Chapter 1

MULTINATIONALS, MULTI-PLANT ECONOMIES, AND THE GAINS FROM TRADE[†]

James R. MARKUSEN*

University of Western Ontario, London, Ontario N6A 5C2, Canada

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A general equilibrium model of a multinational enterprise based on economies of multi-plant operation is developed. These economies are modelled as arising from the existence of a joint input whose productivity in each production facility is independent of the number of facilities maintained by a firm. The multinational thus offers the world increased technical efficiency by eliminating the duplication of the joint input that would occur with independent national firms. Since this technical efficiency may come at the expense of increased market power, the full determinants of home country, host country, and world welfare are considered.

Introduction

For many years there has existed a debate as to the allocative and distributive effects of multinational corporations. There is little general agreement as to these effects and, indeed, formal trade theory has largely failed to provide a rationale as to why these corporations exist at all. The empirical evidence sheds some light on this very basic question insofar as it suggests that the level of multinational activity in a particular industry is related to the importance of 'intangibles' in that industry's overall operation [Caves (1980)]. These 'intangibles' involve activities not directly related to the physical production of goods such as R & D, advertising, marketing, and distribution.¹

Intangibles in turn seem to be closely related to the concept of economies of multiplant operation [Scherer et al. (1975), Scherer (1980)]. By 'economies of multi-plant operation' we will mean technical or pecuniary advantages possessed by a single owner of two or more production facilities over an

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¹A few of the relevant works include McManus (1972), Buckley and Casson (1976), Dunning (1977), Kindleberger (1969, 1970), Caves (1971, 1974), Vernon (1971), Horst (1976), Hymer (1976), Gorecke (1976), and Parry (1980).

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industry in which there are independent (even if joint-profit maximizing) owners of the same production facilities. The great body of research on Canada in particular seems to repeatedly emphasize economies of multi-plant operating in explaining the incidence across industries of United States multinationals operating in Canada [Eastman and Stykolt (1967), Caves et al. (1980)].

These stylized facts suggest two alternative avenues for developing a satisfactory theory of the multinational enterprise (MNE). One is based on strategic considerations such as using R & D, marketing investments, and foreign branch plants to pre-empt foreign competition. This is the approach taken by Magee (1977) and Horstmann and Markusen (1983). The second approach is to examine aspects of technology which by themselves (i.e. quite apart from strategic behaviour) imply the superior efficiency of multi-plant production. This second approach is used in this paper to develop a technology-based theory of MNE. The model is then used to address issues relating to market power, technical efficiency, the pattern of trade, and world income distribution.

In attempting to meet these objectives, a satisfactory model should meet five conditions. (a) The model should provide a rationale as to why a firm wishes to engage in direct rather than in portfolio investment. (b) The model should not rely on factor movements or factor price differences insofar as the MNE literature stresses that the MNE often provides for much of its needs from local factor markets. Both requirements imply that the general-equilibrium literature on factor movements is of little use and that a theory of the firm approach may be more useful.² (c) The model should explain why multi-plant operation is superior to price collusion among independent producers. (d) The model must justify the fact that the MNE, by definition, chooses to carry on at least one type of activity in each of several countries rather than supply all countries from a single production facility. (e) The model should allow for positive economic profits since alternative distributions of profits may have important implications for the gains from trade. This suggests that a monopoly/duopoly model in which firms produce a single homogeneous good may provide a richer treatment than the more recent monopolistic competition models [Krugman (1979), Helpman (1981)].

²Recent analyses of general-equilibrium theory of factor movements can be found, for example, in Jones (1967), Kemp (1969), Brecher and Alejandro (1977), Bhagwati and Brecher (1980) and Markusen and Melvin (1979). These articles are not entirely satisfactory for the study of direct foreign investment since they provide no motivation as to why foreign investment might be concentrated in certain sectors, much less why it might direct rather than portfolio investment. Batra and Ramachandran (1980) have recently formalized the ideas of Caves (1971), who notes that international investment is often sector specific. Yet Batra and Ramachandran still do not come to grips with the issue of direct versus portfolio investment insofar as their model provides no motivation as to why a firm wishes to control a foreign subsidiary versus simply making a portfolio investment in the foreign industry. Like earlier works, the Batra and Ramachandran model continues to rely on perfect competition, constant returns, and physical factor flows generated by ex ante factor price differences.

It seems that these requirements simply cannot be met by any model that relies on the assumptions of either constant returns in production or increasing returns of the usual neoclassical variety. In the former case, there is no role for the individual enterprise and hence direct foreign investment cannot be distinguished from portfolio investment. In the latter case, there will be a tendency for the firm to centralize rather than to geographically diversify production. Similarly, superior technical knowledge combined with an incentive to jump a tariff barrier is not an entirely satisfying basis for a theory. While differences in know-how may imply strategic considerations [Magee (1977), Horstmann and Markusen (1983)], there is no purely technical reason why branch-plant production is superior to simply selling or licensing the superior technology.

The notion of multi-plant economies is thus appealing from a theoretical as well as an empirical point of view. The problem is that to the best of my knowledge, no one has precisely specified this notion in formal algebraic notation. To do so will be the first task of this paper.

