Multinationals, production externalities, and complementarity between domestic and foreign activities?

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I. INTRODUCTION

Policy makers usually worry about the increasing level of foreign production by multinational firms (MNEs) based in their regions because of negative effects on trade, production and employment. Commonly, it is argued that MNEs shut down production facilities because of high costs, especially high wages, at home and shift their production to low cost countries. The premise underlying this argument is that home and foreign production of a given MNE are substitutes. For modelling MNE behaviour, the preconditions for the existence of MNEs, namely the motives for the integration of activities across country borders within one firm as it is analysed in the huge literature on vertical and horizontal integration have to be taken into account. They imply that in the presence of ownership advantages the substitutional relationship between home- and foreign production (e.g. in the case of horizontal integration across borders) may be much weaker as suggested by previous models (e.g. CALDERON-ROSELL, 1985), even a complementary relationship between home and foreign production is possible. This paper applies theories of industrial organisation explaining the motives for vertical and horizontal integration to shed some light on this relationship and gives precise conditions for complementarity.

The theory of the multinational firm states that these firms exploit firm-specific advantages or supply additional services, for example to gain world-wide reputation, which possess the characteristics of a public good within the firm as they can be used in several plants without additional costs. These public good characteristics provide a rationale for internalising these activities within the firm, leading to foreign direct investment if the plants are set up in foreign countries\(^1\). More important, this induces externalities which generate an interdependence between the home and foreign market.

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1. Note that the approach taken in this note may be interpreted as an operationalisation of Dunning’s OLI-framework (DUNNING, 1988).
For conceptual reasons it is important to distinguish between vertically and horizontally integrated multinationals although in reality the two forms often occur simultaneously. Vertical forward integration across country borders into sales units usually generates intrafirm trade and leads to complementarity. It may be desirable in markets where additional services are provided. For example, these services may contribute to the high-quality reputation of the multinational firm or make the manufacturer’s good more attractive to consumers. If the reputation is world-wide, or if consumers are internationally mobile, there are horizontal externalities between the downstreams in several countries and a public good problem arises. The additional services the downstream provides to the consumers or its contribution to world-wide reputation in one country may also increase the demand of all other downstreams in the other countries. Since an independent downstream firm would not obtain the full return of services it provides, an inefficient amount of services would be supplied. Therefore, the upstream has the incentive of forward integration, which leads, among other possible forms of vertical restraints, to an efficient provision of services as well as to higher profits (Tirole, 1988, p. 183).

Horizontally integrated MNEs, in contrast, produce the same good in plants located in several countries in order to exploit differences in cost conditions and/or economise on transportation costs. A common characteristic of horizontally integrated multinational firms is the utilisation of inputs or intermediate products like know-how or management expertise, which can be employed simultaneously in several plants at home and abroad without additional costs. Again a public good problem arises which leads to market failure in the markets for these inputs. In the absence of possibilities for patenting and licensing the know-how its provision by the market would bring about an inefficient allocation of resources (Markusen, 1984; Caves, 1996).

Transaction cost theorists also stress the importance of market failure, e.g. in the market for know-how, reputation or intermediate inputs arising from high transaction costs or the small number condition of bargaining as main determinants for the existence of multinational firms (Hennart, 1991). Although the internalisation decision may also be caused by high transaction costs, the public good characteristics of know-how, reputation or intermediate inputs are viewed as the economically most important source of internationalisation by foreign direct investment (Markusen, 1984; Helpman, 1984, 1990; Caves, 1996). Following Markusen (1984) and Helpman (1984) the approach taken in this study likewise assumes that the exploitation of ownership advantages should be internalised. Licensing or franchising as an alternative contractual framework to becoming multinational by investing abroad is not considered.

2. The engineering branch provides an example: Here it is most likely that a successful project undertaken in one country increases the world-wide reputation of the multinational firm and, therefore, leads to more projects, also in other countries.

3. For example, this is likely to be the case in the tourism branch or in the air travel market.
The motives of vertical and horizontal integration discussed above can easily be incorporated into a model of a monopolistic multinational firm which operates in two countries with segmented markets (see HORST, 1971 for the basic model). The main point of the proposed model is that economies of multiplant operation arising from firm-specific advantages, as well as horizontal externalities between downstream-divisions, generate an interdependence between the home and the foreign market. So the possibility exists, even in the case of horizontal integration across borders that foreign production and home production are complements. This is the case whenever multiplant economies of scale and/or transportation costs are sufficiently large. Furthermore, since both foreign production and home production are considered endogenously, a new definition of the complementary and substitutional relationship is proposed. Foreign production and home production are defined as complements (substitutes) if they move in the same (opposite) direction upon shifts in the exogenous parameters. The next section presents a model of a monopolistic, vertically integrated MNE and states a proposition concerning the complementary relationship of production at home and abroad. Section 3 explores the horizontal integration case, whereas Section 4 extends the simple model of Section 3 to an oligopolistic setting. Section 5 concludes.

