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A MODEL OF FIRMS' DECISION TO EXPORT OR PRODUCE ABROAD

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ABSTRACT

This paper is a theoretical analysis of the factors influencing production location decisions by a multinational corporation. It starts with a simple model of optimization for a firm facing the choice between exporting and producing abroad a single differentiated final product and then develops the model to take account of production of intermediate as well as final products, the existence of scale economies, and finally, the effects of transport cost and of factors affecting the cost of production.

The share of foreign output is shown to be related to the level of transport cost, to the size of host-country markets, to host-country wage levels relative to those of the home country, in combination with labor intensities of production. All of these relationships in turn are shown to interact in various ways with economies of scale in affecting the choice of production locations.

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A MODEL OF FIRMS' DECISIONS TO EXPORT OR PRODUCE ABROAD

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This paper is a theoretical analysis of production location by a multinational corporation (MNC). It starts with a simple model of optimization for a firm facing the choice between exporting and producing abroad a single differentiated final product. The model is then developed to take account of the production of intermediate as well as final products, the existence of scale economies and finally the effects of transport cost and of factors affecting the cost of production.

Among the several analytical approaches to economic multinationalism summarized by Fatemi et al (1976), this paper belongs to the oligopolistic approach that has been introduced and elaborated by Vernon (1966, 1971), Caves (1971) and others. Empirical studies of foreign investment such as those summarized by Hufbauer (1975) and the later study by Swedenborg (1979) show that heavy foreign investors are characterized by attributes such as product differentiation, large size, high profits, and high levels of advertising or research orientation. These characteristics are often associated with oligopolistic industrial organization. Most of them are related to the possible existence of scale economies. Product differentiation is assumed to be a necessary condition for "horizontal" investments, that is, investments in the industry of the parent.

A Model of Production Location

The trade patterns of a multinational firm are implicit in the production decisions if the market is taken to be the consumption in each country, and that is assumed to be independent of the level of production in that country. For some purposes, it might be appropriate to consider production decisions for export separately from those for host-country consumption, on the ground that production for export is relatively footloose while production for host-country consumption is tied to location by host-country policies not easily identified. Here, however, we emphasize the choice between home and foreign production to serve foreign markets and therefore the choice between exporting and foreign production.

The profit function for a multinational firm can be set out in a very general way as

$$Pr = \sum_{ijh}\sum\sum[X^h_{ij}(P^h_{ij}-T^h_{ij})] - \sum_{ih}\sum C^h_i \tag{1}$$

where:

h denotes goods (h=1,...,n)

i denotes producing countries (i=1,...,m)

j denotes purchasing countries (j=1,...,r)

X^h_{ij} is the output of good h produced in country i and sold to country j

P^h_{ij} is the price in country j of good h produced in country i and sold to country j

T^h_{ij} is the unit cost of transfer (tariffs, taxes, transport cost) of good h produced in country i and sold to country j (T^h_{ii} is assumed to be 0)

C^h_i is the total cost of producing good h in country i and is a function of X^h_i or $\sum_j X^h_{ij}$, the total production of good h in country i.

To focus on the decision about ways of serving foreign markets we begin with the case of a firm considering producing a single good, h, in countries i, the home country and j, the foreign country, for sale in the foreign country, ignoring production in the home country for sales in that country. However, we will have to consider it later because such production will be important if there are economies of scale. The profit function then reduces to:

$$Pr = X^h_{ij}(P^h_{ij} - T^h_{ij}) - C^h_i + X^h_{jj}P^h_{jj} - C^h_j \tag{2}$$

The profit maximizing conditions are obtained by differentiating the profit function with respect to X_{ij}^h and X_{jj}^h assuming X_{jj}^h to be a function of P_{jj}^h and X_{ij}^h, and setting the partial derivatives equal to zero.

$$\begin{aligned}\frac{\partial Pr}{\partial X_{ij}^h} = P_{ij}^h - T_{ij}^h + X_{ij}^h \frac{\partial P_{ij}^h}{\partial X_{ij}^h} - \frac{\partial C_i^h}{\partial X_{ij}^h} + \frac{\partial X_{jj}^h}{\partial X_{ij}^h} P_{jj}^h + X_{jj}^h \frac{\partial P_{jj}^h}{\partial X_{jj}^h} \\ \frac{\partial X_{jj}^h}{\partial X_{ij}^h} - \frac{\partial C_j^h}{\partial X_{jj}^h} \quad \frac{\partial X_{jj}^h}{\partial X_{ij}^h} = 0\end{aligned} \tag{3}$$

$$\begin{aligned}\frac{\partial Pr}{\partial X_{jj}^h} = \left(P_{ij}^h - T_{ij}^h\right) \frac{\partial X_{ij}^h}{\partial X_{jj}^h} + \frac{\partial P_{ij}^h}{\partial X_{ij}^h} \frac{\partial X_{ij}^h}{\partial X_{jj}^h} - \frac{\partial C_i^h}{\partial X_{ij}^h} \frac{\partial X_{ij}^h}{\partial X_{jj}^h} + P_{jj}^h + \\ X_{jj}^h \frac{\partial P_{jj}^h}{\partial X_{jj}^h} - \frac{\partial C_j^h}{\partial X_{jj}^h} = 0\end{aligned} \tag{4}$$

We can reformulate equations (3) and (4) in terms of marginal revenues

$$\left\{MR_{ij}^{h} = P_{ij}^{h} + X_{ij}^{h}\,\frac{\partial P_{ij}^{h}}{\partial X_{ij}^{h}},\ MR_{jj}^{h} = P_{jj}^{h} + X_{jj}^{h}\,\frac{\partial P_{jj}^{h}}{\partial X_{jj}^{h}}\right\}$$

and marginal costs

$$\left\{MC_{ij}^{h} = \frac{\partial C_{i}^{h}}{\partial X_{ij}^{h}},\ MC_{jj}^{h} = \frac{\partial C_{j}^{h}}{\partial X_{jj}^{h}}\right\}.$$

as follows:

$$\frac{\partial Pr}{\partial X_{ij}^{h}} = MR_{ij}^{h} - T_{ij}^{h} - MC_{ij}^{h} + \left(MR_{jj}^{h} - MC_{jj}^{h}\right)\frac{X_{jj}^{h}}{X_{ij}^{h}} = 0 \tag{3'}$$

and

$$\frac{\partial Pr}{\partial X_{jj}^{h}} = \left(MR_{ij}^{h} - T_{ij}^{h} - MC_{ij}^{h}\right)\frac{\partial X_{ij}^{h}}{\partial X_{jj}^{h}} + MR_{jj}^{h} - MC_{jj}^{h} = 0 \tag{4'}$$