2. Economies of multi-plant operation

Sources of multi-plant economies are often found in firm-specific as opposed to plant-specific activities. These firm-specific activities include things like R & D, advertising, marketing, distribution, and management services, as noted above [Scherer et al. (1975), Scherer (1980)]. One characteristic of these activities that I wish to capture here is that they often involve a 'public goods' or 'jointness' aspect with respect to the firm's various production facilities. R & D expenditures on designing better products and/or production processes provide an interesting example. Once an innovation is made, it can be incorporated into any number of additional plants without reducing the marginal product of that innovation in existing plants.³ The efficiency advantage of the multi-plant firm as modelled below lies in its ability to avoid the duplication in R & D and other activities which is necessarily involved in single-plant operation.⁴

³Technological assumptions presented below ensure that there will be only a single plant in each country. Also, I should point out that the type of MNE modelled here would probably be termed a 'horizontal' MNE in that production facilities in the two countries are concerned with producing only one good. On the other hand, countries will be partially specialized as to the activities they perform in the production of this good, and thus there is something of a 'vertical' (or 'hierarchical') dimension to this MNE as well. Caves (1980) notes that 'a number of studies have established that the importance of intangible assets to an industry is an excellent predictor of horizontal direct investment'.

⁴We will assume throughout the paper that economies of multi-plant operation are such that independent firms have at best an imperfect ability to transfer 'intangibles' among themselves. The idea is that to share fully in these economies, two independent firms would have to be fully integrated in everything but name (e.g. the two firms' engineers and managers would have to work together). Throughout the paper, the term joint-profit maximization will refer only to price collusion.

We should also note that the MNE often tends to centralize these firm-specific activities (corporate headquarters); that is, R & D, marketing, finance, etc. are often centralized in a particular location while production activities are geographically dispersed. It is easy to think of reasons as to why this might be the case. The total output of two scientists working independently may, for example, be less than their output working cooperatively in the same location. Similarly, communication among different managerial and technical departments is more efficient in a centralized location. The model presented below will attempt to capture this 'centralization' aspect as well as the 'public-goods' or 'jointness' aspect mentioned above.

The model consists of two goods (X and Y) and two countries (m and h). Superscripts m and h will denote countries throughout the model, with m denoting the MNE's home country and h denoting the host country in the MNE version of the problem. Other features of the model are as follows.

(a) X and Y are each produced from labour and sector-specific capital. Total endowments of all factors are fixed.

(b) Countries m and h have identical factor endowments, identical technology, and identical, homothetic community utility functions.

(c) Y is produced with constant returns to scale by a competitive industry.

(d) The output of X is the product of the outputs of two activities: activity C (for corporate or control) and activity F (for factory). C and F may be geographically separated in the production of X .

(e) Capital which is sector specific to X is used in F but not in C , which uses only labour. F is characterized by constant returns (eliminating the possibility of many domestic plants) and thus $X = C \cdot F$ is characterized by increasing returns.

(f) Increasing returns in X are assumed to be weak relative to factor intensity effects such that the production set of each country is strictly convex. This ensures that a monopolist will maintain plants in both countries (i.e. become a MNE) rather than attempt to supply both countries from a single plant.⁵

(g) For the multi-plant firm, the C activity has a 'public goods' or 'jointness' aspect in that additional geographic locations of F activities may be added to the firm without reducing the marginal product of C in existing F activities.

(h) For the multi-plant firm, the C activity is also characterized by a 'centralization' aspect in that for a fixed total allocation of labour to C

⁵See Herberg and Kemp (1969) for an analysis of some local properties of the production frontier with increasing returns to scale. By assuming CES production functions, Markusen and Melvin (1981) are able to derive some global properties. Herberg and Kemp note that the production set must be non-convex in a small neighbourhood about $X=0$, given Heckscher-Ohlin technology. This result does not necessarily hold for the specific-factors technology and we shall simply assume convexity of the production set over the relevant range of the production frontier.

activities, the output of C is maximized by undertaking C at a single location.

(i) Equity ownership may cross international borders, but factors of production are immobile. There are no barriers to trade.

The C activity in producing X is intended to represent the R & D, marketing and managerial factors referred to above. F is intended to represent the physical transformation of inputs into outputs. Assumption (b) is made in order to neutralize the usual Heckscher–Ohlin, Ricardian, and demand bases for trade. The reason for this is that I wish to show clearly how multi-plant economies of scale can affect the pattern of trade and production. If we were to assume differences in factor endowments as well as the existence of scale economies, we would in general not be able to obtain any clear results or be able to tie results to one effect or the other. For the same reasons that we do not normally mix differences in technology (Ricardian trade models) with differences in factor endowments (Heckscher–Ohlin trade models) we will restrict the present analysis to a single basis for trade (scale economies).

The jointness and centralization aspects of C have been briefly discussed above. Only the results having to do with the volume and direction of trade depend on the centralization property as will be discussed from time to time. Gains from trade and welfare results will depend only on the jointness aspect.

Given the specification (a)–(i) production functions for the single-plant and two-plant enterprises are given as follows:

$$X^i = C(L_c^i)F(L_f^i), \quad i = m, h, \quad (1)$$

$$X^m + X^h = C(L_c^m, L_c^h)[F(L_f^m) + F(L_f^h)]. \quad (2)$$

Given the sector-specific nature of capital, we can simply omit the capital arguments in the F functions which as a result are assumed to be characterized by $F'' < 0$.⁶ The jointness aspect of the C activity is captured in (2) by $[F^m + F^h]$: changes in physical production (F) in one location do not affect the marginal product of C in the other location. F^m and F^h are also assumed to be independent in that there are no externality effects between geographically separated production facilities.

