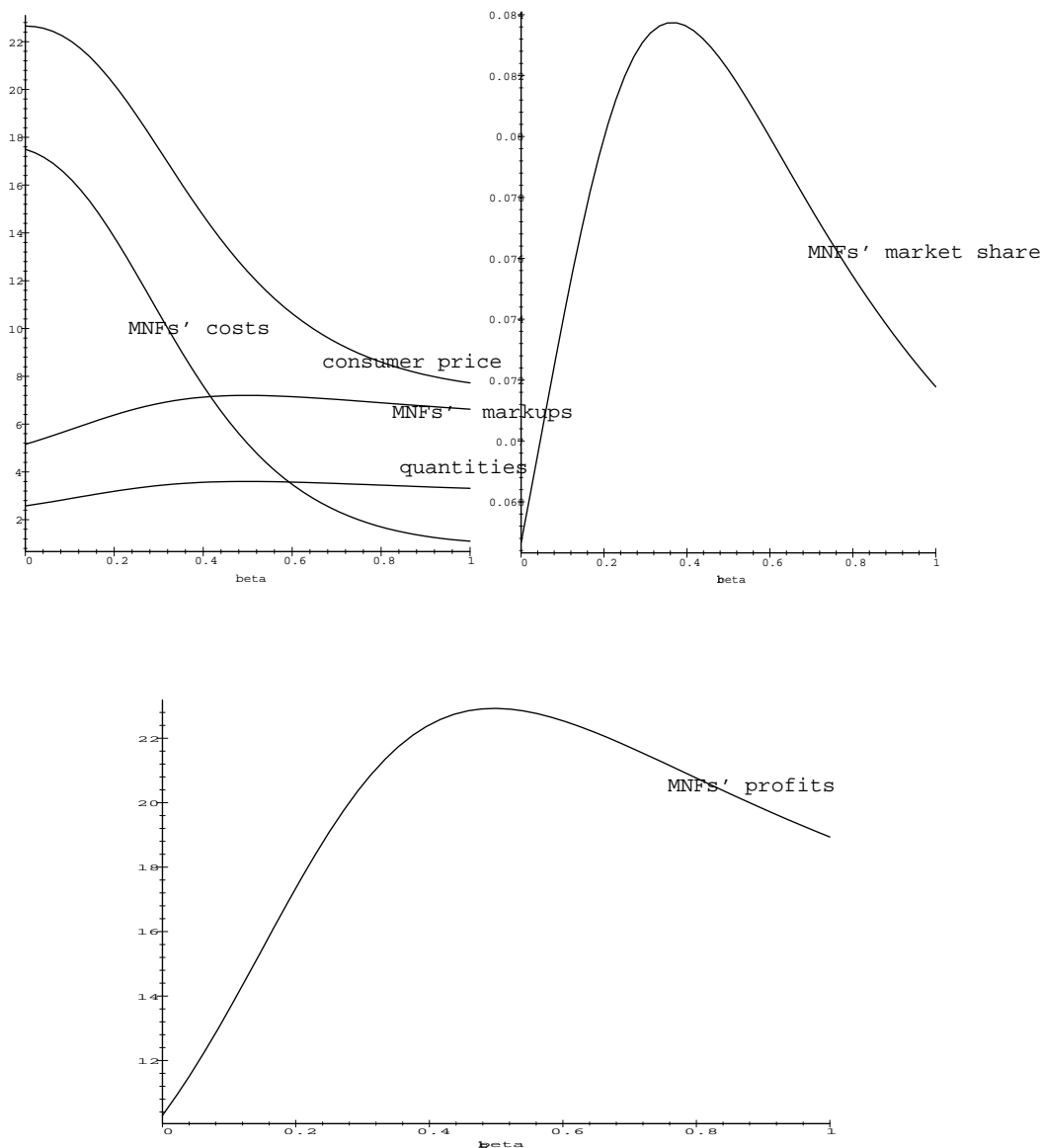
⁴parameters values used in simulations are: $m = 10$, $z_n = 5$; $t_i = 0.1$; $c=1$; $n=20$; $a=100$; $b=2$; $F=3$

Figure 2: case2 : $m = 1$



and (3), we see that profit levels are higher where $m = 1$. Moreover the slope of the curve is not the same since, for $m = 10$, profits are increasing in β until a certain level at which they decrease.

