Service Multinationals in the Theory of International Trade

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This paper examines the consequences of liberalizing trade in producer services through multinationals. The formation of multinattionals in the present paper is not necessarily associated with the failure of factor price equalization. Similar economies in terms of factor endowments engage in two-way intra-industry foreign direct investment. However, the notion of comparative advantage is crucial in predicting the direction of trade and foreign direct investment when two countries differ in factor endowments. In a two-country general equilibrium model of international trade, liberalizing both trade and foreign direct investment gives rise to welfare gains (*JEL* Classification: F23).

I. Introduction

Traditionally, economists have usually considered services as unproductive tertiary activities. This view stems in large part from economists' seeing service activities as extremely labor-intensive and nontradable. Previously, the papers which did assess services typically placed the emphasis on consumer services, without taking full account of the unique functions that services perform in production. However, recent studies on service industries offer an alternative viewpoint (see, e.g., Burgess 1990; Francois 1990a, 1990b; Jones and Kierzkowski 1990; Markusen 1988, 1989; Melvin 1989). They pay attention not to consumer services, but to producer services that are purchased by firms as intermediate inputs in the production process for final goods. Indeed, the most dramatic post-war growth in the service industries has not been in consumer services, but rather in producer services.

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Moreover, the fastest growing component of international services trade is in producer services like banking and finance, insurance, telecommunications, consulting and other professional services, and computer software and data processing.[1]

Characteristically, these trade theorists ask whether trade in services is really different from trade in goods and, if so, how. If no systematic difference can be uncovered, there is no economic reason to treat services differently from goods. The literature contains a variety of suggested differences between goods and services. A common distinction is that the producer and the consumer must meet physically for services trade, while this is atypical for goods trade. Other emphasized differences are that services are nonstorable and nontangible; that they require a small proportion of intermediate inputs of goods; and that they require international direct investment when traded.[2] In most cases, either the producers have moved to the point of consumption or the consumers have moved to the location of production, but the transaction itself takes place within one country. Accordingly, service transactions in the balance of payments, unlike goods transactions, are largely defined by the residence of the transactors. As Kravis and Lipsey (1988) pointed out, the sale of services by U.S. firms to buyers outside the U.S. is accomplished largely through direct investment rather than through direct export of services. For the case of producer services, in particular, parent firms usually establish their subsidiaries in the foreign country in order to provide the services there.

Specifically, this paper explores the mechanism through which knowledge-based producer services enhance the productivity of the final goods. The critical role for services emphasized here stands in

[1]Empirical evidences are found in Duchin (1988), Grubel and Walker (1989), and Park and Chan (1989). Hoekman and Stern (1991) also point out that possible reasons for the growth of producer services include the increasing scope for arm's length sourcing due to innovations in information technology, as well as increasing specialization and product differentiation, driven in part by emerging economies of scale and scope and in part by demand for a larger variety and higher quality of services.

[2]Some authors (Hill 1977; Hoekman and Stern 1991), characterize services as entailing an activity in which both production and consumption take place simultaneously. Of course, there are exceptions: some telecommunication, reinsurance, or banking services are produced in one country and simultaneously consumed in another country, but these are not a large part of service production or trade. See Bhagwati (1984), who discussed the disembodiment effect of this type of services trade.

sharp contrast to the commonly held view that the service sectors are unproductive. We introduce a model of Chamberlinian monopolistic competition in the producer service industry. The monopolistic competition model gives us a very clear view of how the presence of economies of scale can give rise to mutually beneficial trade; that is, within this framework, imported and domestic producer services are complementary as inputs into final production. In this model, liberalizing trade in producer services means liberalizing foreign direct investment to produce producer services on site.

In contrast to recent models of multinational corporations (See, e.g., Ethier 1986; Helpman 1984; Krugman 1982; and Markusen 1984), this paper focuses on service multinationals rather than product multinationals. The formation of multinationals in this paper is not necessarily associated with the failure of factor price equalization. Similar economies, in terms of factor endowments, engage in two-way intra-industry foreign direct investment even in the presence of factor price equalization. Accordingly, this paper rationalizes the presence of service multinationals even in a world of factor price equalization. On the other hand, in the case of intermediate goods, the formation of multinationals does not occur since two-way intra-industry trade is the dominant mode in the presence of factor price equalization.