The centralization property of C is modelled by allowing the C isoquants to be concave to the origin in L^m and L^h space. While this is not in general sufficient to ensure that the MNE will centralize C (L_c^m or L_c^h equal to zero) due to the concavity of Y and F , it will be sufficient if $C(L_c^m, L_c^h) = \max(L_c^m, L_c^h)$; that is, running independent C activities is so inefficient that

⁶See Jones (1971) and Neary (1978) for a discussion of sector-specific factors models.

it is completely redundant. In what follows we will simply assume C is centralized at the MNE equilibrium. It must be emphasized that this assumption plays no role in the welfare analysis and simply serves to make the positive analysis of trade more interesting by introducing an asymmetry into the MNE equilibrium.⁷

In order to facilitate comparisons of eqs. (1) and (2), we will assume the following:

$$C(\bar{L}_c^m, 0) = C(0, \bar{L}_c^h) = C(\bar{L}_c^i), \quad \text{for} \quad \bar{L}_c^h = \bar{L}_c^m = \bar{L}_c^i. \quad (3)$$

Eq. (3) states that if C is carried on in only one location by the MNE, the output of C activities is the same as the output from a single-plant operation given equal levels of L_c in the two cases. Eq. (3) states, in other words, that the number of plants is irrelevant to the production function for C activities. In what follows, $C(\bar{L}_c^m)$ will be used as shorthand for $C(\bar{L}_c^m, 0)$ since we have assumed that centralization is optimal for the MNE and will arbitrarily assume that C is centralized in the home country.

3. The national enterprise equilibria

In this section we will derive reference solutions by assuming that there exists an independent monopoly (or duopoly) producer of X in each country. This formulation will be referred to as the national enterprise (NE) case. The list of NE equilibria is not comprehensive but rather is chosen to illustrate the possible trade-off between technical efficiency and market power when a MNE replaces two domestic firms.

It is assumed, as noted above, that all consumers including the monopolist have identical, homothetic utility functions and that the monopolist (or rather duopolist) in each country maximizes profits. With distributional and income effects thus removed, demand prices are simply a function of the relative outputs of X and Y (X/Y). If production takes place along the efficient production frontier of each country, the demand price ratio can be specified even more simply as just a function of X , since Y is uniquely related to X along the production frontier [Markusen (1981), Melvin and Warne (1973)]. Production must take place on the efficient production frontier even if the duopolists exercise monopsony power since there is only one factor mobile between sectors in this model. We will assume throughout the paper,

⁷Centralization of C could also be achieved by differences in factor endowments between countries m and h and differences in factor intensities between C and F activities. While such factor proportions effects may be empirically quite important, they are well understood from the existing literature. More to the point, one purpose of this paper is to suggest an entirely different basis for trade, as noted above.

however, that producers of X view factor prices as parametric.⁸ This is of some help in simplifying the graphical comparison of the MNE and NE equilibria, as noted below. The formal analysis of section 5 will not rely on this assumption.

Let p denote the price of X in terms of Y . The autarky equilibrium conditions in which there is a single monopoly producer of X in each country are given very simply as follows [Melvin and Warne (1973), Markusen (1981)]:

$$p^i(1 - 1/\eta_x^i) = MRT^i; \quad \eta_x^i = -\frac{p}{X} \frac{dX}{dp} > 0, \quad i = m, h, \quad (4)$$

where MRT^i is the marginal rate of transformation along country i 's production frontier and η_x^i is the elasticity of demand for X in country i . Second-order conditions for (4) will be satisfied if η_x^i is less than one and is a decreasing function of X (or, more correctly, of X/Y). Melvin and Warne (1973) and Markusen (1981) show that these conditions will be satisfied for example by any CES utility function with an elasticity of substitution greater than one.

Given our assumptions of identical tastes, technology, and factor endowments, it should be apparent that the solutions to (4) must be identical for the two countries. Autarky outputs, commodity prices, elasticities of demand, and factor prices will be the same in the two countries. With p^i , η_x^i and MRT^i the same in each country, it must also be true that production takes place on the efficient world production frontier.

The equilibrium given by (4) is shown in fig. 1 by point A . The production frontier YX_n can represent either the domestic or world production frontiers, with the latter being simply a radial blow-up of the former. Similarly, U_n can represent either the world or the national community indifference curve given the symmetry in the solution. Factor prices are also equalized in the autarky equilibria.⁹

When trade is possible, the symmetry in the model implies that any type of symmetric behaviour on the part of the two duopolists results in: (a)

⁸The assumption that firms have no monopsony power may seem strained in a two-good model. However, none of the results to follow relies on the fact that there are only two goods. All results continue to hold if there are many competitive sectors such that we could more reasonably assume that the X sector is a small employer of labour. Recent general-equilibrium models of monopsony include Feenstra (1980), McCulloch and Yellen (1980), and Markusen and Robson (1980).

⁹The commodity price and factor price equalization property of the autarky equilibrium breaks down if countries are of different size. With increasing returns to scale in X , the production frontier of the larger country will be flatter along any ray from the origin. This implies a lower autarky price ratio in the large country, and a world production bundle which is interior to the world production frontier [see Markusen and Melvin (1981) and Markusen (1981)].

Fig. 1

production on the world production frontier; and (b) no trade by virtue of the fact that outputs, commodity prices, etc. are equalized without trade. Interestingly enough, if the two duopolists engage in price collusion to maximize joint profits or engage in a market-shares rivalry, exactly the same equilibrium will be reached as occurred with autarky production. There are no gains to be realized here from price collusion since the equilibrium condition is simply (4) with p^i and η_x^i equalized between countries.¹⁰ But the two equations in (4) are already equalized at the autarky equilibrium. It is in turn fairly well known that a market-shares rivalry results in an outcome identical to price collusion in this type of model.