Figure 3: case : $m = 10$



Recall that the optimal level of intra-firm trade is decreasing with m (profit curve shifts to the left when m increase). That is, the more the number of MNFs high is, the less they will buy intra-firm trade. this is due to the increased competition between them.

The effect of an increase in z_n is a downward effect on the MNFs profits without any effect on the optimal level of intra-firm trade. The same effect is that of F, n and b , whereas a which is the market size has the opposite effect.

- Case three profit maximization :

This case is associated with an investment either in final good and in intermediate good sector by MNE. In fact, in order to avoid markups and transaction costs, they invest in the downstream sector (and pay F) and upstream one (and pay G). Local competitors have a disadvantage on operating profits since they have to pay a markups on their intermediate goods.

3 Interpretations:

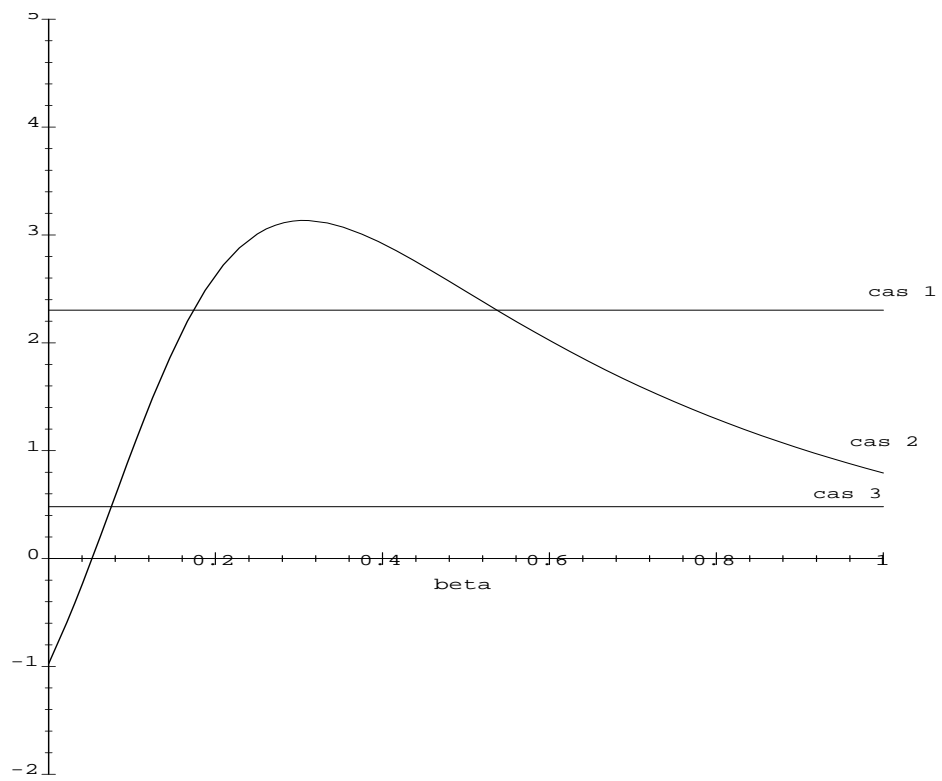
Parameters affecting equilibrium outcome are as described above : final goods transaction costs t_f , intermediate goods transaction costs, t_i , fixed costs of the downstream sector associated with new implementation abroad, F , fixed costs of the upstream sector associated with new implementation abroad, G and markups, μ . Moreover, MNEs number, national final good producers (said differently competition degree) and intermediate good producers number affect outcome. Intra-firm trade in intermediate goods is associated with case two : Multinational firms invest only in final good sector and buy one part of their inputs from their related upstream factories.

Figure (4⁵) plots profits of MNFs in the three cases regarding intra-firm level (β). Profits in cases one and three are not associated with this pattern of trade, so they will be a constant function of β . We plot these cases in order to study the effects of changes in parameter values on foreign firms choices. G affects case 3 profits and t_f case1. We chose variables in order to have comparable profits⁶.

⁵parameter values chosen are: $m = 20$; $t_i = 0.1$; $c=1$; $n=20$; $a=100$; $b=2$; $F=3$; $G=157$

⁶The fact that upstream firms have advantage over downstream ones implies very high markups. That is why G have to be very high regarding F But this does not affect qualitatively the results. The fact that t_f is

Figure 4: $\Pi_m^{1*}, \Pi_m^{2*}, \Pi_m^{3*}$



When does MNFs choose case associated with intra-firm trade ?