In this paper, the production of each differentiated producer service is firm-specific. Once developed with certain fixed costs, this firm-specific producer service can be produced in many plants only with variable costs. The intangible asset obtained from fixed costs might be technology in the usual sense. With this firm-specific intangible asset, the firm possesses some ownership advantage. For our purpose, the important assumption is that fixed costs are not tied to the location of production: that is, the fixed costs are not plant-specific. Thus, parent companies can establish their foreign subsidiaries without incurring additional fixed costs. In this sense, our approach develops a technology-based theory for the multinational firm.

Conventional trade theory treats foreign direct investment as a part of international factor movements. In this paper, however, factors of production do not move across national borders. Instead, only intangible firm-specific technology can be freely transferred within the multinational firm. This aspect highlights the characteristic of high-tech service multinationals which combine the local factors of production with their own technologies.

Another important feature of service multinationals in this paper is

the tendency for multinationals to economize on transaction costs by internalizing the transactions of firm-specific technology transfers within the firm instead of using the arms-length market. Thus, multinationals represent an extension of technology control. In the high-tech service industries, it is the technology itself that gives the foreign multinationals an edge over local competitors.[3]

Our theoretical analysis of service multinationals also conforms to traditional Heckscher-Ohlin trade theory. This paper finds that the notion of comparative advantage is crucial in predicting the direction of trade and foreign direct investment when two countries differ in factor endowments. Clearly, a human-capital-abundant country develops more varieties of producer services and more actively pursues multinational operations while a labor-abundant country tends to exploit foreign multinationals and export manufactured goods. To conclude, this paper shows that in the integrated world equilibrium, both countries are better off compared to the autarky.

The structure of the paper is organized as follows. Section II develops a basic model in which knowledge-based producer services play an important role in enhancing the productivity of the final good. With specific functional forms of production technologies for goods and services, an autarky equilibrium is derived. Section III then presents a general equilibrium trade model in which two identical countries are trading producer services through multinationals. By allowing factor endowment differences, section IV analyzes how two different countries specialize in the production of goods and services and shows the existence of gains from liberalizing trade and direct investment. Finally, section V summarizes the results and discusses limitations and extensions.

II. The Basic Model

Consider a general equilibrium model with a competitive sector Y under autarky. Final good Y is produced with unskilled labor L and an assortment of producer services $S = (S_1,..., S_n)$, where n is the number

[3]Trade in technologies involves a contractual arrangement of technology transfer between two different authorities. In the present paper, such a possibility of technology licensing is abstracted for the sake of simplicity. I appreciate one of referees to point out the distinction between trade in services and trade in technologies.

of varieties of producer services available. Producer services are provided by skilled specialists who develop their unique knowledge-based services with a high fixed cost of research and development. In order to keep the problem tractable, we assume that the production functions for S are identical and that S_j are symmetric but imperfect substitutes in producing Y. The identical production function for the competitive firms in the Y sector is given by

$$Y = AL^{1-\beta}[\sum S_j^{\alpha}]^{\beta/\alpha}, \quad 0<\alpha<1, \quad 0<\beta<1, \tag{1}$$

where L is employment of unskilled labor in the production of final good Y. Accordingly, the production functions in (1) have constant returns to scale for a fixed n.

To continue, the producer services form an assortment of horizontally differentiated inputs. Following Ethier (1982), we assume that for a given aggregate quantity of producer services used in the production of good Y, output is higher according to the greater diversity in the set of producer services. This specification captures the productivity gains from an increasing degree of specialization.

Moreover, each producer service uses only skilled labor, but requires a fixed cost of F units of skilled labor before it can be marketed. This fixed cost includes research and development cost for creating a differentiated producer service and training cost for bringing up specialists in each differentiated producer service. Once a differentiated producer service technology is developed, it becomes a firm-specific asset. For simplicity, the marginal cost of S_j is assumed to be one in terms of skilled labor. Also, the price of Y is normalized to one. Then the cost of producing S_j in terms of Y is

$$qS_j + qF, \tag{2}$$

where q is the wage rate for skilled labor in terms of Y.

