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Trade Patterns and Policies: Intra-Industry Trade and Foreign Direct Investment*

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This paper investigates the patterns of trade and effects of trade policies in a manufacturing industry whose market is monopolistically competitive. Solving the equilibrium solutions explicitly, we show the existence of relative fixed costs, which divide patterns of trade into either a regime with intra-industry trade or active multinational firms. Moreover, it is found that both intra-industry trade and activities by multinational firms are determined by wage differentials, market size, trade costs and relative fixed costs. Thus, politically changing any of these factors may affect both trade patterns and intra-industry trade or multinational activities.

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Keywords: Intra-industry trade, Multinational firms, Wage differentials, Market size, Trade costs, Trade policies

1. Introduction

In the last several decades, dramatic changes in the way firms supply foreign markets have been observed in many industries. For example, during the 1970s, Japanese automakers started exporting automobiles to the U.S. market, whose market size was considered large. The tremendous volume of exports from Japan, however, caused trade conflicts in the late 1970s. In 1981, Japanese automakers exercised Voluntary Export Restraints (VER) and were engaged in foreign direct investment (FDI) during the mid-1980s.[1] We can think of such FDI as arising from the high trade cost charged by the U.S.[2]

Rowthorn (1992) and Horstmann and Markusen (1992) explain the changes in supply logistics well. They assert that the firms concerned may choose one of three strategies: (i) not to enter the market, (ii) to enter the market as a domestic producer, or (iii) to enter the market as a multinational. In the second case, they export some part of their output to the market of a trade

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1. The details of these episodes are summarized in Ono (1999).
2. Trade costs include not only physical trade costs such as tariffs and transport costs but also non-physical ones such as VERs.

partner. Exporting activities, however, are associated with trade costs such as tariffs and transport costs. If the market of the trade partner is large, firms have an incentive to build plants overseas and sell their products without incurring trade costs. This framework suggests a trade-off between market size and trade costs.[3] Furthermore, Markusen and Venables (1998, 2000) point out the active role of multinational firms among industrialized countries. They show with simulations that as two countries become similar trade patterns are explained by multinationals. In contrast to this, Ethier (1982) has mentioned the possibility of intra-industry trade among similar industrialized countries.

The purpose of this paper is to investigate the patterns of trade and effects of policies in a manufacturing industry with increasing returns to scale. In particular, we analytically show that the claims by both Markusen and Venables (1998, 2000) and Ethier (1982) can be explained within a unified framework. Our model has features common with recent analysis on multinationals in the new trade theory (see Helpman and Krugman, 1985; Krugman, 1995): (1) CES type preferences over commodities; (2) monopolistic competition (see Dixit and Stiglitz, 1977); (3) increasing returns to scale; and (4) the existence of trade costs.

We predict trade patterns by using wage differentials, market size, trade costs and a fixed cost ratio. We find that there exists a threshold fixed cost ratio, which divides trade patterns. Since the fixed cost ratio expresses the relative ease with which multinational firms can penetrate the foreign market, the relationship between the actual ratio and the critical ratio determines the patterns of trade when economies become similar. When wage differentials do not exist, we obtain a critical value for trade cost, which plays a role similar to that of the critical fixed cost ratio. Our results imply that with trade liberalization intra-industry trade may occur as economies converge.

We then investigate the effects of policies within our framework. We show that policies may affect not only the activities of firms but trade patterns as well. Our results explain some real world examples well. For instance, in the mid 1980s, many states in the U.S. offered preferential taxes and land at cheap prices to Japanese automakers, who were interested in building plants in the U.S. These FDI-promoting policies induced them to switch from exporting to producing in the U.S. market. Of course, the strategies undertaken by Japanese automakers were also affected by the VER.

The rest of this paper is organized as follows. In section 2, we present the basic model. We then define the equilibrium conditions and derive trade patterns in section 3. We examine the effects of policies in section 4. Section 5 concludes.

2. The Model

We consider two countries, labelled country 1 and country 2, and focus on

3. Markusen (2002) summarizes this point. Brainard (1997) and Carr et al. (2001) test this issue empirically.

an industry called "manufacturing". This industry has product differentiation with Dixit-Stiglitz type monopolistic competition. The fundamental factor of production is labor and, for simplicity, one unit of manufacturing product is assumed to be produced using one unit of labor. Furthermore, increasing returns to scale are considered; that is, labor requirement (*i.e.,* total cost) for each firm consists of marginal labor inputs (*i.e.,* marginal costs) and fixed labor inputs (*i.e.,* fixed costs).