II. VERTICAL FORWARD INTEGRATION OF A MULTINATIONAL FIRM – A SIMPLE MODEL

The simplest way to illustrate the vertical integration case is to assume a price-discriminating, monopolistic, multinational firm operating in the home (H) and the foreign (F) market. The multinational firm supplies \( s_i, i = H, F \) units of a good in each market. Additionally, it provides services, \( z_i \), in each country which are perfect substitutes to price discounts (TIROLE, 1988, p. 178). As discussed above, it is assumed that service externalities exist, so that in each market the overall service available amounts to \( z_i + \alpha z_j \), \( i, j = H, F, \alpha < 1 \). The parameter \( \alpha \) measures these service externalities. They form an incentive to vertical integration across borders since providing services to one market increases demand in both the home and the foreign market simultaneously. With these assumptions demand in each market is given by a function

\[
s_i(p_i, z_i, z_j) = f_i(p_i - z_i - \alpha z_j) \text{ or } f_i^{-1}(s_i) + z_i + \alpha z_j = p_i(s_i) + z_i + \alpha z_j, \quad i, j = H, F
\]

4. As an anonymous referee has pointed out there are a variety of examples for services with public properties that may be captured by \( z_\cdot \). For example, it could represent after sales services or a warranty, which, if available worldwide, would obviously make the firm’s output more appealing in all markets. It could also represent advertising, the impact of which tends to spread across borders (thanks to international magazines and newspapers, satellite TV, etc.), even if the costs are occurred in one or the other country specifically.

5. With these externalities a linear franchise contract is not efficient. However, as MATHEWSON, WINTER (1984) show, a combination of various instruments of vertical control may suffice.
Note that $p_i(s_i)$ corresponds to the price in the case of no additional services ($z_H = z_F = 0$). In addition, it is supposed that the multinational enterprise produces an intermediate product, $x$, at constant marginal costs, $c$, in the home country. The downstream-divisions in each country add an input $y_i$ using one unit $x$ per unit of $y_i$. This generates additional country-specific, constant marginal costs $c_i$. So in each market the final product is supplied at constant marginal costs $c + c_H$ and $c + \tau + c_F$, respectively. $\tau$ refers to a specific tariff on imports of the intermediate input. Services are produced with country specific quadratic costs (D’ASPREMONT, JACQUEMIN, 1988)

$$K_i(z_i, k_i) = z_i^2 / 2k_i$$

where $k_i$ is a parameter which shifts the marginal costs of producing $z_i$ downwards. For ease of exposition the cost function of services is formulated in such a way that higher $k_i$ implies lower service costs. An increase in $k_i$ may thus be interpreted as an increase of labour productivity or as a decrease of the wage rate in the service sector, for example. Home production consists of $y_H$, $x_H$, $x_F$, $z_H$ and foreign production is $y_F$ and $z_F$. Note that in contrast to a tax on profits at home and abroad or an ad-valorem tariff the multinational firm does not set high transfer prices to circumvent the specific tariff. Thus, the specific tariff on imports of the intermediate good should be interpreted as a kind of transportation costs. Summing up, the multinational firm wants to maximise profits, which are given by

$$\max_{s_H, s_F, z_H, z_F} \{ [p_H(s_H) + z_H + \alpha z_F - c - c_H]s_H + [p_F(s_F) + z_F + \alpha z_H - c - c_F - \tau]s_F - K^H(z_H, k_H) - K^F(z_F, k_F) \}$$

(2)

The first order conditions are straightforward. Conditions (3) and (4) demonstrate that marginal revenues should equal marginal costs in each market. Furthermore, the demand in both markets can be increased by supplying additional services. Equations (4) and (5) underline this public good characteristic, indicating that for profit maximisation marginal revenues of additional services depend positively on total supply in both markets. Denoting $p_i(s_i)$ by $r^i$, $i = H, F$, the first order conditions read:

$$r^H_{s_H} + z_H + \alpha z_F - c - c_H = 0$$

(3)

This does not form a restrictive assumption. The following proposition also holds with a more general cost function $K^i(z_i, k_i)$, $K^i_z > 0$, $K^i_{zz} > 0$, $K^i_{zk} < 0$. However, the calculation of comparative statics are rather intractable in this case.