The decision choice of MNFs depends on their variable costs and the nature of their fixed costs in each case.

If fixed costs associated with upstream stage of production are too high (plant-level fixed costs), MNFs' profits in case three decrease, they choose case 1, in which they do not invest in the country and pay transaction costs on final goods, or case 2 in which they choose the optimal level of intra-firm proportion of their intermediate inputs. If it is not the case (firm-level fixed costs in the upstream stage), firms will choose case three in which they invest either in downstream and in upstream stage in order to avoid markups and transaction costs.

If t_f are not too high, they will choose case 1 in which they export from their home country. In doing so, they avoid markups and fixed costs.

If markups imposed by local intermediate goods producers are not too high, they choose case 2, otherwise, MNFs profits decrease and the latter choose cases 1 or 3 which are not associated with intra-firm trade. Also, the more local intermediate goods producers are, the less MNFs profits important are, the less likely they choose case 2 associated with this pattern of trade. Moreover, the more MNFs invest in the considered country, the more competition among them high is, the less is the proportion of intra-firm trade they choose in addition to the decrease in their profits.

The main conclusion is that intra-firm trade exist between countries with the same variable costs (same technological development and same wages). These results suggest that MNFs will choose to invest only in the downstream stage and buy one part of their intermediate goods from their related affiliates in intra-firm if :

higher than t_i is in accordance with studies on the structure of protection which show that tariffs on finished goods always tend to be higher than tariffs on intermediate inputs(Gillis et al. (1996)p:536)

- Trade costs on intermediate goods are not high relative to those on finished ones and markups imposed by national upstream producers;

- Fixed costs in the upstream sector are very high relative to those on downstream one. This means that, it is not costly to invest in a foreign country to produce final good (knowledge is transferable) which is not the case for the upstream stage.

4 Conclusion

The aim of this paper was to explain theoretically the existence of intra-firm trade between identical countries. The stress was put on firm (difference in fixed costs, industrial strategies) and sectorial characteristics (degree of competition, trade costs).

Results suggest that intra-firm exports of intermediate goods are associated with low level of intermediate goods trade costs compared to those on finished ones and technological structure such that scale economies are at the firm-level for downstream sector and plant-level for upstream one. So, without taking into account demand and costs differences between countries, intra-firm trade can emerge as an optimal choice by multinational firms. The level of this pattern of trade is function of competition in this market, especially it depends on the competition between MNFs in this market.

This model explains only one part of intra-firm trade (intra-firm exports of intermediate goods), it does not describe neither intra-firm imports of intermediate goods nor intra-firm trade of finished goods which constitute a non negligible proportion of this pattern of trade. Moreover, this model do not take into account the fact that national firms can also be vertically integrated avoiding markups on their inputs. We chose not to complicate calculations in order to have only explanation on the determinants of intra-firm exports of intermediate goods between identical countries.

In future research the same model structure could be extended to introduce industrial strategies such as foreclosing. This enables us to have more realistic cases which could be used to make some other interesting economic policy analysis on transfer prices, fiscal competition among others.

A Case 1

Markups imposed by local upstream producers to downstream ones are :

$$\mu_z^{1*} = \frac{a - c + mt_f}{(1 + z_n)(1 + m)} \quad (3)$$

From this expression, we have prices of national intermediate good, p_z^{1*} which equals $\mu_z^{1*} + c$,

$$p_z^{1*} = \frac{a + z_n c + m(t_f + c(z_n + 1))}{(1 + z_n)(1 + m)} \quad (4)$$