When producing manufacturing goods, firms face two kinds of fixed costs; firm-specific investment and plant-specific investment. The former investment includes management, advertising, marketing, etc. and is transferable once firms are multinationals.

When products are exported, trade costs are incurred. Following Venables (1996), we assume ad valorem trade costs.[4] This means that consumer prices of products exported from country i to country j are $t(>1)$ times as high as those of domestic products.

Let superscripts n and m stand for *national firms*, which are firms having a plant in their home country and supply the products to domestic and foreign markets, and *multinational firms*, which are firms having a plant in each country to supply to the local market, respectively. Under the above assumptions, profit functions for national firms and multinational firms, π_i^n and π_i^m, are respectively given by

$$\begin{aligned} \pi_i^n &= (p_i - w_i)(x_{ii}^n + x_{ij}^n) - w_i(f+g), \\ \pi_i^m &= (p_i - w_i)x_{ii}^m + (p_j - w_j)x_{ij}^m - w_i(f+g) - w_j g', \end{aligned} \tag{1}$$

where p_i is the price of manufacturing goods in country i, x_{ij}^k denotes output produced by firm $k(k=n, m)$ originated from country i and purchased in country $j(i, j=1, 2)$, f and g respectively denote headquarter investment and plant-specific investment in terms of labor units, and g' stands for plant-specific investment in the foreign country. Note that g and g' are not necessarily equal.

When the number of firms is sufficiently large, the symmetric firms' first order condition with respect to each output is given by

$$p_i\left(1-\frac{1}{\varepsilon}\right) = w_i, \tag{2}$$

where w_i and ε respectively stand for the wage rate in country i and the elasticity of demand. With CES preferences over varieties, equation (2) implies that, with the exception of exporting, all outputs are equal; that is,

$$x_{ii}^n = x_{ii}^m = x_{ji}^m = x_{ii} \qquad (\mathrm{i} \neq \mathrm{j}=1, 2).$$

Then, demand for a particular variety is given by

4. As stated by Venables (1996), introducing iceberg trade costs instead of ad valorem trade costs does not change the results qualitatively.

$$x_{ii} = (p_i)^{-\varepsilon}(P_i)^{\varepsilon-1}E_i,$$
$$x_{ii}^n = (p_i t)^{-\varepsilon}(P_j)^{\varepsilon-1}E_j, \tag{3}$$

where E_i and P_i respectively stand for expenditure on manufactured goods and the price index in country i, where

$$(P_i)^{1-\varepsilon} \equiv (p_i)^{1-\varepsilon}(n_i + m_i + m_j) + (tp_i)^{1-\varepsilon}n_j. \tag{4}$$

n_i and m_i respectively denote the number of national firms and multinational firms originated from country i (i=1, 2).

With monopolistic competition, zero-profit conditions must hold. Substituting equation (2) into equations (1), the zero-profit conditions for national firms and multinational firms are derived as follows.

$$x_{ii} + x_{ij}^n = (\varepsilon - 1)(f + g),$$
$$w_i x_{ii} + w_j x_{jj} = (\varepsilon - 1)(w_i(f + g) + w_j g'). \tag{5}$$

In order to examine trade patterns analytically, we now introduce the following variables.

$$y_{ii} \equiv \frac{p_i x_{ii}}{E_i}, \qquad y_{ij} \equiv \frac{p_i t x_{ij}^n}{E_j} \tag{6}$$

$$q_{ii} \equiv \left(\frac{p_i}{P_i}\right)^{1-\varepsilon}, \qquad q_{ij} \equiv \left(\frac{p_i t}{P_j}\right)^{1-\varepsilon} \tag{7}$$

$$S_i = \frac{E_i}{p_i(\varepsilon - 1)(f + g)} = \frac{E_i}{\varepsilon w_i (f + g)}. \tag{8}$$

Equations (6) denote market shares. Equations (7) present the weighted price indices. Equations (8) define market sizes.[5] As stated in Dixit and Stiglitz (1977), whether firms can survive in the long-run depends on the level of fixed costs.