7. To see this, denote the transfer price on imports of the intermediate input by $p_m$. Total profits including transfer pricing are

$$\Pi = [p_H(s_H) + z_H + \alpha z_F - c - c_H]s_H + [p_F(s_F) + z_F + \alpha z_H - p_m - \tau - c_F]s_F - K^H(z_H, k_H) - K^F(z_F, k_F) + (p_m - c)s_F = [p_H(s_H) + z_H + \alpha z_F - c - c_F]s_H + [p_F(s_F) + z_F + \alpha z_H - c - c_F - \tau]s_F - K^H(z_H, k_H) - K^F(z_F, k_F)$$

8. Throughout the paper a superscript of $r$ refers to the market, whereas a subscript refers to the partial derivative.
\[ r_{s_F} + z_F + \alpha z_H - c - c_F - \tau = 0 \]  
(4)

\[ s_H + \alpha s_F - K_H^F = s_H + \alpha s_F - \frac{z_H}{k_H} = 0 \]  
(5)

\[ \alpha s_H + s_F - K_F^H = \alpha s_H + s_F - \frac{z_F}{k_F} = 0 \]  
(6)

Assuming that the second order condition holds, the comparative static effects of parameter variations can be easily derived by substituting (5) and (6) in (3) and (4), respectively. Solving the total differential of (3) and (4) yields the comparative statics which are provided in the Appendix[^9] and summarised in Table 1. Table 1 also compares the comparative statics of the system (3)–(6) with the case of no externalities (\( \alpha = 0 \)).

<table>
<thead>
<tr>
<th>Parameter-variation</th>
<th>( \alpha &gt; 0 )</th>
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a) home production: \( y_H, x_H, x_F, z_H \)

b) foreign production: \( y_F, z_F \)

Since both supply at the home and the foreign market are endogenous, we define these (and likewise home production and foreign production) as complementary (substitutional) with reference to variations of a certain parameter, if they move in the same (opposite) direction in the case of an exogenous parameter change. It should be borne in mind that there is a difference between the quantity sold in each market and the production of the MNE at each location, since production also includes exports of the intermediate input. The comparative statics for \( s_H \) and \( s_F \) show that the supply of the vertically integrated multinational firm at the home and the foreign market is independent.

[^9]: The specific tariff is neglected, since its comparative static effect is equal to that of marginal costs \( C_F \).
in the case of $\alpha = 0$ for small variations of $c_H, c_F, k_H, k_F$, and complementary for variations of $c$. However, the production including exports of the intermediate inputs are complements for small variations of $c, c_F, k_F$ since a rise in the quantity sold abroad generates additional intrafirm trade and increases production at home. In contrast, supply at home and abroad as well as home production and foreign production are complements in any case, if service externalities exist. Reduced marginal costs of services abroad, for example, lead to a higher amount of services supplied in the foreign market and, due to the service externalities, to increased demand in both markets. In addition, the marginal returns on services in the home market are also increased, so it pays for the multinational firm to expand services also in the home market. Thus, both supply at the home and at the foreign market along with production of the intermediate input are further increased. Intrafirm exports of the intermediate product are driven up, too. The same argument also applies to reduced country-specific costs of production, to give another example. A decrease of $c_H$ raises supply in the home market as well as the returns on additional services so that again demand is promoted in both markets. Proposition 1 summarises these results, the proof is provided in the Appendix.

Proposition 1:
In the case of an international vertically integrated monopolist which uses intermediate products produced at the home location and supplies additional services with public good characteristics, supply at the home and the foreign market as well as home production and foreign production (and exports) are complements for small variations of all exogenous parameters.

III. THE HORIZONTAL INTEGRATION CASE

Consider a horizontally integrated monopolistic firm which operates two plants, one in the home country and one in the foreign country. For simplicity, again it is assumed that marginal costs in each plant are constant\(^ {10} \). The multinational firm can reduce both of them to $c_i - z$ by obtaining production know-how, $z$, at cost $K(z,k)$, $K_z > 0$, $K_{zz} > 0$, $K_{zk} < 0$. In order to secure positive marginal costs for $z > 0$, it has to be assumed that $z < c_H$ and $z < c_F$ implying further restrictions on $K(z,k)$. The multinational enterprise also engages in trade in order to exploit cost differences between the locations. It is postulated that the home plant operates with lower marginal costs so that the multinational firm exports to the foreign country. Hence, exports $(x)$ are positive. To avoid corner solutions due to constant marginal costs where the production is concentrated in the lower cost plant, quadratic transportation costs $T(x) = tx^2 / 2 + \tau x$ are assumed. $\tau$ again refers to a specific tariff on the imports of the foreign country. The assumption of quadratic transportation costs seems reasonable, if they are interpreted as