Competition in final good sector Y ensures marginal-cost pricing of Y. By appropriate choice of the constant A, producer price of the good Y satisfies

$$1 = w^{1-\beta}[\Sigma p_i^{1-\epsilon}]^{\beta/1-\epsilon}, \quad \epsilon = 1/1-\alpha, \tag{3}$$

where w is the wage rate for unskilled labor and p_i is the price of the producer service i. The derived demand for the producer service i in the production of good Y is

$$S_i = (\Sigma p_i^{1-\epsilon})^{-1} p_i^{-\epsilon} \beta Y. \tag{4}$$

Furthermore, the existing S_i producers engage in monopolistic competition. Each one takes as given the price of his or her rivals, as well as the output and price of the good Y. The S_i producer chooses p_i to maximize profits, as follows,

$$\pi_S(i) = p_i S_i - qS_i - qF. \tag{5}$$

The first order condition for S_i implies the usual fixed-markup pricing rule.

$$\alpha p_i = q. \tag{6}$$

Thus, all producer services bear equal prices. Free entry of S producers results in zero profits, so

$$p_i S_i - qS_i - qF = 0. \tag{7}$$

Combining the two equations (6) and (7), we get the values of S_i at the monopolistic competition equilibrium:

$$S_i = \left(\frac{\alpha}{1-\alpha}\right)F, \tag{8}$$

We also assume full employment in both unskilled and skilled labor, so that the unskilled labor force must be exhausted by labor used in production of good Y and the skilled labor force by producer services S. Substituting (3) into the conditional factor demand for L, we see that a final good producer demands $(1-\beta)Y/w$ unskilled workers. The demand for skilled labor by the S producers is $\Sigma(S_i + F)$. Hence,

$$\begin{aligned} L &= \frac{(1-\beta)Y}{w}, \\ H &= \Sigma_i(S_i + F), \end{aligned} \tag{9}$$

where L and H are the endowment of unskilled and skilled labor force, respectively. By using the condition of full employment with (8), we can determine the number of differentiated producer services.

$$n = (1-\alpha)\left(\frac{H}{F}\right). \tag{10}$$

Due to fixed costs in production of producer services, the number of producer services actually produced is limited by the extent of the market. In the autarky equilibrium, a country with a larger skilled labor force can have more differentiated producer services in the production of final good Y. When the fixed cost is smaller, the more differentiated

producer services are produced. Finally, using equations (4) and (8)-(10), the relative factor prices are determined as follows:

$$\frac{q}{w} = \left[\frac{\beta}{(1-\beta)}\right]\left(\frac{L}{H}\right). \tag{11}$$

As the unskilled labor is relatively more abundant (higher L/H), the relative factor price of skilled labor to unskilled labor, q/w, will be higher.

III. Intra-industry Foreign Direct Investment and a Symmetric Equilibrium

To a firm selling a product in a foreign market, trade is one of several alternative modes of international competition. Other alternatives include local production by a controlled subsidiary in the foreign market or licensing to a local independent producer(in other words, trade in technologies). Which of the three options is actually chosen depends on the nature of the product, the nature of the market (including restrictions on movements of outputs and inputs), and the nature of the firm's own competitive strengths and weaknesses. In principle, a firm selling a service in a foreign market faces the same choice among alternative modes of international competition as a firm selling goods. But because of the locational constraints imposed on the provision of most services, the role of local production in the foreign market is likely to be relatively greater for a service product. Furthermore, we implicitly assume that multinationals prefer foreign direct investment to trade in technologies in order to internalize the transactions of firm-specific technology transfer within the firm. Thus, in this paper, we confine our attention to the establishment of subsidiaries as the unique mode of trade in producer services.

First, we consider the case where two countries have identical tastes, technology, and factor endowment (both in amount and proportion).