Equation (4') shows that the relevant variables in the profit maximization process as formulated here are the following: (1) The different MR's which represent the difference in demand functions in country j for good h produced in the host country (j) rather than in the home country (i), some of which may be attributable to marketing advantages generated by the production in the host country; (2) The different MC's which, assuming that the technology of producing commodity h is the same for the multinational firm whether it produces in i or in j, are due to different factor prices and/or different productivity of factors; (3) The unit transfer cost of exporting h from i to j, including transportation costs, custom duties, insurance premiums, etc.; (4) The marginal rate of substitution between X^h_{ij} and X^h_{jj}: $\partial X^h_{ij}/\partial X^h_{jj}$.

If X^h_{ij} and X^h_{jj} are perfectly independent ($\partial X^h_{ij}/\partial X^h_{jj} = 0$), the commodity produced in i and that produced in j are really different products. The profit maximizing condition is that each MR (or MR-T) = MC, which is simply the condition for a producer under imperfect competition.

If X^h_{ij} and X^h_{jj} really are the same commodity and are so perceived by consumers, $\partial X^h_{ij}/\partial X^h_{jj} = -1$, the two equations (3') and (4') are identical and the two MR's are equal. The maximization of profits simply involves equalizing the marginal cost of foreign production, MC^h_{jj}, with the marginal cost of home production plus transport cost:

$$MC^h_{jj} = MC^h_{ij} + T^h_{ij} \tag{5}$$

If X^h_{ij} and X^h_{jj} are substitutes, but not perfect substitutes, ($-1 < \partial X^h_{ij}/\partial X^h_{jj} < 0$), presumably the typical situation, we have the case of product differentiation. Home country production would be encouraged by higher foreign demand for the imported product, or higher foreign production costs, but discouraged by higher home country production costs, transport cost, or foreign demand for the foreign-made product. Foreign production would be encouraged by higher home production cost, transport cost, or foreign demand for foreign-made products and discouraged by higher foreign demand for imported products or foreign production cost. These effects are summarized in the following table:

Home and Foreign Production Imperfect Substitutes
Final Production Only

	Effects on production in	
	i (home country)	j (foreign country)
Higher MR^h_{ij}	+	-
" MR^h_{jj}	-	+
" MC^h_{ij}	-	+
" MC^h_{jj}	+	-
T^h_{ij}	-	+

Finally, if $\partial X^h_{ij}/\partial X^h_{jj}$ is positive, which would be the case if the goods produced in the two countries were complements, as when the sale of one product by a company familiarizes the market with a trade mark or the sale of a machine gives rise to a demand for spare parts, the relationships are different, as can be seen in the table. Higher demand in either country encourages higher production in both countries and higher production costs in either country or higher transport costs discourage production in both countries.

Home and Foreign Production Complements
Final Production Only

	Effects on production in	
	i (home country)	j (host country)
Higher MR^h_{ij}	+	+
" MR^h_{jj}	+	+
" MC^h_{ij}	-	-
" MC^h_{jj}	-	-
" T^h_{ij}	-	-

Intermediate and Final Products

The relation of foreign production and investments to exports and therefore to domestic production and employment, and more specifically, whether foreign investments and production reduce home-country exports and employment, has troubled policy makers, legislators, labor unions, and of course economists. An intuitive answer is that outflows of capital create jobs abroad at the expense of potential domestic jobs. This seems to have been the logic underlying the Burke-Hartke Bill that was supported by the AFL-CIO. One way of examining this issue theoretically is by incorporating intermediate goods into the analysis.

Up to this point, we have assumed that a firm produces only final products for sale. Yet much of the trade between parent firms and their affiliates takes place in intermediate products, typically exported by the parent in the home country to the affiliate in the host country.

Let us assume that a good--g--is an input into the production of h and must be used in a fixed proportion in producing h, and that it is produced only in the home country. The profit function corresponding to (2) is

$$Pr = X^h_{ij}(P^h_{ij}-T^h_{ij})-C^h_i+X_{jj}P^h_{jj}-C^h_j-C^g_i-T^g_{ij}X^g_{ij} \tag{6}$$

where:

C^h_i and C^h_j are now costs other than those for input g and are functions of X^h_{ij} and X^h_{jj},

C^g_i is a function of X^g_{ii}, the amount of g used in production of X^h_{ij}, and X^g_{ij}, the amount of g exported from i to j for use in production of X^h_{jj}.

The profit maximizing condition, in terms of MR and MC, is:

$$\frac{\partial Pr}{\partial X_{jj}^{h}} = \left(MR_{ij}^{h} - T_{ij}^{h} - MC_{ij}^{h}\right) \frac{\partial X_{ij}^{h}}{\partial X_{jj}^{h}} + MR_{jj}^{h} - MC_{jj}^{h} -$$

$$MC_{i}^{g} \left(\frac{\partial X_{i}^{g}}{\partial X_{ij}^{h}} \quad \frac{\partial X_{ij}^{h}}{\partial X_{jj}^{h}} + \frac{\partial X_{i}^{g}}{\partial X_{jj}^{h}}\right) - T_{ij}^{g} \frac{\partial X_{ij}^{g}}{\partial X_{jj}^{h}} = 0 \tag{7}$$