10. This assumption has been made for ease of exposition. The results derived in the sequel do hold with increasing marginal costs as well.
costs of running service or transportation networks for the distribution of goods (SCHERER, ROSS, 1990, p. 120–125). In this case it is plausible that marginal transportation costs (in a wide interpretation) increase with the volume of exports. The results, however, do not depend on the specific assumptions on transportation costs\textsuperscript{11}, but simplify the analysis considerably, for the decision about exports is separable with this assumption. Furthermore, an interior solution for $x$ is postulated, ($x < s_F$), so that it never pays to concentrate production in the home plant even in the case of quadratic transportation costs. The horizontally integrated multinational firm maximises profits, which are formally nearly identical to (1), but augmented by a term describing the gains from the exploitation of cost differences by exporting\textsuperscript{12}.

$$\begin{align*}
\text{Max} \left( p_H(s_H) - c_H + z \right) s_H &+ \left( p_F(s_F) - c_F + z \right) s_F - K(z, k) + (c_F - c_H - \tau) x - \frac{tx^2}{2} \\
&= (p_H s_H - c_H + z) s_H + (p_F s_F - c_F + z) s_F - K(z, k) + (c_F - c_H - \tau) x - \frac{tx^2}{2}
\end{align*}$$

(7)

The first order conditions are straightforward as follows:

$$r_{s_H}^H + z - c_H = 0$$

(8)

$$r_{s_F}^F + z - c_F = 0$$

(9)

$$s_H + s_F - K_z = 0$$

(10)

$$c_F - c_H - \tau - tx = 0$$

(11)

Differentiating of (8)–(11), and assuming again that the second order condition holds, gives the comparative static effects of parameter variations as summarised in Table 2.

\textsuperscript{11} The results also hold true under more general assumptions. Only convex transportation costs or convex costs of production in each plant are required.

\textsuperscript{12} In this setting transfer prices, $p_m$, also have no role and cancel out, since:

$$\Pi = (p_H(s_H) - c_H + z) s_H + (p_F(s_F) - c_F + z) s_F - K(z, k) + (c_F - c_H - \tau) x - \frac{tx^2}{2}$$

$$= \left( p_H(s_H) - c_H + z \right) s_H + \left( p_F(s_F) - c_F + z \right) s_F - K(z, k) + (c_F - c_H - \tau) x - \frac{tx^2}{2}$$
Table 2: Comparative statics in the case of horizontal integration

<table>
<thead>
<tr>
<th>Parameter-variation</th>
<th>( z &gt; 0 )</th>
<th>( z = 0 )</th>
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<td>( c_F )</td>
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<td>( k )</td>
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</table>

a) \( q_H = s_H + x \), home production
b) \( q_F = s_F - x \), foreign production
c) negative if multiplant economies of scale and/or marginal transportation costs are sufficiently large

A detailed proof is given in the Appendix which shows that home and foreign production are substitutes for small variations of all parameters in the absence of firm-specific know-how \( (z = 0) \). Furthermore, supply at the home market and the foreign market is independent in this case. The possibility of a complementary relationship between home and foreign production arises if multiplant economies of scale and/or marginal transportation costs are rather large. If this is the case, a cost reduction in the home plant, for example, induces higher investment in firm-specific assets, \( z \). Home production and exports are driven up, but since the now higher firm-specific assets have public good characteristics, (the know-how can be employed at the foreign plant without additional costs), marginal costs of producing abroad are also reduced so that foreign production is enlarged as well. In contrast, a cost reduction in the foreign plant leads to reduced exports and increased foreign production, but it may likewise generate higher production at the home location due to the effect on firm specific assets if it more than offsets the reduction in exports. An increase in the costs of producing firm-specific know-how, \( z \), reduces both home and foreign production, whereas exports are not affected. Conversely, an increase in marginal transportation costs or in the specific tariff only has an effect on exports in this model. For small variations in \( t \) and \( \tau (k) \), home production and foreign production are therefore substitutes (complements) in any case. Proposition 2 states the precise sufficient condition for a complementary relationship between home and foreign production. A proof of the argument is likewise given in the Appendix.