[4]Conventional trade theory teaches us that foreign direct investment as a part of international factor movements is induced by differences in factor endowments, but the large part of actual direct investment occurs between countries with relatively similar factor endowments. In this section, we are much concerned with two-way direct in vestment within service industries between identical economies like two-way intra-industry trade treated in recent developments in trade theory.

Both identical countries will not engage in goods trade since there is no conventional reasons for trade; there will nevertheless be both trade and gains from trade in services.[4] Trade will occur because, in the presence of increasing returns, producer services will be traded through multinationals. Gains from trade will occur because the world economy will have a greater diversity of producer services available than would either country alone.

Now, we can easily characterize the world economy equilibrium. The symmetry of the situation ensures that the two countries will have the same factor prices, and the price of any good produced in either country will be the same.

The S_i producer chooses p_i to maximize joint-profits

$$\pi_S(i) = p_i(S_i + S_i^*) - q(S_i + S_i^*) - qF, \tag{12}$$

where S_i^* is the amount of producer services produced by its foreign subsidiaries. In our symmetry equilibrium there is no reallocation effect of liberalizing foreign direct investment because unskilled labor and skilled labor are sector-specific. Each country produces the same number of producer services and each producer service firm supplies the same amount of services. The only difference lies in the fact that each producer service is supplied to both home and foreign market by a single firm through the parent and its subsidiary, respectively.

In contrast to the autarky equilibrium, foreign subsidiaries earn a positive amount of profits since they do not need to pay fixed costs when they enter the foreign market. But as in equation (12), considering the combined profits of the parent and its foreign subsidiary, the assumption of free entry and monopolistic competition ensures zero profits. As the foreign multinationals' entry increases the competition, given fixed costs, domestic firms cannot cover their production costs in their home markets. Only with their foreign affiliates' profits, can multinationals meet their total costs. Thus, in the open economy there exists a strong incentive for each producer service firm to export services; in our model through establishing foreign subsidiaries.

As a result, the total number of varieties of producer services is now

$$N = n + n^*, \tag{13}$$

where $n = (1-\alpha)(H/F)$ and $n^* = (1-\alpha)(H^*/F)$. Thus, final goods producers can employ more varieties of producer services as intermediate inputs and they can also enjoy productivity gains. Using the same numeraire of the final good Y, the productivity gains are transferred to factors,

both unskilled labor and skilled labor. Since in our symmetry equilibrium the equation (11) still holds, the factor rewards rise proportionately.

In our case of producer service multinationals, nothing tangible is being traded, yet some kind of trade is going on—and both countries find trade mutually beneficial. In an accounting sense the countries trade in services; that is, each country's foreign subsidiaries are earning profits in the other country, and the balance of payments thereby show equal and opposite entries in this line of the service account. In the economic sense, however, the countries are basically trading technology. Each country has incurred the cost of developing a number of producer services; that is what enables its firms to manage to produce abroad. By allowing each other's firms to establish subsidiaries, the countries trade their technologies. Thus, in our paper, even with the same factor prices service multinationals can coexist. Furthermore, multinationals' ownership need not coincide at all with physical capital movements. Our explanation as to why multinationals exist at all does not rely on factor movements, factor price differences, or barriers to international trade. Thus, service multinationals do not substitute for trade in goods or factor movements. Instead, service multinationals facilitate direct technology transfer.

IV. Comparative Advantage and Producer Service Multinationals

Now we consider a more general case where two countries have different factor endowments (in amount and proportion) as well. In the previously discussed symmetric case, factor price equalization was a natural result. But we will show below that even under different factor endowments, the integrated world economy has factor price equalization in equilibrium and we will also see that comparative advantage which results from different factor proportions determines trade patterns. That is, the notion of comparative advantage will be central to prediction of the direction of trade and the consequences of liberalizing trade when the factor endowments are different in two countries. Clearly, a skilled-labor-abundant country develops more varieties of producer services and more actively pursues multinational activity while an unskilled-labor-abundant country tends to exploit foreign multinationals instead of developing its own producer services. Even if

both countries are producing final goods, the unskilled-labor-abundant country exports its final goods in exchange for importing foreign technology through multinationals. In the integrated world equilibrium, both countries are better off compared to the autarky equilibrium.