Cournot-Nash behaviour on the part of the duopolists does on the other hand produce a distinct equilibrium [Markusen (1981)]. Suppose the duopolist in country m now views X^h as parametric. Revenue and marginal revenue as viewed by the duopolist in m are now given by:

¹⁰This result will generally not hold if there are strongly increasing returns in X such that the production frontiers of m and h are convex (i.e. the production sets are non-convex). In that case, the joint maximum will involve a non-symmetric equilibrium in which countries specialize [see Melvin (1969), Kemp (1969), or Markusen and Melvin (1981)].

$$R^m = p(X^m + \bar{X}^h)X^m; \quad MR^m = p + X^m \frac{dp}{dX}$$

$$MR^m = p + (X^m + X^h) \frac{dp}{dX} \left(\frac{X^m}{X^m + X^h} \right) = p \left(1 - \frac{\sigma^m}{\eta_x} \right), \quad \sigma^i = \frac{X^i}{X^m + X^h}, \quad (5)$$

where σ^m represents m 's market share and η_x continues to represent the world elasticity of demand for X . The Cournot-Nash equilibrium is thus given by:

$$p(1 - \sigma^i/\eta_x) = MRT^i, \quad i = m, h. \quad (6)$$

As in the previous three cases, the solutions to (6) must be symmetric for m and h . Each country must have the same outputs, market share, consumption levels, factor prices, and so forth. Note, however, that there are gains from (potential) trade in the sense that welfare levels will be higher than in autarky. The symmetric equilibria in (6) must imply a market share of one-half for each duopolist. Thus, at the autarky equilibrium (point A in fig. 1), each duopolist will now find that perceived marginal revenue exceeds marginal costs. The national or world equilibrium must now be at a point like B in fig. 1 which, given our demand assumptions, constitutes an unambiguous improvement in welfare relative to A .¹¹ Further increases in production and welfare could be realized if the firms engaged in average-cost pricing to prevent entry (point C in fig. 1).

We could of course also examine some non-symmetric NE equilibria such as Stackelberg leader-follower behaviour. But the point here is simply to establish that competitive forms of duopoly behaviour (Cournot-Nash, average-cost pricing) create a situation in which it is unclear whether or not replacing an inefficient duopoly with an efficient monopoly will increase welfare. Since the properties of a Stackelberg equilibrium require a rather lengthy analysis, we do not therefore present this case here.

4. The multinational enterprise equilibrium

Since it is not obvious that the MNE will produce efficiently, perhaps we should solve for the conditions that characterize the efficient world production frontier and compare them to the MNE's equilibrium conditions. It now makes little sense to talk about national production frontiers since the position of country h 's production frontier will, for example, be determined by the level of C activities carried on in country m . A similar problem confronted Ethier (1979) in dealing with international externalities.

¹¹I should be a bit careful in talking about 'social welfare', since there are, of course, distributional differences between A and B in fig. 1 (e.g. the monopolists are worse off at B). From either a revealed preference or a compensation principle approach, however, B is superior to A .

Assuming that it is optimal to centralize the C activity in country m , the conditions characterizing the efficient production frontier can be found by maximizing the output of X for a given level of Y production:

$$\begin{aligned} & \max C(L_c^m)[F(L_f^m) + F(L_f^h)] \\ \text{s.t.} \quad & \bar{Y} = G(\bar{L} - L_c^m - L_f^m) + G(\bar{L} - L_f^h), \end{aligned} \quad (7)$$

$$\frac{G^{m'}}{C^{m'}(F^m + F^h)} = \frac{G^{m'}}{C^m F^{m'}} = \frac{G^{h'}}{C^m F^{h'}} = MRT, \quad (8)$$

where $\bar{L}$ denotes each economy's endowment of labour and $Y = G(L_y)$.

Let w^i denote the wage of labour in terms of Y . $w^i = G^{i'}$ follows from the assumption that factor markets and the Y industry are competitive ($G^{i'}$ equals the marginal product of labour in the production of Y). The MNE's programming problem and first-order conditions are given as follows:

$$\max pC(L_c^m)[F(L_f^m) + F(L_f^h)] - w^m(L_c^m + L_f^m) - w^h L_f^h, \quad p = p(X), \quad (9)$$

$$p \left(1 - \frac{1}{\eta_x} \right) = \frac{G^{m'}}{C^{m'}(F^m + F^h)} = \frac{G^{m'}}{C^m F^{m'}} = \frac{G^{h'}}{C^m F^{h'}}, \quad \text{since } w^i = G^{i'}. \quad (10)$$

Eq. (10) satisfies the conditions given in (8) for the efficient use of inputs. Thus, the MNE equilibrium lies on the efficient MNE world production frontier. As shown in the next section, this MNE frontier will lie everywhere outside the NE frontier except at the Y axis ($\bar{YX}_m$ and $\bar{YX}_n$ in fig. 1, respectively).