**Proposition 2:**
In the case of an international horizontally integrated monopolist with firm-specific assets, foreign production and home production are complements for small variations of \( c_H, c_F \) if

\[
t > - \text{det}(H) = r_{s_F}^F \left( r_{s_H}^H K_{z z} + 1 \right) + r_{s_H}^H
\]

\( H \) denotes the matrix of the second order derivatives of (8)-(10). For small variations of \( t \) and \( \tau (k) \) they are substitutes (complements) in any case.
If a multinational firm faces high and increasing transportation costs, proximity to the market becomes important, since exports as a mode of serving foreign markets are bounded to an optimal level (BRAINARD, 1993). However, if supply at the foreign market increases further, for example because of more firm-specific assets, foreign production and home production move in the same direction and are thus complementary.

The vertical integration and the horizontal integration model are formally nearly identical. This can be seen most easily, if we compare the vertical integration case setting $\alpha = 1$ with the horizontal one. The case of $\alpha = 1$ amounts to the maximal externality where one unit of service has the same effect on demand in both markets just like one unit of know-how on production costs at both locations. The main difference then is a matter of interpretation. Additional services provided in one market shift demand in both markets by the same amount as know-how does the marginal cost curves. There are, however, important differences concerning the costs. Services are produced separately in each market and thus also affected by foreign cost conditions ($k_i$), whereas the production of know-how is assumed to be centralised in the home country. The second difference between the two models lies in the role of exports. In the vertical integration case they are determined by the quantities of the final product sold abroad, whereas in the horizontal integration case exports help to exploit differentials between marginal costs at home and abroad.

IV. HORIZONTAL INTEGRATION ACROSS BORDERS AND OLIGOPOLISTIC BEHAVIOUR

It would be desirable to extend the simple model of a horizontally integrated, monopolistic, multinational enterprise to a more realistic oligopolistic setting where the multinational firm faces rival national firms, at least on the foreign market. One possible extension, for example, is the assumption that the multinational firm acts as a leader on the foreign market due to its firm-specific advantages and as a monopolist at home. It could be postulated that the rival national firms on the foreign market produce with the same marginal costs but have no advantages arising from economies of multiplant operation or service externalities. Reinterpreting demand at the foreign market as perceived residual demand one can immediately conclude that in this case Proposition 1 and 2 also hold true. Note, however, that in the leader-follower-game the spillovers

$$\left| \frac{\partial s_H}{\partial c_F} \right| \leq \left| \frac{\partial s_F}{\partial c_H} \right|$$

are lower, since the slope of perceived marginal revenue abroad is smaller (in absolute terms). Consequently, we can safely conclude that in the leader-follower game complementarity becomes more likely for small variations in $c_H$ and $c_F$ as compared to monopoly.
The leader-follower game on the foreign market does not capture the whole story. Therefore, a multinational enterprise which acts as monopolist at the home market and as an oligopolist in the foreign market is also considered. We analyse a simultaneous, open loop game where the strategies of the multinational firm comprise decisions about \((s_H, s_F, x, z)\) and that one of the \(n\) identical foreign incumbent firms consist of \((S'_F, Z)\) (Variables and parameters referring the foreign firms are denoted by capital letters). Again quadratic costs of producing firm-specific assets, \(K(z, k) = z^2 / 2k\) and \(K(Z, K) = Z^2 / 2K\) are assumed. In an open loop game the maximisation procedure of the multinational firm can be broken up into two stages. In the first stage the optimal \(z\) and \(x\) as well as \(Z\) are determined for given \(s_H\) and \(s_F\) as well as \(S'_F\), respectively, by the minimisation of costs leading to first order conditions for these variables which are identical to (10) and (11). With these assumptions, by substituting for \(z\), \(Z\) and \(x\) from the first order conditions and denoting \(S_F = \sum_{i=1}^{n} S'_F\) the reaction functions can easily be derived as:

\[
\begin{align*}
  r^H(s_H) + k(s_H + s_F) - c_H &= 0 \\
r^F(s_F, S'_F) + k(s_H + s_F) - c_F &= 0 \\
R(s_F, S'_F) + KS'_F - C_F &= 0
\end{align*}
\]

The comparative statics are derived in the usual way by differentiating the system (12)–(14) totally (DIXIT, 1986). They are summarised in Table 3 and Proposition 3. The calculation is shown in the Appendix:

13. With this set-up of the game it is ruled out that the firms also engage in R&D competition. If this is the case, a two-stage game would be appropriate where in the first stage the firms compete in R&D and in the second stage they have Cournot competition. BRANDER, SPENCER (1984) present an analysis for the much simpler case of one market. DE BOND'T, SLEUWAGEN, VEUGELERS (1988) analyse a two stage game between a multinational firm and an incumbent firm assuming linear demand and R&D spillovers. Both show that under plausible conditions the closed loop equilibrium exhibits higher R&D of both the foreign and the multinational firm as compared to the open loop game.
Table 3:
Comparative static in the case of horizontal integration and oligopoly in the foreign market