Given that the ratio of X^g input to X^h output is fixed, $\partial X_i^g/\partial X_{ij}^h =$ $\partial X_i^g/\partial X_{jj}^h$, and both can be represented by an input coefficient, a. Then

$$\frac{\partial P_r}{\partial X_{jj}^{h}} = \left(MR_{ij}^{h} - T_{ij}^{h} - MC_{ij}^{h}\right) \frac{\partial X_{ij}^{h}}{\partial X_{jj}^{h}} + MR_{jj}^{h} - MC_{jj}^{h} -$$

$$MC_{i}^{g} \left(a \frac{\partial X_{ij}^{h}}{\partial X_{jj}^{h}} + a\right) - aT_{ij}^{g} = 0 \tag{8}$$

If X_{ij}^h and X_{jj}^h are perfect substitutes, $\partial X_{ij}^h/\partial X_{jj}^h = -1$, $MR_{ij}^h = MR_{jj}^h$, and the profit maximizing condition reduces to

$$\frac{\partial Pr}{\partial X_{jj}^{h}} = MC_{ij}^{h} + T_{ij}^{h} - MC_{jj}^{h} - aT_{ij}^{g} = 0 \tag{9}$$

The profitability of host-country production is increased by higher home country production costs and higher transfer costs for the finished product and reduced by higher host country production cost and transfer cost for the intermediate product.

In the more likely case that X^h_{ij} and X^h_{jj} are substitutes, but not perfect substitutes, the effects on host-country production are a little more complex.

Home and Foreign Production Imperfect Substitutes
Final and Intermediate Production

	Effect on Host-country Production
Higher MR^h_{ij}	-
" MR^h_{jj}	+
" MC^h_{ij}	+
" MC^h_{jj}	-
" MC^g_i	-
" T^h_{ij}	+
" T^g_{ij}	-

The commodity g might be one which incorporates a high level of skill or technology, inputs of country-specific resources, or one for which there are substantial economies of scale. In the last case, the marginal cost of producing g for export [MC^g_i in equation (7)] is a declining function of X_{ii} (production in the home country for sale in the home country, which we have ignored up to this point), X_{ij}, and X_{jj} (provided that X_{ij} and X_{jj} are not perfect substitutes in which case it is a function of X_{ii} and the sum of X_{ij} and X_{jj}). In this case, an increase of home market sales encourages host-country production by bringing down the cost of production of the input product. Using the same logic it is easy to think of a case where foreign production stimulates the total exports of the parent firm when these exports include both the intermediate product and the final good.

To sum up, when there is product differentiation and host-country production is not a perfect substitute for home-country production, a higher level of foreign production can be associated with a higher level of exports.

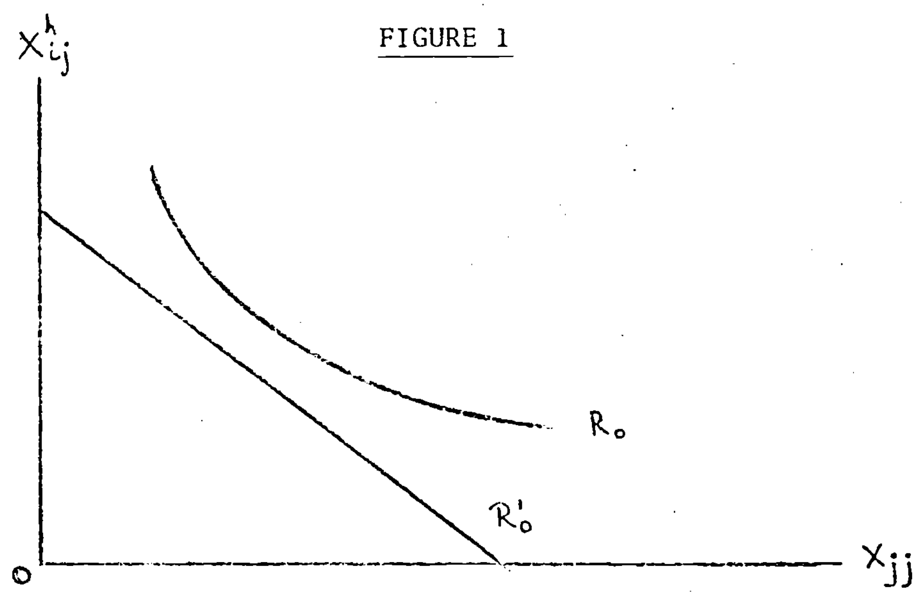
There is empirical evidence of such relationships. Bergsten, Horst, and Moran (1978) concluded from a cross-section of industries that "...a modest amount of foreign investing is highly complementary to U.S. exporting but that higher levels of foreign investment have no strong or consistent impact on U.S. exports." Swedenborg (1979) found that for Swedish multinationals there was "a highly significant and positive effect on exports of goods which are complementary to foreign manufacturing by Swedish firms...." but also "...a negative effect on exports which are non-complementary to foreign manufacturing...." with "...The net effect of these opposing influences....a very small positive effect on the firm's exports to countries where they have manufacturing affiliates." Lipsey and Weiss (1976a and 1976b) found that affiliates' production in foreign countries was positively associated with home-country exports to these countries. In addition they found that in the pharmaceutical industry the promotion of exports by affiliates was mainly of bulk pharmaceutical at the expense of packaged products. In other words, exports of intermediate goods were stimulated by the production and activity of foreign subsidiaries.

Scale Economies

So far we have mentioned scale economies only in passing and have not integrated them into the analysis. Aside from the pure cost analysis with which we began, we have not specified anything about the nature of the cost function. Economies of scale, in the absence of transfer costs, imply concentration of production in one location. Our problem, as with the earlier analysis of the factor cost model, is to justify the existence and explain the distribution of production in more than one market.

We can begin again with the case in which a firm considers producing a single product in two locations. Isorevenue curves can be plotted in the plane X^h_{ij}, X^h_{jj}, as in Figure 1.