From equations (3), (6) and (7), we find that

$$y_{ii} = q_{ii}, \quad y_{ij} = q_{ij} \tag{9}$$

for i, j=1, 2; $i \neq j$. Moreover, using equations (2), (6), (7) and (9), we obtain the relationship

$$y_{ii} = (d_{ji})^{1-\varepsilon} y_{ji}, \tag{10}$$

5. Our definition of market size is essentially of the same spirit as that of Rowthorn (1992).

where $d_{ji} \equiv w_i / w_j t$, which measures relative wages including trade costs $(i, j=1, 2; i \neq j)$. Substituting equations (7) and (10) into equation (4), we obtain

$$y_{ii}(n_i + m_i + m_j) + y_{ji} n_j = 1, \tag{11}$$

which describes the market clearing condition in country i $(i, j=1, 2; i \neq j)$. Finally, using equations (2), (6) and (8), we can rewrite the zero-profit conditions (equation (5)) as follows.

$$y_{ii} S_i + y_{ij} d_{ij} S_j = 1, \tag{12}$$

$$y_{ii} S_i + y_{jj} S_j w_{ji} = 1 + \rho w_{ji}, \tag{13}$$

for $i, j \equiv 1, 2$; $i \neq j$, where $w_{ij} \equiv w_i / w_j$ and $\rho \equiv g'/(f+g)$. Equations (12) and (13) respectively correspond to the zero profit conditions for national and multinational firms. w_{ij} stands for the wage differential and ρ reflects the relative ease with which firms become multinationals. For smaller values of ρ, firms easily engage in foreign direct investment.

It is worth noting that while there are four market shares, y_{ii} and y_{ij} $(i, j=1, 2; i \neq j)$, equation (10) expresses that only two of them are independent. This implies that at most two firm types can survive in our model. Substituting the values of y_{12} and y_{21} into equations (12) and (13) (zero-profit conditions), these four equations can be expressed as functions of y_{11} and y_{22}. Therefore, there are at most only two equations which satisfy the zero-profit conditions.

3. Equilibrium Analysis

In this section, we explicitly solve y_{ii}, y_{ij}, n_i, m_i $(i, j=1, 2; i \neq j)$ and investigate the patterns of trade. In the following, we analyze two cases: (1) a wage-differential case ($w_{12} \neq 1$), and (2) an equi-wage case ($w_{12}=1$). In the former, without loss of generality, we assume $w_{12}>1$(*i.e.,* $w_1>w_2$). In this case, multinational firms never appear in country 1.[6] We may express the equilibrium trade pattern regimes (we simply call them "regimes" hereafter) in terms of the existing types of firms. There are six different regimes; $(n_1, 0)$, $(n_2, 0)$, $(m_2, 0)$, (n_1, n_2), (n_1, m_2) and (n_2, m_2). In the equi-wage case, because multinational firms produce the same amount of output in both countries with the same cost function, there is no way to distinguish between m_1 and m_2. Thus the number of multinational firms is determined as $m = m_1 + m_2$. There are six regimes in this case as well.[7] We label these six regimes as Regime I, ..., VI, respectively.

It is natural to assume that if some firms, which belong to a particular regime, have negative profit, then that regime cannot be an equilibrium regime.

6 . From equation (1), $\pi_j^m > \pi_i^m$ as according to $(w_i - w_j)(f+g-g') > 0$. Since $w_1 > w_2$, $\pi_2^m > \pi_1^m$ as far as $f+g-g' > 0$. When $f+g-g' < 0$, there is no possibility that multinational firms will exist. Therefore, we assume $f+g-g' > 0$.

7 . In this case, m is included instead of m_2.