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<tr>
<th>Parameter-variation</th>
<th>$z, Z &gt; 0$</th>
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a) $q_H = s_H + x$, home production
b) $q_F = s_F - x$, foreign production
c) negative if multiplant economies of scale and/or marginal transportation costs are sufficiently large

Table 3 and the calculation in the Appendix indicate that the results of the monopolistic case carry over to oligopoly quite well. We thus can formulate

**Proposition 3:**

In an international oligopoly with a horizontally integrated multinational enterprise with monopoly at the home market and identical rival firms at the foreign market all possessing firm-specific assets, foreign production and home production are complements for small variations of $c_H$, $c_F$ if

$$ t > \frac{\det(H)}{k(R_{S_F} + K)} = \frac{1}{k}(r_{s_H}^H + k)(r_{s_F}^F + k) - \frac{r_{s_F}^F R_{S_F} (r_{s_H}^H + k)}{k(R_{S_F} + K)} - k. $$

$H$ denotes the matrix of the second order derivatives of (6.1)–(6.3). For small variations of $t$ and $\tau$ ($C_F$, $k$, $K$) they are substitutes (complements) in any case.

In oligopoly, home production and foreign production of the multinational enterprise are likewise substitutes for small variations of transportation costs and of the specific tariff. In the presence of firm-specific assets they are unambiguously complements for variations in $C_F$, $k$, and $K$. If the foreign firms become less competitive because of higher costs of generating firm specific assets or because of higher marginal costs, the multinational firm can increase its sales in the foreign market and will also expand its production abroad. As pointed out already in the monopoly case, this increases the profitability of generating firm-specific assets and thus also home production. For small variations in marginal costs, home production and foreign production complement each other if multiplant economies or scale and/or transportation costs are sufficiently large, respectively. Compared to monopoly, the condition for complementarity also includes the
reactions of the foreign firms. As can be seen from Proposition 3, this effect is unambiguously negative. Since, in addition, perceived marginal revenue usually possesses a lower slope in absolute value than in monopoly, we can conclude that this condition is less stringent than that one of Proposition 2. It follows that if home and foreign production are complements in monopoly they are complements under oligopoly, too. The reason for this should be obvious. If, for example, marginal costs at the home location decrease, it does not only pay to increase exports and production at home, but also investment in R&D to generate more firm-specific assets. This improves the foreign cost conditions of the multinational firm but additionally fosters its competitive position at the foreign market vis-à-vis the rival firms and leads to gains in market shares abroad\textsuperscript{14}.

V. CONCLUSIONS

This note uses a simple model of a monopolistic, vertically or horizontally integrated multinational firm which has firm-specific advantages arising from externalities between the downstream divisions or from economies of multiplant operation due to firm-specific assets. It is argued that in the vertical integration case home and foreign production are complements in any case in the presence of such externalities. For certain parameter variations the same holds true for horizontally integrated multinational firms with firm-specific assets and transportation costs. It has especially been shown that home production and foreign production are complements for small variations in marginal costs of production if multiplant economies are sufficiently large compared to transportation costs. The assumption of an international monopoly is rather restrictive. Modelling competition on the foreign market by a simultaneous, open loop quantity Cournot game has likewise established the possibility of complementarity. It has been demonstrated that complementarity is more likely in oligopoly since there is an additional effect owing to the strategic reactions of foreign firms.

The conclusions for an economic policy of the home country towards increased internationalisation by foreign direct investment of multinational firms should also be obvious. There is no simple argument for favouring or discouraging multinational production from the home country's point of view. The analysis has made clear that multinational production may substitute or complement home production and exports depending on the form of foreign direct investment, the relation of multiplant economies of scale and transportation costs and also on the motive, i.e. the parameter variation which has induced it.

\textsuperscript{14} JOEN, SLEUWAGEN, (1994) also analyse the behavior of multinational firms in an oligopolistic setting. They likewise conclude that the strategic effects of this kind are important.
Appendix

**Proof of Proposition 1:**

Substituting (5) and (6) in (3) and (4) gives first order conditions in \( s_H \) and \( s_F \):

\[
egin{align*}
    r_H^H + k_H^H (s_H + \alpha s_F) + \alpha k_F^F (s_F + \alpha s_H) - c - c_H &= 0 \\
    r_F^F + k_F^F (s_F + \alpha s_H) + \alpha k_H^H (s_H + \alpha s_F) - c - c_F - \tau &= 0
\end{align*}
\]