In the centralized equilibrium (10), the intra-country labour allocations cannot be the same. Suppose, for example, that $L_y^m = L_y^h$, then it must be the case that $L_f^m < L_f^h$, since some of L^m must be used in C . Such an allocation cannot satisfy (10) since $L_f^m < L_f^h$ implies $F^{m'} > F^{h'}$. A similar argument implies that L_f^m cannot equal L_f^h . In short, we must have the following:

$$\begin{aligned} & \frac{G^{m'}}{C^m F^{m'}} = \frac{G^{h'}}{C^m F^{h'}}, \\ & \text{if and only if } L_y^m < L_y^h, L_f^m < L_f^h, \text{ given } L_c^m > L_c^h = 0 \end{aligned} \quad (11)$$

The centralized equilibrium must imply that country m has less resources in both Y and F such that both $G^{m'}$ and $F^{m'}$ exceed $G^{h'}$ and $F^{h'}$. Country m has more total resources in X ($L_y^m < L_y^h$) but the distribution of these resources between C and F differs from that in country h . Since $G^{m'} > G^{h'}$, the wage rate must be higher in country m in terms of Y but also in terms of X since

commodity prices are equalized. Conversely, both forms of capital must earn a lower return in country m . Each country has a relatively high price for the factors used intensively in its predominant activity (C for country m and G and F for country h).

The relationship between outputs in the two countries is not however so simple. Whether or not country m 's production ratio (X/Y) differs from country h 's ratio depends on the global properties of G and F . The fact that $(G^m/F^m) = (G^h/F^h)$ from (10) does not imply that $(X^m/Y^m) = (X^h/Y^h)$ or alternatively that $(G^m/F^m) = (G^h/F^h)$.

The implication of this dependence on the properties of G and F is that the direction and volume of trade cannot be fully predicted in the model. If the solution of (10) by pure chance involves $(X^m/Y^m) = (X^h/Y^h)$, as just noted, then trade will consist simply of a one-way profit repatriation of both commodities in the same production ratio. If the solution involves different production ratios, then identical, homothetic demand may imply two-way trade with m exporting Y , for example, if $(X^m/Y^m) < (X^h/Y^h)$.

These findings suggest that MNE activity as modelled above does affect the inter-sectoral allocation of economic activity in a country (i.e. $L_j^m < L_j^h$) and does therefore provide a basis for trade. It does not however offer a simple prediction as to the direction of trade. Nevertheless, there will always exist some trade (profit repatriation at a minimum) in the MNE equilibrium as opposed to the symmetric no-trade NE equilibria.

5. Comparing the MNE and NE equilibria

Consider a fixed allocation of resources between the X and Y sectors for the NE version of the model. First-order conditions imply an optimal allocation of labour in X between the C and F activities. Denoting these labour allocations as $\bar{L}_j^i$, the maximum value of world X production given the fixed level of Y production is given by:

$$\bar{X} = C(\bar{L}_c^m)F(\bar{L}_f^m) + C(\bar{L}_c^h)F(\bar{L}_f^h), \quad (12)$$

where $\bar{L}_i^m = \bar{L}_i^h$ by virtue of the symmetry of all of the NE equilibria.

The efficiency advantage of the MNE can easily be demonstrated by considering a simple (although not optimal) production plan. Specifically, the two-plant MNE enterprise could if it wished produce $\bar{X}$ from $\bar{L}_c^m$, $\bar{L}_f^m$, and $\bar{L}_f^h$ and still have $\bar{L}_c^h$ left over:

$$\bar{X} = C(\bar{L}_c^m)[F(\bar{L}_f^m) + F(\bar{L}_f^h)]. \quad (13)$$

Indeed, the MNE can do even better by optimally reallocating labour among the four X -sector activities so as to satisfy the MNE first-order conditions

given in (10). Thus, producing $\bar{X}$ with $\bar{L}_c^h$ left over is the *minimum* improvement in productive efficiency that the MNE can realize.

In a sense, production by the MNE thus represents a technical improvement in the world production function for X . The efficient MNE world production frontier must lie everywhere outside the efficient NE world production frontier (except at $X=0$). This is shown in fig. 1, where $\bar{YX}_m$ represents the world MNE production frontier and $\bar{YX}_n$ represents the world NE production frontier.

An analysis of total world gains or losses from the MNE is straightforward. The process begins by noting that with a convex world production set, the value of the MNE equilibrium production bundle evaluated at a 'price ratio' tangent to the production frontier at the MNE production point must exceed the value of any other feasible production bundle evaluated at the same price ratio [Kemp (1969), Markusen (1981)]. In our case, this 'price ratio' is given by the *MRT* at the MNE equilibrium and therefore by $p_m(1-1/\eta_x)$, where subscript m denotes the MNE equilibrium value. The principle is illustrated in fig. 1: at M , for example, the value of production evaluated at $(MRT)_m$ exceeds the value at that price ratio of all other feasible production bundles. Using subscript i to denote any arbitrary NE equilibrium allocation, this value relationship becomes:

$$\begin{aligned} (Y_m^m + Y_m^h) + p_m(1-1/\eta_x)(X_m^m + X_m^h) \\ \geq (Y_i^m + Y_i^h) + p_m(1-1/\eta_x)(X_i^m + X_i^h). \end{aligned} \quad (14)$$

Let C_{ij} denote the consumption of good j in allocation i . Aggregate market clearing requires that:

$$(Y_i^m + Y_i^h) = (C_{iy}^m + C_{iy}^h), \quad (X_i^m + X_i^h) = (C_{ix}^m + C_{ix}^h). \quad (15)$$

Substituting (15) into (14) and rearranging, we have:

$$\begin{aligned} [(C_{my}^m + C_{my}^h) + p_m(C_{mx}^m + C_{mx}^h)] \geq [(C_{iy}^m + C_{iy}^h) + p_m(C_{ix}^m + C_{ix}^h)] \\ + (p_m/\eta_x)(X_m^m + X_m^h - X_i^m - X_i^h). \end{aligned} \quad (16)$$

Eq. (16) states, for example, that the value of MNE consumption will exceed the value of NE consumption (i.e. the MNE bundle will be revealed preferred) if the total output of X is higher in the MNE equilibrium relative to the NE equilibrium ($X_m^m + X_m^h > X_i^m + X_i^h$).