FIGURE 1



The curves Ro and Ro' in Figure 1, based on different assumptions about the markets for X^h, represent distributions of production of commodity h between countries i and j resulting in the same constant level of revenue. In the simple "competitive" case when a producer faces constant prices for X^h_{ij} and X^h_{jj} (even if the prices are different) the isorevenue curve will be linear as Ro'. When the two sources of h are perfect substitutes for consumers and thus $dX^h_{ij}/dX^h_{jj} = -1$, the Ro' curve will have a unitary slope, even if the price for h in country j is not constant for the producer and he faces a downward sloping demand curve. In the case when $dX^h_{ij}/dX^h_{jj} \neq -1$ but is constant, a curve of the type of Ro' will be the isorevenue line.

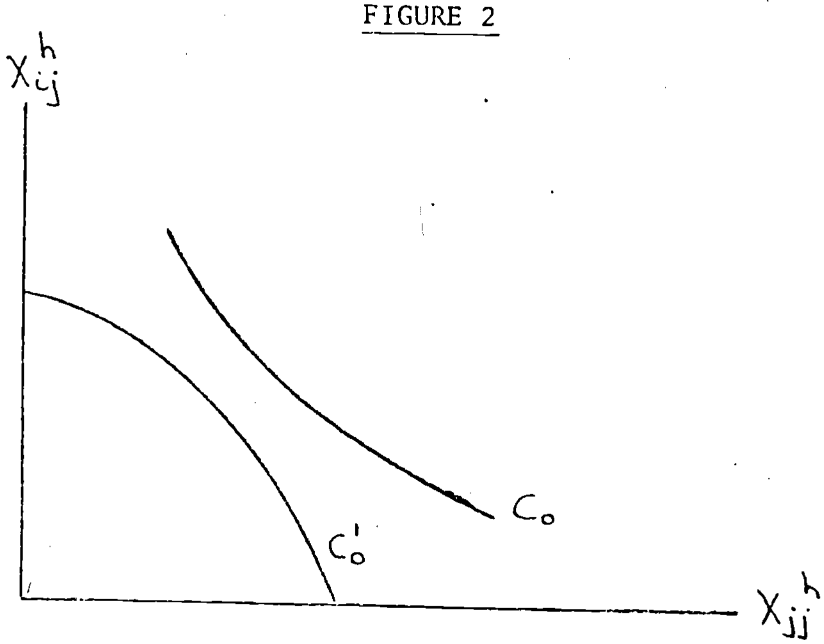
The isorevenue curve will be of the type of Ro, convex toward the origin, when the firm has some degree of monopolistic power in selling X^h_{ij} and X^h_{jj}. The coefficient of substitution dX^h_{ij}/dX^h_{jj} is not constant. The firm thus faces two downward sloping demand curves, one for X^h_{ij} and one for X^h_{jj}. In this case, the slope for Ro is:

$$\frac{dX^h_{ij}}{dX^h_{jj}} = -\frac{MR^h_{jj}}{MR^h_{ij}} \tag{10}$$

It is obvious that a whole map of isorevenue curves can be plotted, each curve representing a different level of revenue (R), and the alternative allocations of this revenue between exports and foreign production.

Using the same method we can draw an isocost curve representing different combinations of X^h_{ij} and X^h_{jj} resulting in the same constant level of the cost of production:

FIGURE 2



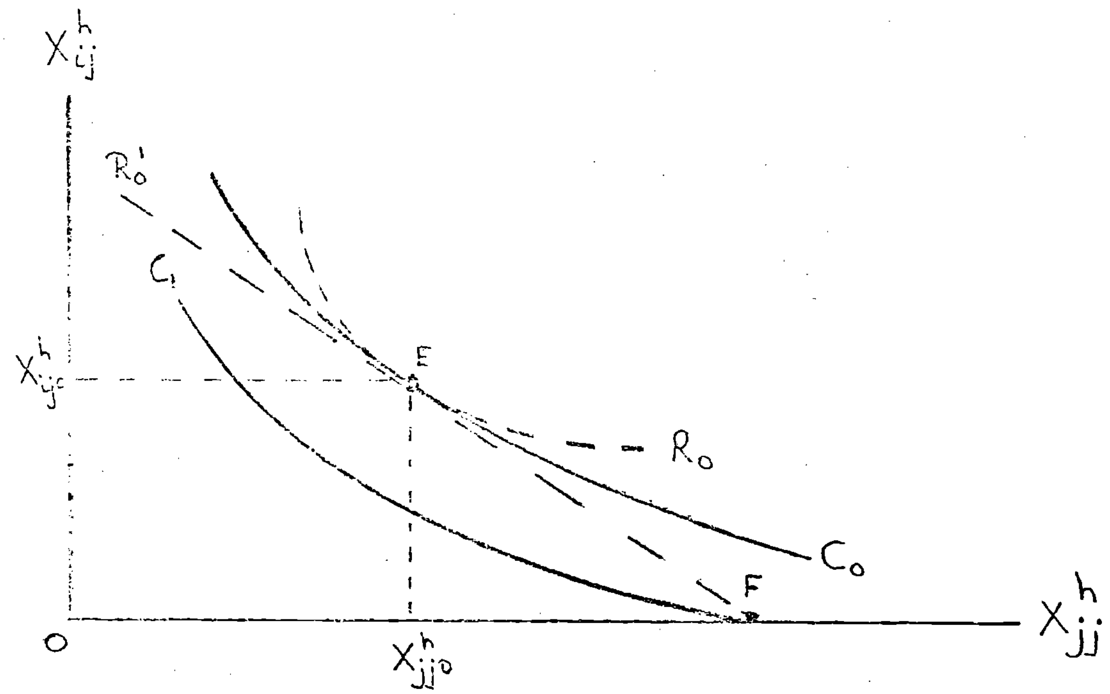
In Figure 2, two alternative isocost curves are presented: Co represents the case of scale economies, while Co' represents the case of increasing cost of production. When the producer faces constant returns to scale the isocost curve is linear.

The slope of the isocost curve, obtained by differentiating the cost function, $C_o = C_{ij} + T_{ij}X_{ij} + C_{jj}$, to get $dC_o = MC_{ij}dX_{ij} + T_{ij}dX_{ij} + MC_{jj}dX_{jj}$ and setting it equal to zero, is:

$$\frac{dX_{ij}^h}{dX_{jj}^h} = -\frac{MC_{jj}^h}{MC_{ij}^h + T_{ij}^h} \tag{11}$$

By combining the isocost and the isorevenue curves on the same diagram, one can see the way in which a multinational corporation maximizes its profits. A firm that enjoys scale economies and some monopolistic power (isorevenue curve is R_0) could maximize its profits by producing at a point such as E in Figure 3.