Table 1. Outputs and the number of frms (in equilibrium)

Regime	y_{11}	y_{12}	y_{21}	y_{22}	Number of firms
I : $(n_1, 0)$	$\frac{1}{S_1+d_{12}S_2}$	$\frac{1}{S_1+d_{12}S_2}$	n.a.	n.a.	$n_1=\frac{1}{y_{11}}=\frac{1}{y_{12}}$
II : $(n_2, 0)$	n.a.	n.a.	$\frac{1}{S_2+d_{21}S_1}$	$\frac{1}{S_2+d_{21}S_1}$	$n_2=\frac{1}{y_{21}}=\frac{1}{y_{22}}$
III : $(m_2, 0)$	$\frac{1+w_{12}\rho}{S_2+w_{12}S_1}$	n.a.	$\frac{1+w_{12}\rho}{S_2+w_{12}S_1}$	n.a.	$m_2=\frac{1}{y_{11}}=\frac{1}{y_{22}}$
IV : $(n_1,\ n_2)$	$\frac{1-(d_{12})^{\varepsilon}}{S_1(1-(d_{12}d_{21})^{\varepsilon})}$	$\frac{(d_{12})^{\varepsilon-1}(1-(d_{21})^{\varepsilon})}{S_2(1-(d_{12}d_{21})^{\varepsilon})}$	$\frac{(d_{21})^{\varepsilon-1}(1-(d_{12})^{\varepsilon})}{S_1(1-(d_{12}d_{21})^{\varepsilon})}$	$\frac{1-(d_{21})^{\varepsilon}}{S_2(1-(d_{12}d_{21})^{\varepsilon})}$	$n_1=\frac{y_{22}-y_{21}}{\Delta_1}$ $n_2=\frac{y_{11}-y_{12}}{\Delta_1}$
V : $(n_1,\ m_2)$	$\frac{1-(d_{12})^{\varepsilon}(1+w_{12}\rho)}{S_1(1-(d_{12})^{\varepsilon}w_{12})}$	$\frac{(d_{12})^{\varepsilon-1}(1+w_{12}\rho-w_{12})}{S_2(1-(d_{12})^{\varepsilon}w_{12})}$	$\frac{(d_{21})^{\varepsilon-1}(1-(d_{12})^{\varepsilon}(1+w_{12}\rho))}{S_1(1-(d_{12})^{\varepsilon}w_{12})}$	$\frac{1+w_{12}\rho-w_{12}}{S_2(1-(d_{12})^{\varepsilon}w_{12})}$	$n_1=\frac{y_{22}-y_{11}}{\Delta_2}$ $m_2=\frac{y_{11}-y_{12}}{\Delta_2}$
VI : $(n_2,\ m_2)$	$\frac{w_{12}\rho}{S_1(w_{12}-(d_{21})^{\varepsilon})}$	n.a.	$\frac{(d_{12})^{\varepsilon-1}w_{12}\rho}{S_1(w_{12}-(d_{21})^{\varepsilon})}$	$\frac{w_{12}-(d_{21})^{\varepsilon}(1+w_{12}\rho)}{S_2(w_{12}-(d_{21})^{\varepsilon})}$	$n_2=\frac{y_{11}-y_{22}}{\Delta_3}$ $m_2=\frac{y_{22}-y_{21}}{\Delta_3}$

Note that $\Delta_1 \equiv y_{12}y_{21}((d_{12}d_{21})^{1-\varepsilon}-1)$, $\Delta_2 \equiv y_{11}(y_{22}-y_{12})$, and $\Delta_3 \equiv y_{22}(y_{11}-y_{21})$.

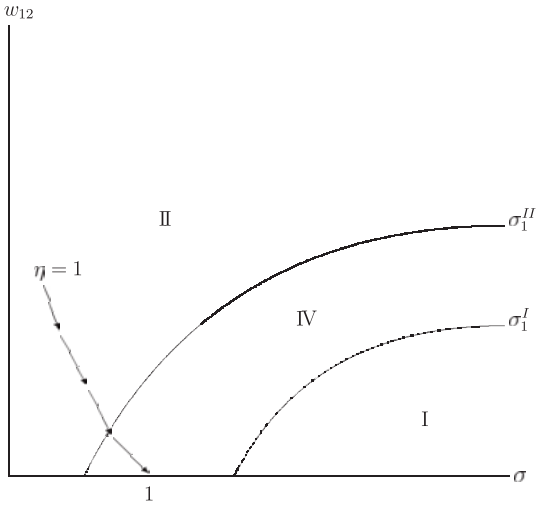

Figure 1. Trade patterns for $\rho > \rho^0$ $(w_{12} > 1)$

Definition (Equilibrium condition)
Suppose Regime k (k = I, II, ... ,VI) is an equilibrium regime. Then, the following two conditions must be satisfied.