Differentiating totally leads to the comparative static effects as summarised in Table 1:

\[
\begin{bmatrix}
    ds_H \\
    ds_F
\end{bmatrix} = \frac{1}{\det \mathbf{H}} \begin{bmatrix}
    r_F^F + k_F^F + \alpha^2 k_H^H & -\alpha (k_H^H + k_F^F) \\
    -\alpha (k_H^H + k_F^F) & r_H^H + k_H^H + \alpha^2 k_F^F
\end{bmatrix} \begin{bmatrix}
    dc_H \\
    dc_F \\
    dc \\
    dk_H \\
    dk_F \\
    d\alpha
\end{bmatrix}
\]

with \( A_1 = -(s_H + \alpha s_F) \), \( A_2 = -\alpha (s_H + \alpha s_F) \), \( B_1 = -\alpha (s_F + \alpha s_H) \), \( B_2 = -(s_F + \alpha s_H) \), \( C_1 = -2\alpha k_F s_H - s_F (k_H + k_F) \) and \( C_2 = -2\alpha k_H s_F - s_H (k_H + k_F) \) which are all negative. Note that \( \det \mathbf{H} = \left( r_F^F + k_F^F + \alpha^2 k_H^H \right) \left( r_H^H + k_H^H + \alpha^2 k_F^F \right) - \alpha^2 (k_H^H + k_F^F)^2 > 0 \) if the second order condition holds. The second order condition furthermore implies that \( \left( r_F^F + k_F^F + \alpha^2 k_H^H \right) < 0 \) and \( \left( r_H^H + k_H^H + \alpha^2 k_F^F \right) < 0 \). So all elements of the inverse coefficient matrix \( \mathbf{H}^{-1} \) are negative. Since the corresponding elements of the second right hand side matrix \( (A_1, \ldots, C_2) \) likewise are negative, unambiguous comparative static results as stated in Table 1 can be derived. If externalities \( (\alpha = 0) \) do not exist, \( \mathbf{H} \) is diagonal and the comparative static effects are straightforward as shown in Table 1.
Proof of Proposition 2:

Differentiating (8)–(11) totally gives

\[
\begin{bmatrix}
\frac{ds_H}{dc} \\
\frac{ds_F}{dc} \\
\frac{dz}{dx} \\
\frac{dt}{dx}
\end{bmatrix}
= \begin{bmatrix}
H^{-1} & 0 \\
0' & -1 \\
0 & 1 & 0 & 0 & 0 \\
1 & -1 & 0 & 1 & x
\end{bmatrix}
\begin{bmatrix}
\frac{dc_H}{dc} \\
\frac{dc_F}{dc} \\
\frac{dK}{dc} \\
\frac{dt}{dc}
\end{bmatrix}
\]

\(0\) is a vector of zeros and \(H\) denotes the matrix of second order derivatives of (8)-(10) as above. Its inverse reads

\[
H^{-1} = \begin{bmatrix}
r_{s_H s_H}^H & 0 & 1 \\
0 & r_{s_F s_F}^F & 1 \\
1 & 1 & -K_{zz}
\end{bmatrix}^{-1} = \frac{1}{\det H} \begin{bmatrix}
-r_{s_F s_F}^F K_{zz} -1 & 1 & -r_{s_F s_F}^F \\
1 & -r_{s_H s_H}^H K_{zz} -1 & -r_{s_H s_H}^H \\
-r_{s_F s_F}^F & -r_{s_H s_H}^H & r_{s_F s_F}^F
\end{bmatrix}
\]

The second order condition implies \(r_{s_H s_H}^H < 0, \ r_{s_F s_F}^F > 0\) and \(\det H = -r_{s_H s_H}^H r_{s_F s_F}^F K_{zz} - r_{s_F s_F}^F - r_{s_H s_H}^H < 0\) which is equivalent to

\[
K_{zz} > \frac{1}{r_{s_H s_H}^H} - \frac{1}{r_{s_F s_F}^F}.
\]

This implies

\[
-r_{s_F s_F}^F K_{zz} -1 > \frac{r_{s_F s_F}^F}{r_{s_H s_H}^H} > 0
\]

and

\[
-r_{s_H s_H}^H K_{zz} -1 > \frac{r_{s_H s_H}^H}{r_{s_F s_F}^F} > 0,
\]

so the comparative static results as summarized in Table 2 can easily be derived. The condition for complementarity of home and foreign production for small variations of \(c_H, c_F\) follows immediately from Table 2. In the most restrictive case, we have

\[
\frac{\partial (s_F - x)}{\partial c_H} = \frac{\partial (s_H + x)}{\partial c_F} = \frac{1}{\det H} + \frac{1}{t} < 0 \iff t > -\det H = r_{s_H s_H}^H + r_{s_F s_F}^F + r_{s_H s_H}^H r_{s_F s_F}^F K_{zz}
\]