It is easy to show that the MNE production of X exceeds the combined autarky totals, implying from (16) that welfare is higher in the MNE equilibrium. If the NE autarky equilibrium is at point A in fig. 1, then the

MNE equilibrium must be at a point like M or M' in that diagram. M or M' must be 'downhill' of the point on YX_m which lies on the same ray from the origin as point A . On such a ray, the MNE would face the same marginal revenue as the NE firms at A (since X/Y is the same) but a lower MRT (at equal X/Y , the MRT on $\overline{YX}_m$ is less than the MRT of $\overline{YX}_n$). Total X production at M or M' in fig. 1 must exceed total production at A .

The relation between the MNE and Cournot–Nash equilibria (point B in fig. 1) is ambiguous. Along the same ray from the origin as that through B , the MRT on $\overline{YX}_m$ is less than on $\overline{YX}_n$, but marginal revenue for the MNE is also less than the perceived marginal revenue of the Cournot–Nash duopolies. Thus, the MNE may continue to achieve a gain in welfare over the NE equilibrium as shown by points M' and B in fig. 1. On the other hand, the MNE and Cournot–Nash equilibria could be at points M and B , respectively, in fig. 1, indicating a deterioration in welfare. Relative to the Cournot–Nash equilibrium, the MNE equilibrium enjoys greater productive efficiency at the expense of a higher degree of exercised market power. A more complete welfare analysis requires that we exploit profit and entry restrictions at the level of the individual countries, a subject to which we now turn.

Consider first the situation in the MNE's home country. A sufficient condition for country m to be better off with the MNE is that

$$C_{my}^m + p_m C_{mx}^m \geq C_{iy}^m + p_m C_{ix}^m, \quad (17)$$

where subscript i again denotes some arbitrary NE equilibrium. The balance of payments constraint for country m is given by

$$C_{my}^m + p_m C_{mx}^m = Y_m^m + p_m X_m^m + \pi^*, \quad (18)$$

where π^* is profits repatriated from country h . Assuming that we are comparing the MNE equilibrium with a symmetric NE equilibrium with no trade, we will have $C_{ij}^m = X_{ij}^m$. Substituting this relationship and (18) into (17) gives us the sufficient condition for home country gains:

$$Y_m^m + p_m X_m^m + \pi^* \geq Y_i^m + p_m X_i^m. \quad (19)$$

Now subtract from each side of (19) the value of the economy's factor endowment evaluated at the MNE equilibrium factor prices. This is given by:

$$w_m \bar{L} + r_{my} \bar{K}_y + r_{mx} \bar{K}_x = w_m L_{jy}^m + w_m L_{jx}^m + r_{my} \bar{K}_y + r_{mx} \bar{K}_x, \quad (20)$$

where $\bar{K}_y$ and $\bar{K}_x$ are the endowments of sector-specific capital in Y and X and r_y and r_x their respective rental rates. $\bar{L}$ and w are the total endowment

of labour and the wage rate, respectively. Subtracting (20) from (19), the latter becomes:

$$\begin{aligned} & [Y_m^m - w_m L_{my}^m - r_{my} \bar{K}_y] + [p_m X_m^m - w_m L_{mx}^m - r_{mx} \bar{K}_x] + \pi^* \\ & \geq [Y_i^m - w_m L_{iy}^m - r_{my} \bar{K}_y] + [p_m X_i^m - w_m L_{ix}^m - r_{mx} \bar{K}_x]. \end{aligned} \quad (21)$$

Eq. (21) expresses the gains from trade inequality in terms of industry profits evaluated at the MNE equilibrium. Sufficient conditions for (21) to hold and therefore for gains from trade to occur are that

$$\{Y_m^m - w_m L_{my}^m - r_{my} \bar{K}_y\} \geq [Y_i^m - w_m L_{iy}^m - r_{my} \bar{K}_y] \quad (22)$$

and

$$[p_m X_m^m - w_m L_{mx}^m - r_{mx} \bar{K}_x] + \pi^* \geq [p_m X_i^m - w_m L_{ix}^m - r_{mx} \bar{K}_x]. \quad (23)$$

Eq. (22) can be rewritten as:

$$[1 - w_m a_{lm} - r_{my} a_{km}] Y_m^m \geq [1 - w_m a_{li} - r_{my} a_{ki}] Y_i^m, \quad (24)$$

where a_{lm} and a_{li} are, for example, the unit labour requirements at the MNE and NE equilibria, respectively, for good Y . The left-hand side of (24) is thus unit revenue ($p_y = 1$) minus unit cost at the MNE equilibrium. This is zero due to the assumption of constant returns and perfect competition in Y . The right-hand side of (24) is unit revenue minus unit costs evaluated at the MNE prices but using the NE input coefficients. Since (a_{lm}, a_{km}) are the profit-maximizing input coefficients at prices (w_m, r_{my}) , costs must be greater using unit inputs (a_{li}, a_{ki}) and thus the right-hand side of (24) is negative. Thus, the inequality shown in (24) and (22) does indeed hold.