From this price, we calculate equilibrium quantities of intermediate goods produced, Q_z^{1*} , then equilibrium price of finished good p^{1*}

$$p^{1*} = \left(\frac{1}{1 + n + m}\right)[a + m(c + t_f) + np_z^{1*}] \quad (5)$$

quantities produces by downstream firms are :

$$q_n^{1*} = \left(\frac{1}{b(1 + n + m)}\right)[a + m(c + t_f) - (1 + m)p_z^{1*}] \quad (6)$$

$$q_m^{1*} = \left(\frac{1}{b(1 + n + m)}\right)[a - (n + 1)(c + t_f) + np_z^{1*}] \quad (7)$$

markups of national downstream firms are, then :

$$\mu_n^{1*} = p^{1*} - p_z^{1*} \quad (8)$$

$$\mu_m^{1*} = p^{1*} - (c + t_f) \quad (9)$$

Profits of national (n) and multinational (m) final good producers are :

$$\Pi_n^{1*} = \mu_n^{1*} q_n^{1*} \quad (10)$$

$$\Pi_m^{1*} = \mu_m^{1*} q_m^{1*} \quad (11)$$

B Case 2

$$\mu_z^{2*} = \frac{(a-c)((1-\beta)m+n) + t_i m \beta (\beta(n+1)-1)}{(1+z_n)(nm\beta^2+n+(1-\beta)^2m)} \quad (12)$$

From this expression, we have prices of national intermediate good, p_z^{2*} which equals $\mu_z^{2*} + c$,

$$p_z^{2*} = \frac{[(n+(1-\beta)m)a + \beta m(c+t_i)(\beta(n+1)-1) + cz_n(n+m(1+\beta^2(n-1)))]}{(1+z_n)(nm\beta^2+n+(1-\beta)^2m)} \quad (13)$$

$$q_z^{2*} = \frac{(a-c)((1-\beta)m+n) + t_i m \beta (n\beta - (1-\beta))}{b(1+n+m)(1+z_n)} \quad (14)$$

From this price, we calculate equilibrium quantities of intermediate goods produced, Q_z^{2*} ,

$$Q_z^{2*} = m q_z^{2*} \quad (15)$$

then equilibrium price of finished good p^{2*}

$$p^{2*} = \left(\frac{1}{1+n+m}\right)[a + (m+n)c + \beta m t_i + \mu_z^{2*}(n+(1-\beta)m)] \quad (16)$$

quantities produces by downstream firms are :

$$q_n^{2*} = \left(\frac{1}{b(1+n+m)}\right)[a + m\beta t_i - c - (1+m\beta)\mu_z^{2*}] \quad (17)$$

$$q_m^{2*} = \left(\frac{1}{b(1+n+m)} \right) [a - (1+n)\beta(c+t_i) + (n\beta - (1-\beta))p_z^{2*}] \quad (18)$$

markups of national downstream firms are, then :

$$\mu_n^{2*} = p^{2*} - p_z^{2*} \quad (19)$$

$$\mu_m^{2*} = p^{2*} - (\beta(c+t_i) + (1-\beta)p_z^{2*}) \quad (20)$$

Profits of national (n) and multinational (m) final good producers are :

$$\Pi_n^{2*} = \mu_n^{2*} q_n^{2*} \quad (21)$$

$$\Pi_m^{2*} = \mu_m^{2*} q_m^{2*} - F \quad (22)$$

C Case 3

$$\mu_z^{3*} = \frac{a-c}{(1+z_n)(1+m)} \quad (23)$$

price of intermediate good:

$$p_z^{3*} = \frac{a + cz_n + mc(z_n + 1)}{(1+m)(1+z_n)} \quad (24)$$

$$q_z^{3*} = \frac{n(a-c)}{b(1+n+m)(1+z_n)} \quad (25)$$

$$Q_z^{3*} = z_n \frac{n(a-c)}{b(1+n+m)(1+z_n)} \quad (26)$$

prices of final goods :

$$p^{3*} = \left(\frac{1}{1+n+m} \right) [a + mc + np_z^{3*}] \quad (27)$$

quantities produces by downstream firms are :

$$q_n^{3*} = \left(\frac{1}{b(1+n+m)}\right)[a + mc - (1+m)p_z^{3*}] \quad (28)$$

$$q_m^{3*} = \left(\frac{1}{b(1+n+m)}\right)[a - c(1+n) + np_z^{3*}] \quad (29)$$

markups of national downstream firms are, then :

$$\mu_n^{3*} = p^{3*} - p_z^{3*} \quad (30)$$

$$\mu_m^{3*} = p^{3*} - c \quad (31)$$

Profits of national (n) and multinational (m) final good producers are :

$$\Pi_n^{3*} = \mu_n^{3*} q_n^{3*} \quad (32)$$

$$\Pi_m^{3*} = \mu_m^{3*} q_m^{3*} - (F + G) \quad (33)$$

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