The producer service multinational i chooses p_i and p_i^* to maximize joint-profits

$$\begin{aligned} \pi_S(i) &= (p_i S_i - qS_i) + (p_i^* S_i^* - q^* S_i^*) - qF \quad \text{for } i \text{ in } \Omega_n, \\ \pi_S(i) &= (p_i S_i - qS_i) + (p_i^* S_i^* - q^* S_i^*) - q^* F \quad \text{for } i \text{ in } \Omega_{n^*}, \end{aligned} \tag{14}$$

where Ω_n and Ω_{n^*} are the set of producer services developed in the home and foreign country, respectively, and are mutually disjoint. The first order conditions for S_i and S_i^* imply the usual fixed-markup pricing rule:

$$p_i = \frac{q}{\alpha} \text{ and } p_i^* = \frac{q^*}{\alpha}. \tag{15}$$

Thus, varieties of producer services produced within the same country bear the same prices. Using the symmetry assumption of the final good production function in terms of intermediate producer services, we know that the derived demand for each producer service is identical within the same country:

$$S_i = S, \quad S_i^* = S^* \quad \text{for all } i \text{ in } \Omega_N, \tag{16}$$

where $\Omega_N = \Omega_n \cup \Omega_{n^*}$. However, S and S^* are not necessarily equal. With free entry into the producer service industry, a zero profit condition in each producer service firm warrants $q = q^*$ and make each producers service firm's aggregate supply identical to the autarky level,

$$S^W = S + S^* = \left(\frac{\alpha}{1-\alpha}\right)F. \tag{17}$$

In addition, all intermediate producer services bear the same prices in the integrated world economy. In this free trade equilibrium, the price of the homogeneous final good should be the same. Thus, we have the same wage rates for unskilled labor in both countries. As above, we take the price of Y as a numeraire. Then, by using (4), we have

$$\begin{aligned} S &= \left(\frac{\alpha}{Nq}\right)\beta Y = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{L}{L+L^*}\right)F, \\ S^* &= \left(\frac{\alpha}{Nq}\right)\beta Y^* = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{L^*}{L+L^*}\right)F. \end{aligned} \tag{18}$$

Compared to the autarky equilibrium, each producer service is used less in the production of the final good since more varieties are used, as will be shown. A country with a larger unskilled labor endowment will employ a larger amount of each producer service.

We also assume full employment in both unskilled and skilled labor. Factor market equilibrium conditions provide

$$\begin{aligned} &H = NS + nF, \quad H^* = NS^* + n^* F, \\ &L = (1-\beta)\frac{Y}{w}, \quad L^* = (1-\beta)\frac{Y^*}{w}. \end{aligned} \tag{19}$$

Thus, the total number of varieties of producer services is now

$$N = n + n^* = (1-\alpha)\left(\frac{H+H^*}{F}\right). \tag{20}$$

Due to the factor endowment differences, both the home and foreign country may develop different numbers of its own varieties, as follows,

$$\begin{aligned} n &= \frac{H}{F}\left\{1-\alpha\left(\frac{1+H^*/H}{1+L^*/L}\right)\right\}, \\ n^* &= \frac{H^*}{F}\left\{1-\alpha\left(\frac{1+H/H^*}{1+L/L^*}\right)\right\}. \end{aligned} \tag{21}$$

If the home country is relatively skilled-labor intensive in its factor endowment ($H/L > H^*/L^*$), then it creates more varieties of producer services than its autarky level. By contrast, the foreign country creates less varieties. In order for both countries to create its own varieties, α should be within the following range,

$$0 < \alpha < \left(\frac{L+L^*}{H+H^*}\right)\left(\frac{H^*}{L^*}\right). \tag{22}$$

If α is close to one, i.e., producer services are almost perfect substitutes, then the number of varieties are smaller since the monopoly power of each producer service firm is weaker. Further, when the above condition (22) is violated—as we would expect, the differences in factor endowments are very large—n^* would be zero. Namely, the home country specializes in developing all varieties of producer services and establishes subsidiaries in the foreign country, while the foreign country does not have its own multinationals. In this case, the foreign country imports technology by allowing home multinationals to produce

their producer services in its location while it exports its final goods to the home country.