The decision on market sales is separable from exports. So the effect of small variations in \(t, \tau\) and \(k\) on home and foreign production are straightforward.
**Proof of Proposition 3:**

Aggregating over all \( n \) foreign firms and differentiating (12)-(14) totally (DIXIT, 1986) gives

\[
\begin{bmatrix}
d_s^H \\
d_s^F \\
d_S^F
\end{bmatrix}
= \begin{bmatrix}
r_s^H + k & k & 0 \\
k & r_s^F + k & r_s^F \\
0 & R_{s^F} & R_{s^F} + K
\end{bmatrix}^{-1}
\begin{bmatrix}
1 & 0 & 0 \\
0 & 1 & 0 \\
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
-(s_H + s_F) \\
-(s_H + s_F) \\
-S_F
\end{bmatrix}
\begin{bmatrix}
dc_H \\
dc_F \\
dK
\end{bmatrix}
\]

\[
= \frac{1}{\det H}
\begin{bmatrix}
(r_s^F + k)(R_{s^F} + K) - r_s^F R_{s^F} & -k(R_{s^F} + K) & kr_s^F \\
-k(R_{s^F} + K) & (r_s^H + k)(R_{s^F} + K) & -(r_s^H + k)r_s^F \\
kR_{s^F} & -(r_s^H + k)R_{s^F} & (r_s^H + k)(r_s^F + k) - k^2
\end{bmatrix}
\]

\[
\begin{bmatrix}
1 & 0 & 0 \\
0 & 1 & 0 \\
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
-(s_H + s_F) & 0 & 0 \\
-(s_H + s_F) & 0 & 0 \\
-S_F \\
\end{bmatrix}
\begin{bmatrix}
dc_H \\
dc_F \\
dK
\end{bmatrix}
\]

where \( \det H = (r_s^H + k)(r_s^F + k)(R_{s^F} + K) - r_s^F R_{s^F} (r_s^H + k) - k^2(R_{s^F} + K) < 0 \).

Furthermore, the second order condition requires that \( r_s^H + k < 0 \), \( r_s^F + k < 0 \) and \( R_{s^F} + K < 0 \). Since \(-H\) is positive definite due the second order condition, the determinant of every principal submatrix of \(-H\) is positive. Again, the condition for complementarity of home and foreign for small variations of \( c_H, c_F \) follows from the comparative statics above. For example, we have for

\[
\frac{\partial s_F}{\partial c_H} = \frac{-k (R_{s^F} - S_F - S_F) + K}{t \det H} + \frac{1}{l} \lesssim t
\]

\[
\frac{\det H}{k(R_{s^F} + K)} = \frac{1}{k} (r_s^H + k)(r_s^F + k) - \frac{r_s^F R_{s^F}(r_s^H + k)}{k(R_{s^F} + K)} - k
\]

**REFERENCES**


**SUMMARY**

This paper applies theories of industrial organisation explaining the motives for vertical and horizontal integration to shed some light on the relationship between home and foreign production of multinational firms (MNEs). It is argued that once the precondi-
tions for the existence of MNEs are taken into account, namely the motives for integration of firm across country borders, both in the vertical integration and the horizontal integration case a complementary relationship is plausible. Especially, for horizontally integrated MNEs with multiplant economies of scale generated by inputs with public good characteristics it is demonstrated that home and foreign production are complements if multiplant economies of scale and/or marginal transportation costs are sufficiently large. The horizontal integration model is also analyzed in an oligopolistic setting and similar results are obtained.

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RÉSUMÉ

Cet article utilise des théories de l’organisation industrielle expliquant les motifs de l’intégration horizontale et verticale pour étudier les relations entre production intérieure et étrangère des entreprises multinationales. Il développe l’argument que même une complémentarité entre production intérieure et étrangère peut être expliquée, si l’on prend en considération ces motifs de l’intégration (horizontale ou verticale ) à travers les frontières nationales. Il est démontré notamment, que pour une entreprise multinationale horizontalement intégrée disposant d’un monopole à l’échelle mondiale, production nationale et étrangère sont complémentaires quand les économies à l’échelle liées au grand nombre de lieux de production («multi-plant economies of scale») générées par des ressources ayant un caractère de bien publique comme le capital humain («know-how») ou les coûts marginaux de transport sont suffisamment larges. Une version élargie de ce modèle de l’intégration horizontale peut aussi être appliquée au cas de l’oligopole et y produit des résultats similaires.