The inequality in (24) is illustrated in fig. 2, where $Y_m = Y_i = 1$ is the unit isoquant for Y . M and N are the efficient input combinations at the MNE and NE factor prices, respectively. Unit costs at the MNE equilibrium are just tangent to $Y = 1$, as shown. Unit costs using the NE inputs (point N) but MNE factor prices are greater than one as shown in fig. 2. The left-hand side of (24) thus equals zero, while the right-hand side is negative.

To demonstrate that (19) and (17) hold such that country m gains from the MNE now only requires us to show that (23) holds. The left-hand side of (23) is the MNE's total profits (domestic plus foreign repatriation), while the right-hand side is the profits from the NE output evaluated at the MNE prices. This inequality has a revealed preference interpretation similar to the one used above; that is, if (23) holds the MNE's profits are revealed preferred to its alternative NE profits. If this inequality did not hold, then the MNE would find it advantageous to drop one plant or alternatively to not have

Fig. 2

become a MNE in the first place. Thus, profit maximization plus freedom of entry or exit from MNE operation assures us that (23) holds and thus (17) holds. If the MNE exists, the home country must gain.

Equations equivalent to (17)–(24) can be derived for the host country, the only difference being that π^* enters with a minus sign in (18), (19), (21) and (23). The analysis of (24) and fig. 2 remains valid for the Y industry, and thus the host country equivalent of (22) holds. Gains from trade will therefore be realized if the host country equivalent of (23) holds. This is written as:

$$[p_m X_m^h - w_m L_{mx}^h - r_{mx} \bar{K}_x] - \pi^* \geq [p_m X_i^h - w_m L_{ix}^h - r_{mx} \bar{K}_x]. \quad (25)$$

The left-hand side of (25) is the profits earned by the MNE minus the profits repatriated and is assumed to be greater than or equal to zero. The right-hand side is the profits that would be earned by producing the NE output at the MNE prices. This is not necessarily negative, as will be discussed below. Thus, even though the MNE produces with greater technical efficiency, the fact that it repatriates profits which might otherwise have gone to host country entrepreneurs means that gains are not assured for the host country.

The possible trade-offs between efficiency and market power are shown in figs. 3 and 4, where $\bar{Y}^h \bar{X}_n^h$ represents the NE transformation frontier for country h . $\bar{Y}^h \bar{X}_m^h$ gives the MNE frontier under the assumption that activity C is centralized in m and thus resources are freed for production in h . M denotes the MNE equilibrium and N the NE equilibrium in each diagram. The value of gross output measured in terms of Y is given by point G .

Since F is characterized by constant returns (as is Y), the marginal costs of producing X and Y equal average costs. Payments to domestic factor owners which equal total domestic income at the MNE equilibrium are therefore given in terms of Y by point F in each diagram (the slope of $\bar{Y}^h \bar{X}_m^h$ at M is the ratio of marginal costs). The budget line of domestic factor owners is constructed by drawing a line with slope p_m through point F . The distance between the price lines through G and F gives the MNE profits.

Using the revealed preference criteria employed above, the host country is assured of gains if the price line through F passes above N which gives national income (factor income plus profits of the domestic firm) at the NE equilibrium. (The dotted line in each diagram gives NE income at MNE prices.) As constructed, this does occur in fig. 3 but not in fig. 4. In the latter case, domestic gross income increases with the MNE, but repatriation leaves the host country worse off. The question now is whether or not the possibility illustrated in fig. 4 can be ruled out by further considerations such as limit pricing.

Suppose that the entrants in the host country behave in a 'Bertrand' fashion, viewing the MNE's prices as parametric in making their entry decision. Assume further that the MNE prices to prevent entry by these Bertrand firms; that is, the MNE must produce an output sufficiently large that at the resulting commodity and factor prices there is no profitable output that a single-plant entrant could produce. The right-hand side of (25) gives the profits that an entrant could earn at MNE prices by producing the NE output. If there is no profitable output that could be produced by a single-plant entrant at these prices, then this expression must be negative. This type of pricing to prevent entry by Bertrand firms thus implies that the inequality in (25) holds and that the host country is assured of gains.

Bertrand behaviour by entrants is not, of course, the only or the most reasonable form of entry behaviour. Unfortunately, it is also true that other forms of behaviour do not ensure that the right-hand side of (25) is non-positive. Suppose, for example, that entrants behave in a Cournot fashion, viewing the output of the MNE as fixed. The entrant then knows that if he enters, the price of X will fall as world production increases. With increasing returns to scale, he may therefore not find it profitable to enter even if the right-hand side of (25) is positive (e.g. if X_i^h is actually produced, price changes will lead to negative profits).

We can, however, offer one alternative sufficient condition for gains which looks at the problem from a somewhat different perspective. Suppose that

Fig. 3

Fig. 4

country h taxes repatriated profits (in a non-distortionary manner) such that the left-hand side of (25) is positive. If the tax is set such that the revenue (country h 's share of profits) is at least equal to the profits that would be earned by a domestic entrepreneur producing the NE output at MNE prices, then (25) holds and gains are assured.

6. Extensions

The purpose of this section is to very briefly discuss the implications of relaxing some of the assumptions used throughout the paper.

6.1. Non-centralization

As noted above, the assumption that the MNE finds it optimal to centralize C plays no role at all in the welfare analysis and the results thereof. Centralization of C is only assumed in order to generate an asymmetric equilibrium in which the two identical countries engage in a positive amount of trade. Assuming that the C isoquants in (2) are convex to the origin would simply imply that the MNE equilibrium is symmetric, with $L_c^m = L_c^h > 0$.