FIGURE 3



At this point the first order condition that justifies both exports and foreign production and that provides maximum revenue subject to the cost, is:

$$\frac{dX_{ij}^h}{dX_{jj}^h} = - \frac{MC_{jj}^h}{MC_{ij}^h + T_{ij}^h} = - \frac{MR_{jj}^h}{MR_{ij}^h} \qquad (12)$$

This condition will represent maximum income only if the isorevenue curve is more convex than the isocost curve, as is true for R_o and C_o in Figure 3. In this case, the returns to scale are small compared to the revenue losses from concentrating all production in either market.

On the other hand, if the firm has no monopolistic power or if X^h_{ij} and X^h_{jj} are perfect substitutes the isorevenue curve is linear (R'_o in Figure 3). In this case, point E would represent a point of minimum revenue subject to the cost, hence a solution of maximum loss. The optimal solution in this case would be a corner solution such as point F, where the firm produced in only one location. The larger the scale economies (the convexity of the isocost curve) the more likely that the firm will concentrate its production in one location. The choice of the location will depend on the production cost conditions, the transfer cost, the degree of monopolistic power of the producer and the degree of substitutability between X^h_{ij} and X^h_{jj}.

The degree of convexity of the above curves can be measured by their elasticities of substitution. This measure can be formulated for each of the curves **as:**

$$\sigma = \frac{d(X_{ij}/X_{jj})}{X_{ij}/X_{jj}} \Bigg/ \frac{d(dX_{ij}/dX_{jj})}{dX_{ij}/dX_{jj}} \tag{13}$$

Thus **the second order condition for production to take place in both countries is** that $\sigma_R < \sigma_C$, or $\sigma_C/\sigma_R > 1$.(1) Since the numerator in (13) is the same for σ_c and σ_R,

$$\frac{\sigma_C}{\sigma_R} = \frac{\left.\dfrac{d(dX_{ij}^h/dX_{jj}^h)}{dX_{ij}^h/dX_{jj}^h}\right|_R}{\left.\dfrac{d(dX_{ij}^h/dX_{jj}^h)}{dX_{ij}^h/dX_{jj}^h}\right|_C} \tag{14}$$

which, after substituting from (13) and differentiating

$$= \frac{\dfrac{dMR_{jj}^h}{MR_{jj}^h} - \dfrac{dMR_{ij}^h}{MR_{ij}^h}}{\dfrac{dMC_{jj}^h}{MC_{jj}^h} - \dfrac{dMC_{ij}^h}{MC_{ij}^h + T_{ij}^h}} \tag{15}$$

Multiplying the host-country terms by $X_{jj}^h/X_{jj}^h \cdot dX_{ij}^h/dX_{jj}^h$ and the home-country terms by $X_{ij}^h/X_{ij}^h \cdot dX_{ij}^h/dX_{ij}^h$, we have, as the second order condition for production in both countries, where

$$\zeta_{MR}^h = \frac{dMR^h}{dX^h} \cdot \frac{X^h}{MR^h}, \quad \zeta_{MC_{ij}}^h = \frac{dMC_{ij}^h}{dX_{ij}^h} \cdot \frac{X_{ij}^h}{MC_{ij}^h + T_{ij}^h}, \text{ and } \zeta_{MC_{jj}}^h = \frac{dMC_{jj}^h}{dX_{jj}^h} \cdot \frac{X_{jj}^h}{MC_{jj}^h}$$

$$(2) \quad \frac{\sigma_C}{\sigma_R} = \frac{\zeta_{MR_{jj}}^h \dfrac{dX_{jj}^h}{X_{jj}^h} - \zeta_{MR_{ij}}^h \dfrac{dX_{ij}^h}{X_{ij}^h}}{\zeta_{MC_{jj}}^h \dfrac{dX_{jj}^h}{X_{jj}^h} - \zeta_{MC_{ij}}^h \dfrac{dX_{ij}^h}{X_{ij}^h}} > 1 \,. \tag{16}$$

The ratio in (16) is computed assuming that the relative change of the proportions X^h_{ij}/X^h_{jj}, $d(X^h_{ij}/X^h_{jj})/(X^h_{ij}/X^h_{jj})$ is the same on both curves. $\zeta^h_{MR_{ij}}$ and $\zeta^h_{MR_{jj}}$ are functions of several variables related to the demands for X^h_{ij} and X^h_{jj} respectively. Each of them is a function of the appropriate market price, price elasticity and quantity. $\zeta^h_{MC_{ij}}$ and $\zeta^h_{MC_{jj}}$ are functions of the variables determining MC such as factor prices in each country, the factor inputs and the outputs, X^h_{ij} and X^h_{jj}. In addition, $\zeta^h_{MC_{ij}}$ depends also on the transfer cost T^h_{ij}.

We will now explore the impacts of changes in some of the above variables on the allocation of production between the home and the host country. This test will provide some insight into the decision of a firm in its choice of a location for its foreign production.

The Effect of Transport Cost

The transfer cost, denoted above by T^h_{ij}, is composed of several variables, such as customs duties in country j, transportation cost, and possibly also the money value of some other trade barriers.

According to our formulation, T^h_{ij} is a part of the cost of selling in country j, good h that is produced in country i. A change in T^h_{ij} generates a change in both the slope and the convexity of the isocost curve.

The slope of the isocost curve is given by equation (11) above. Higher transport cost implies a slope (negative) that is lower in absolute value, though higher in algebraic value.