In our model, the trade balance must be satisfied since we do not consider international financial transactions. As in the above symmetric equilibrium case, if both countries create their own varieties, each country's foreign subsidiaries are earning profits in the other country. But the trade account would be the sum of both goods and service accounts. In our two-country model, we only need to consider one country. Taking the skilled-labor abundant home country as an example, we shall show how trade balance is satisfied in equilibrium.

In equilibrium, total factor earnings are spent on final good consumption. Thus, we have

$$C = wL + qH. \tag{23}$$

Since final goods are produced under perfect competition, we have

$$Y = wL + pSN. \tag{24}$$

Under free trade in goods and services, domestic earnings (payments) from direct exports (imports) of goods and profits of foreign subsidiaries are $(Y - C) + (p - q)S^*n$. Thus, from (23) and (24), we have

$$(Y - C) + (p - q)S^*n = pSN - qH + (p - q)S^*n. \tag{25}$$

Using factor market equilibrium condition (19), we have

$$(Y - C) + (p - q)S^*n = (p - q)Sn^* + n[(p - q)(S + S^*) - qF]. \tag{26}$$

The last term in the bracket should be zero because we assume free entry in the monopolistic producer service industry. Meanwhile, the right hand side reflects the payment for using foreign technology in the home production of intermediate producer services, (debit in the service account). In particular, the skilled-labor-abundant home country is likely to import final goods. Thus, the net goods trade account should be equal to net service account in equilibrium. In sum, we have

$$(C - Y) = (p - q)\ S^*n - (p - q)Sn^*. \tag{27}$$

In words, the left hand side reflects the net imports of final goods while the right hand side reflects the net balance in the national service account. Thus, the overall trade account is balanced in equilibrium.

In this integrated world equilibrium, the relative factor prices will be different from those in the autarky equilibrium. Using (18) and (19), we can derive free trade relative factor prices as follows,

$$\left.\frac{q}{w}\right|_F = \left(\frac{\beta}{1-\beta}\right)\left(\frac{\alpha L}{H-nF}\right). \tag{28}$$

Substituting (21) into (28), we have

$$\left.\frac{q}{w}\right|_F = \left(\frac{\beta}{1-\beta}\right)\left(\frac{L+L^*}{H+H^*}\right). \tag{29}$$

If $L/H < L^*/H^*$,

$$\left.\frac{q}{w}\right|_A = \left(\frac{\beta}{1-\beta}\right)\left(\frac{L}{H}\right) < \left.\frac{q}{w}\right|_F < \left(\frac{\beta}{1-\beta}\right)\left(\frac{L^*}{H^*}\right) = \left.\frac{q}{w}\right|_{A^*}. \tag{30}$$

Finally, we shall show that in the integrated world equilibrium both countries are better off compared to the autarky equilibrium. Since we only consider a single final good, a country gains from trade if $C_F > C_A$ where subscripts F and A denote free trade and autarky equilibrium, respectively. In the autarky, $C_A = Y_A$. But, in the free trade equilibrium, as indicated above, domestic final good consumption does not necessarily equal domestic final good production. Instead, we have balance-of-payment equilibrium as shown in equations (27). Using (23), we have

$$\begin{aligned} C_F - C_A &= w_F L + q_F H - Y_A \\ &= q_F H - p_F S_F N_F - (Y_F - w_F L - p_F S_F N_F). \end{aligned} \tag{31}$$

But, $(Y_A - w_F L - p_F S_F N_F)$ is non-positive because the autarky factor proportion is not the most efficient way to produce Y_A at free trade factor prices; hence, we have

$$C_F - C_A \geq q_F H - p_F S_F N_F. \tag{32}$$

From the factor market equilibrium condition and (15), the right hand side of (32) becomes zero. Thus, $C_F > C_A$. Similarly, for the foreign country we have $C_F^* > C_A^*$. In sum, both countries are better off in the free trade equilibrium as compared to the autarky equilibrium.