6.2. Monopsony

With only one factor mobile between sectors, allowing firms to exercise monopsony power makes no difference to the qualitative analysis of the NE. Monopsony does not pull the countries off their efficient production frontiers, but rather simply shifts each equilibrium shown in fig. 1 toward the Y axis.¹² With centralization and asymmetric production in the two countries, the MNE exercising monopsony power may produce at different MRT in the two countries and thus may not produce on the efficient world production frontier. The sufficient conditions for gains from trade are however unaffected by this complication.

6.3. Tariffs

I noted above that multi-plant economies form a basis for direct foreign investment irrespective of the existence of tariffs. The addition of tariffs to the model would create an additional incentive for multi-plant production, but otherwise leaves the analysis pretty much unchanged. The complication is that domestic prices will appear in (17) while world prices appear in (18). Eq. (19) will consequently have an additional positive term on the right-hand

¹²This result generally does not hold if there is more than one factor mobile between sectors [Feenstra (1980), McCulloch and Yellen (1980), Markusen and Robson (1980)].

side which will equal tariff revenue. The sufficient conditions for gains from trade will still be valid if there was no trade at the NE equilibrium or if tariff revenue at the MNE equilibrium exceeded revenue at the NE equilibrium.

6.4. Two MNEs

In this model, two MNEs (one in each country) will produce an equilibrium identical to the NE equilibrium with the same form of duopoly behaviour. Each firm would simply capture a symmetric share of its rival's market with its foreign plant. There are no gains from MNE activity since the gains noted above arise from avoiding the duplication of *C* activities that exists when there are two independent firms.

6.5. Non-symmetric NE equilibria

Non-symmetric NE equilibria such as Stackelberg leader–follower behaviour could be analyzed, but note again that the sufficient conditions for gains from trade do not depend on symmetry assumptions. Certain positive aspects of the NE equilibrium would change (e.g. the volume of trade), but not the welfare aspects of the MNE–NE comparison.

7. Summary and conclusions

(1) The purpose of this paper was to develop a general-equilibrium model which explains the allocative and distributive effects of multinational corporations. In doing so, it was noted that an adequate model should meet five pre-conditions: (a) it should provide rationale for direct versus portfolio investment; (b) it should preferably not rely on international factor movements, factor price differences, or barriers to international trade; (c) it should explain why monopoly production is superior to collusion among independent producers; (d) it should explain why a multinational corporation might wish to diversify geographically, yet possibly carry on different activities in otherwise identical countries; and (e) it should allow for positive economic profits insofar as profits may play an important role in the gains from trade. I argued that these conditions could be met by a model based on the industrial-organization concept of economies of multi-plant operation.

(2) These economies are modelled algebraically by an activity which enters the firm's production function as a joint input across production facilities. The technical (as opposed to economic) efficiency advantage of the MNE then lies in its ability to avoid the duplication of this joint input that would occur with independent national enterprises.

(3) Two versions of the basic model were developed and compared. In one version, world production of a good was monopolized by a multinational

enterprise (MNE) while in the other version there was a single independent national enterprise (NE) producing the good in each of two countries. In certain cases (e.g. the NEs behave in a Cournot–Nash fashion), the MNE produces with greater technical efficiency at the possible expense of higher exercised market power. In these cases it is not clear that the MNE will increase world welfare or the welfare of either country. It was shown that a sufficient condition for the MNE to increase world real income relative to the NE equilibrium was simply that the MNE increased the output of the good in question.

(4) Sufficient conditions for the home country to gain from the MNE were that the MNE's profits are 'revealed preferred' to the profits it could earn as a single plant firm at an alternative NE equilibrium. Since this condition presumably must hold if the firm is rational, the home country is guaranteed of gains in this model.

(5) The situation for the host country is more uncertain due to the fact that the MNE and the home country capture monopoly rents that would accrue to host country entrepreneurs at the NE equilibrium. Nevertheless, we were able to derive two alternative sufficient conditions which ensured gains for the host country. First, if the MNE must price to prevent entry by Bertrand firms in the host country, then that country is assured of gains. Second, if the host country can retain a share of the MNE's profits (via some tax) which is at least equal to the profits that would be earned by producing the NE output at MNE prices, then the host country gains.

(6) When the MNE finds it efficient to concentrate certain activities in the home country, the equilibrium involves the identical countries specializing in different activities and producing different bundles of goods. Thus, the MNE can lead to trade creation and to an 'international division of labour' [Hymer (1976)]. MNE activity can, per se, form a basis for trade. Alternatively, this finding notes that direct investment, unlike portfolio capital movements, can act as a complement rather than as a substitute to commodity trade [Markusen (1983)].

(7) The MNE equilibrium involves unequal factor prices between countries, whereas the symmetric NE equilibria all involve factor price equalization. At the MNE equilibrium each country has a relatively high price for the factors used intensively in its predominant activities (C for country m and G and F for country h). Note that if factors are then permitted to move internationally, factors will flow in a manner that increases the degree of international specialization and the volume of commodity trade. Similar to the previous point, this implies that direct investment, unlike portfolio capital movements, can make countries more unequal in certain respects. These results are in fact quite consistent with the findings in related papers by Melvin (1969), Krugman (1979), Markusen and Melvin (1981), and Markusen (1981, 1983) who note that with imperfect

competition and/or increasing returns, trading equilibria may involve specialization by two identical economies and a complementarity between trade in factors and trade in goods.

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