The elasticity of substitution along the isocost curve, which reflects its convexity, is given by expression (17). Since $\zeta^h_{MC_{ij}}$ is assumed to be

$$\sigma_c = \frac{d(X^h_{ij}/X^h_{jj})}{X^h_{ij}/X^h_{jj}} \Bigg/ \left(\zeta^h_{MC_{jj}} \frac{dX^h_{jj}}{X^h_{jj}} - \zeta^h_{MC_{ij}} \frac{dX^h_{ij}}{X^h_{ij}}\right) \tag{17}$$

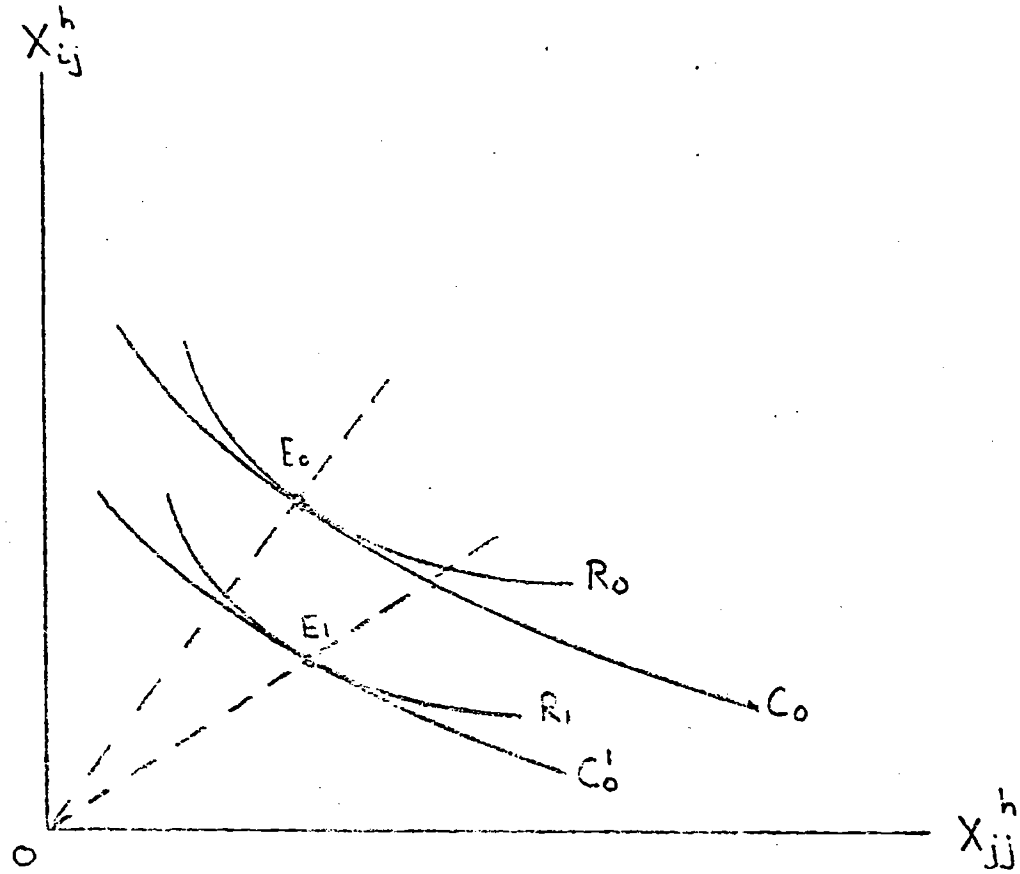
negative (given economies of scale), and therefore $d\zeta^h_{MC_{ij}}/dT^h_{ij} > 0$,

$\frac{d\sigma_c}{dT_{ij}} > 0$.

An increase in the transfer cost T^h_{ij} will decrease the optimal ratio X^h_{ij}/X^h_{jj} and thus tend to increase foreign production and decrease exports. Given the change of the elasticity of substitution, if the firm had no host-country production and was only exporting before the change of T^h_{ij}, the chances that it will combine exports with foreign production are now greater. If the firm was both exporting and producing in country j before the change, after the change of T^h_{ij} the chances of concentrating production in country j and stopping exporting become greater. In Figure 4 a change such as the one described above is presented.

R_o and C_o are equilibrium isocost and isorevenue curves for the initial T^o_{ij}, E_o reprsents the optimal allocation of production between countries i and j. When the transfer cost rises to T^1_{ij} the new optimal allocation of production will be represented by a point such as E_1 representing a lower ratio

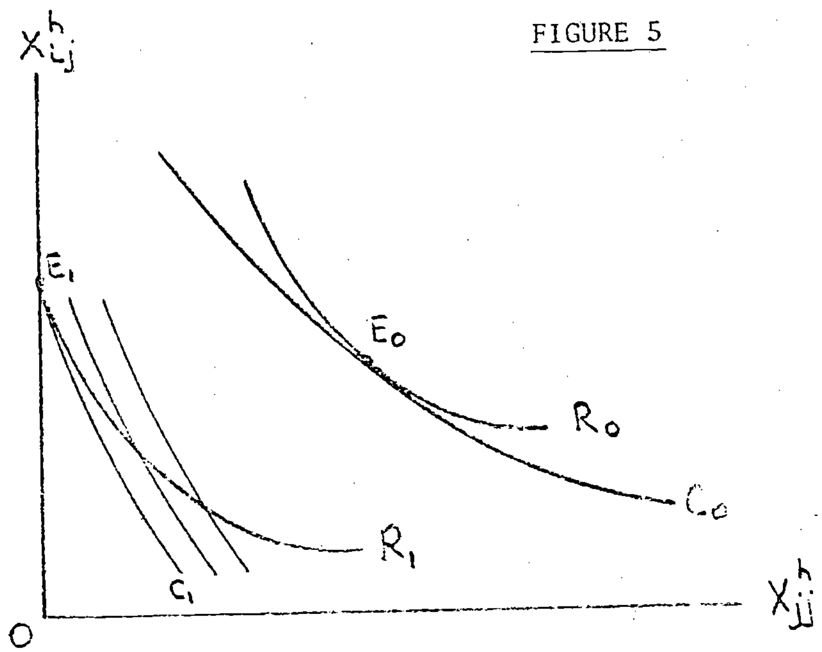
FIGURE 4



X_{ij}^{h}/X_{jj}^{h}. If T_{ij}^{h} rises high enough the optimal solution for the producer might be a corner solution where he will be producing in country j only.