V. Conclusion

To conclude, this paper has examined the consequences of liberalizing trade in producer services through multinationals. Notably, producer services are important inputs for the production of final goods and trade in producer services allows more varieties to be employed in

the process of the final goods production. Furthermore, differences in factor proportions result in international division of production of goods and services.

Nonetheless, our model has many restrictions on its specifications. First, we assumed that technologies in goods and services are universal in two countries. We may relax these assumptions. First, we may think that in some developing countries skilled-labor is not only a scarce factor, but also that producer services are more costly to develop. For example, we may assume that $F^* > F$ when $H/L > H^*/L^*$ and $H > H^*$. The equilibrium values for endogenous variables are given in the Appendix. Second, we may consider factor movements, in particular, movements of skilled labor accompanied by multinationals. If producer services are embodied in firm-specific employment of skilled labor, some portion of skilled labor in parents should move in order to service the foreign market or newly employed indigenous skilled labor in the foreign market should be trained at some cost. Third, we may consider more final goods without loss of simplicity of our model. Or we may introduce intermediate products and product multinationals. In future research, all these considerations will be useful. (*Manuscript received August, 1993; final revision received December, 1993*)

Appendix

THE FOLLOWING TABLE SUMMARIZES THE RESULTS IN THE TEXT AND SOME EXTENSIONS

	Autarky	$\frac{H}{L}=\frac{H^*}{L^*}$ $F=F^*$	$\frac{H}{L}\neq\frac{H^*}{L^*}$ $F=F^*$	$\frac{H}{L}\neq\frac{H^*}{L^*}$ $F\neq F^*$
S	$\frac{\alpha}{1-\alpha}F$	$\frac{\alpha}{1-\alpha}\frac{L}{L+L^*}F$	$\frac{\alpha}{1-\alpha}\frac{L}{L+L^*}F$	$\frac{\alpha}{1-\alpha}F\left(1+\frac{F}{F^*}\frac{L^*}{L}\right)^{-1}$
S^*	$\frac{\alpha}{1-\alpha}F^*$	$\frac{\alpha}{1-\alpha}\frac{L^*}{L+L^*}F$	$\frac{\alpha}{1-\alpha}\frac{L^*}{L+L^*}F$	$\frac{\alpha}{1-\alpha}F^*\left(1+\frac{F^*}{F}\frac{L}{L^*}\right)^{-1}$
n	$(1-\alpha)\frac{H}{F}$	$(1-\alpha)\frac{H}{F}$	$\frac{H}{F}\left[1-\alpha\left(\frac{1+H^*/H}{1+L^*/L}\right)\right]$	$\frac{H}{F}\left[1-\alpha\left(\frac{1+H^*/H}{1+L^*/L}\right)\right]$
n^*	$(1-\alpha)\frac{H^*}{F^*}$	$(1-\alpha)\frac{H^*}{F^*}$	$\frac{H^*}{F}\left[1-\alpha\left(\frac{1+H/H^*}{1+L/L^*}\right)\right]$	$\frac{H^*}{F^*}\left[1-\alpha\left(\frac{1+H/H^*}{1+L/L^*}\right)\right]$
$\frac{q}{w}$	$\frac{\beta}{1-\beta}\frac{L}{H}$	$\frac{\beta}{1-\beta}\frac{L+L^*}{H+H^*}$	$\frac{\beta}{1-\beta}\frac{L+L^*}{H+H^*}$	$\frac{\beta}{1-\beta}\frac{L+(F/F^*)L^*}{H+(F/F^*)H^*}$
$\frac{q^*}{w^*}$	$\frac{\beta}{1-\beta}\frac{L^*}{H^*}$	$\frac{\beta}{1-\beta}\frac{L+L^*}{H+H^*}$	$\frac{\beta}{1-\beta}\frac{L+L^*}{H+H^*}$	$\frac{\beta}{1-\beta}\frac{L+(F/F^*)L^*}{H+(F/F^*)H^*}$

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