Transfer cost interacts with the size of the host country when production involves scale economies. For example, even if a market involves very high cost of transfer for the home-country producer, the firm will not produce there if the market is too small. This might occur when the sufficient condition for production in both country i and country j is not met. The second order condition, $\sigma_C/\sigma_R > 1$, may be satisfied, but if no combination of outputs can provide that $MR^h_{jj}/MR^h_{ij} = MC^h_{jj}/MC^h_{ij}+T^h_{ij}$ the firm will export to country j but not produce there. This will happen when $MR^h_{jj}/MR^h_{ij} < MC^h_{jj}/MC^h_{ij}+T^h_{ij}$, namely when, for every relevant level of the output in country j the alternative of producing in country i and exporting to j is more profitable, as in Figure 5.

FIGURE 5



If the host country is large, the optimal allocation of production between i and j is represented by point E_0. If the host country is small, even with similar demand conditions the firm will allocate optimally by producing only in the home country (E_1).

The implication of the above analysis is that the transfer cost operates in a system of this type (which involves scale economies) in positive interaction with the size of the potential host country. The decision to start producing in a host country will depend on the combination of the transfer cost and the size of the host country. The choice of the location will also depend on the combination of these two variables. Horst (1971) discusses the issue and draws a conclusion that is in general similar to this one:

"Foreign competition comes both from imports and local production by foreign owned subsidiaries. A high tariff policy may encourage subsidiary production and increase the competition from abroad". This conclusion is here extended to the case in which there are scale economies. In this case, the above mentioned competition is stronger the larger is the size of domestic market.

The Impact of Cost of Production

The impact of different levels of the cost of production in different economies has two aspects: (a) the possible existence of scale economies and their relation to the size of production in different countries; (b) factor prices in different economies in conjunction with factor intensities in production.

(a) The degree of scale economies in production can be measured as the magnitude of either the negative $\frac{\partial MC}{\partial X}$, or the negative ζ_{MC}. The greater the absolute value of each of these expressions the higher the degree of scale economies in production. We can see in expression (16) that the greater ζ_{MC}, both for X^h_{ij} and for X^h_{jj}, the smaller the chance that $\sigma_C/\sigma_R > 1$, and the smaller the chance that production will take place in more than one location. The higher the degree of scale economies the greater the probability that a producer will concentrate his production in one location. If production costs, transfer cost, and the degree of differentiation between X^h_{ij} and X^h_{jj} do not justify production abroad, the producer will produce only in the home country and export to other countries. If these conditions favor production in a host country, the firm will tend to concentrate its production other than for the home market in the host country, and its output there will be larger the greater the degree of scale economies.

(b) Factor price differentials can obviously influence the location of production. If we assume that prices of capital are, more or less, uniform across countries within firms, wage differences will determine the location and size of foreign production.

Marginal cost is positively related to the wage rate, and for given wage differentials between countries i and j, the differences (both absolute and relative) between MC^h_{ij} and MC^h_{jj} will be greater the more labor-intensive is the commodity. Thus, for a given differential between host-country (low) and home-country (high) wage rates, the relative cost of producing abroad relative to producing at home and exporting $(MC^h_{jj}/MC^h_{ij}+T^h_{ij})$ will be lower and the ratio of production abroad to production at home (X^h_{jj}/X^h_{ij}) will be higher, the more labor intensive is the good, h. When we take scale economies into consideration, we see that σ_C/σ_R is smaller the greater the difference between the wage rates. This is due to the fact that $d\zeta_{MC}/dw < 0$ $(\zeta_{MC} < 0)$. We can conclude then, that the greater the wage differentials between countries (when the producer faces scale economies) the lower the probability for the second order condition $(\sigma_C/\sigma_R > 1)$ to be met. The producer will then tend to concentrate his output in the host country j and produce there as much as possible. This is one more possible interaction between the degree of scale economies and another (exogenous) variable, in this case, the wage differentials.

To conclude, one can say that the impact of wage differentials on international production is stronger (1) the greater the labor intensity in production (2) the higher the degree of scale economies. This chain of effects relates wage differentials to the size of the potential host country; thus, the impact of low wages on production in the foreign country is stronger, the larger the size of the host country.

Summary and Empirical Implications

The location and magnitude of the international production of a firm depend on two groups of variables: the endogenous variables of the firm (industrial characteristics) and exogenous variables for which the firm adjusts its behavior (national characteristics). The latter include T^h_{ij} -- the transfer cost, w_i and w_j -- home and foreign wages, and demand conditions in foreign countries.(3) On the other hand, factors such as the degree of scale economies, the factor intensities, the possible production of allied goods (inputs and/or final goods), are endogenous to the firm.

The impact of national characteristics on the location and the size of production of a firm will depend on industrial characteristics. In theory we know the signs of the effects of the various national characteristics on the size of foreign production and on the ratio of foreign production in a given location to total output of the firm.

In general we would expect the following relationships:

1. The higher transport costs are, the larger foreign output is relative to the home output and total output of the firm. In symbolic terms, $\partial X^h_{jj}/\partial T^h_{ij} \geqq 0$ and $\partial(X^h_{jj}/X^h_{ij})/\partial T^h_{ij} > 0$. Assuming that the output in country $i(X^h_i)$, or its major part $(X^h_i - X^h_{ij})$, is completely independent of T^h_{ij}, the above derivative means that $\partial(X^h_{jj}/X^h_i)/\partial T^h_{ij} > 0$.

If commodity h is produced with scale economies, the greater the degree of scale economies the greater the value of these derivatives. The size of the host country also affects the optimal ratio X^h_{jj}/X^h_i. When the firm decides to produce in country j (involving scale economies), for a given level of T^h_{ij}, the greater the size of country j the greater the optimal ratio X^h_{jj}/X^h_{ij} and also the ratio X^h_{jj}/X^h_i.

2. Production in a foreign country will be higher, the larger the size of the natural market of that country.(4) That is, if S_j denotes the size of the natural market in country j, $\partial X^h_{jj}/\partial S_j > 0$. When production of h involves scale economies, the value of the derivative will be greater the greater the degree of scale economies. The same is true for the ratios X^h_{jj}/X^h_{ij} and X^h_{jj}/X^h_i.

3. The higher the wage in the home country (w_i) relative to the foreign wage (w_j), the larger foreign production will be. $\partial X^h_{jj}/\partial(w_i/w_j) > 0$ and $\partial(X^h_{jj}/X^h_{ij})/\partial(w_i/w_j) > 0$. These two derivatives are positively affected by the labor intensity in the production of h (and by the elasticity of substitution between the factors), and by the degree of scale economies in production. Since this is so, we can add the size of the market in the host country - S_j, as magnifying the wages effect through the impact of the degree of scale economies.

Thus $\partial(X^h_{jj}/X^h_i)/\partial(w_i/w_j) = f$ (Labor/Capital, scale economies, S_j).
We can conclude then that the three variables, in parentheses above, operate in positive interactions with wage differentials (or other factor prices) in determining the relative and absolute level of foreign production by a firm.

Footnotes

1. σ_c and σ_R stand for the elasticity of substitution of the isocost and the isorevenue curves respectively.

2. Expression (16) is computed as follows:

   In general:

$$\sigma = \frac{d(X_{ij}/X_{jj})}{X_{ij}/X_{jj}} \Bigg/ \frac{d(dX_{ij}/dX_{jj})}{dX_{ij}/dX_{jj}}$$

$$\sigma_c = \frac{d(X_{ij}/X_{jj})}{X_{ij}/X_{jj}} \Bigg/ \frac{d\left(-\frac{MC_{jj}}{MC_{ij}+T_{ij}}\right)}{-\frac{MC_{jj}}{MC_{ij}+T_{ij}}}$$

$$\sigma_R = \frac{d(X_{ij}/X_{jj})}{X_{ij}/X_{jj}} \Bigg/ \frac{d\left(-\frac{MR_{jj}}{MR_{ij}}\right)}{-\frac{MR_{jj}}{MR_{ij}}}$$

$$d\left(-\frac{MC_{jj}}{MC_{ij}+T_{ij}}\right) = -\frac{1}{(MC_{ij}+T_{ij})^2}\left[(MC_{ij}+T_{ij})\frac{\partial MC_{jj}}{\partial X_{jj}}\, dX_{jj} - \right.$$

$$\left. - MC_{jj}\frac{\partial MC_{ij}}{\partial X_{ij}}\, dX_{ij}\right]$$

Define: $a = -\dfrac{MC_{jj}}{MC_{ij} + T_{ij}}$.

$$\frac{da}{a} = \frac{1}{(MC_{ij} + T_{ij})\ MC_{jj}} \left[(MC_{ij} + T_{ij}) \frac{\partial MC_{jj}}{\partial X_{jj}} dX_{jj} - MC_{jj} \frac{\partial MC_{ij}}{\partial X_{ij}} dX_{ij} \right]$$

denote: $\zeta_{MC_{ij}} = \dfrac{\partial MC_{ij}}{\partial X_{ij}} \cdot \dfrac{X_{ij}}{MC_{ij} + T_{ij}}$

and $\zeta_{MC_{jj}} = \dfrac{\partial MC_{jj}}{\partial X_{jj}} \cdot \dfrac{X_{jj}}{MC_{jj}}$

Thus $\dfrac{da}{a} = \zeta_{MC_{jj}} \dfrac{dX_{jj}}{X_{jj}} - \zeta_{MC_{ij}} \dfrac{dX_{ij}}{X_{ij} + T_{ij}}$

Using the same method for the isorevenue function:

$$\frac{d(dX_{ij}/dX_{jj})}{dX_{ij}/dX_{jj}} = \zeta_{MR_{jj}} \frac{dX_{jj}}{X_{jj}} - \zeta_{MR_{ij}} \frac{dX_{ij}}{X_{ij}}$$

3. If we assume that a firm might improve its market share in a country by producing there, or that the location of production involves marketing advantages, then the demand conditions facing the firm are not perfectly exogenous.
4. The size of the natural market in country j can be larger than the size of its national market. For example, production in Belgium can be designated to supply the whole EEC, or a part of it.

References

(1) Bergsten, C. Fred, Thomas Horst, and Theodore H. Moran (1978), American Multinationals and American Interests, Brookings Institution.

(2) Caves, Richard E. (1971), "International Corporations: The Industrial Economics of Foreign Investment," Economica, Vol. 38, Feb.

(3) Fatemi, N.S., G.W. Williams, and T. Saint Phalle (1976), Multinational Corporations, A.S. Barnes and Co., Inc., New Jersey.

(4) Horst, Thomas (1971), "The Theory of the Multinational Firm: Optimal Behavior Under Different Tariff and Tax Rates," Journal of Political Economy, Vol. 79, April.

(5) _____ (1972), "Firm and Industry Determinants of the Decision to Invest Abroad: An Empirical Study," Review of Economics and Statistics, Vol. 54, August.

(6) _____ (1976), "American Multinationals and the U.S. Economy," American Economic Review, Vol. 66, May.

(7) Hufbauer, Gary C. (1975), "The Multinational Corporation and Direct Investment" in Peter Kenen (Ed.), International Trade and Finance: Frontiers for Research, Cambridge.

(8) Lipsey, Robert E. and Merle Yahr Weiss (1976a), "Exports and Foreign Investment in the Pharmaceutical Industry," NBER Working Paper 87 (Revised).

(9) _____ (1976b), "Exports and Foreign Investment in Manufacturing Industries," NBER Working Paper 131 (Revised).

(10) Swedenborg, Birgitta (1979), The Multinational Operations of Swedish Firms, The Industrial Institute for Economic and Social Research, Stockholm.

(11) Vernon, Raymond (1966), "International Investment and International Trade in the Product Cycle," Quarterly Journal of Economics, Vol. 80, May.

(12) _____ (1971), Sovereignty at Bay: The Multinational Spread of U.S. Enterprise, Basic Books, New York.