(1) *For firm $i \in$ Regime k, $\pi_i^{l_i}=0$, $y_{ii}^{l_i}>0$, $y_{ij}^{l_i}>0$ and $l_i>0$, $i \neq j$=1, 2, $l_i=n,\ m$.*

(2) *For firm $i \notin$ Regime k, $\pi_i^{l_i}<0$, $i \neq j$=1, 2, $l_i=n,\ m$.*

3.1 Wage-differential case

Table 1 provides the solutions for y_{ii}, y_{ij}, n_i and m_i in each regime. For instance, let us consider Regime IV, where n_1>0 and n_2>0. Using equations (10)

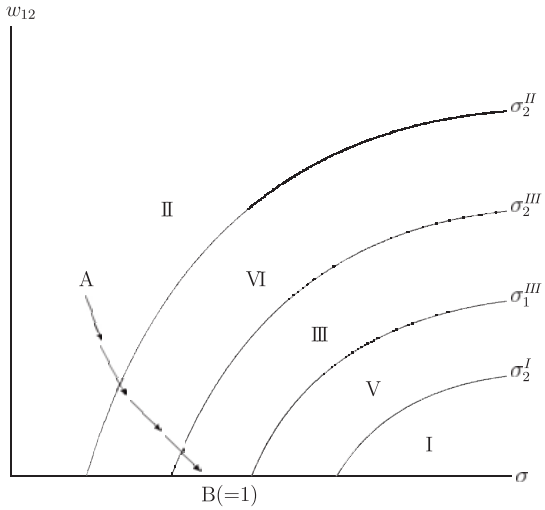

Figure 2. Trade patterns for $\rho < \rho^0$ $(w_{12} > 1)$

and (12), we can determine the values of y_{21} and y_{22}. Then, since $m_2=0$, equations (11) provide the values of n_1 and n_2.

First of all, equations (1) imply that the autarky economies cannot be the equilibrium. Since headquarter services are freely transferable, multinational firms can produce the same amount of output as national firms in each country at a lower cost. In addition, values in Table 1 show that if intra-industry trade (Regime IV) is the equilibrium regime, then $y_{ii} > y_{ij}$ $(i, j=1, 2; i \neq j)$; that is, it is necessary for both n_1 and n_2 to be positive. This result is similar to results obtained by Rowthorn (1992) and Horstmann and Markusen (1992); firms' sales in the domestic market are larger than those in the foreign market.

Define $\sigma \equiv S_1/S_2$ as the relative market size between country 1 and 2. Using the equilibrium values of y_{ii}, y_{ij}, n_i, m_i $(i \neq j=1, 2)$ in Table 1 and the definition of equilibrium, we find the boundaries of each regime with respect to relative market size (see Appendix). Figures 1 and 2 show that these boundaries can be configurated using wage differentials (w_{12}) and relative market size (σ).[8] Moreover, we derive the threshold relative fixed cost ratio,

$$\rho^0 = \frac{(1-(d_{12})^{\varepsilon})(1-(d_{21})^{\varepsilon} w_{12}^{-1})}{1-(d_{12})^{\varepsilon}(d_{21})^{\varepsilon}}. \tag{14}$$

If the actual relative fixed cost ratio is greater (*resp*. smaller) than ρ^0, regimes with multinational firms (*resp*. intra-industry trade) are not feasible.

8. It is obvious that when the wage rate in one country is very high, there may be no intra-industry trade and no multinational firms. That is, if $w_1 > tw_2$ and $w_2 > tw_1$, only national firm in country 2 can survive in the former case and only national firms in country 1 can remain the latter case. In our case, without loss of generality we assume $w_{12} > 1$. Therefore when $w_{12} > t$, only national firms in country 1 engage in exporting.

Proposition 1

Intra-industry trade and foreign direct investment cannot coexist. In particular, there exists a constant ρ^0, which divides the equilibrium regimes.

(1) *When $\rho > \rho^0$, Regime III, V and VI cannot exist in the equilibrium.*

(2) *When $\rho < \rho^0$, Regime IV cannot be in the equilibrium.*

Proof. *See Appendix.*

Proposition 1 states that where multinational firms have easy access in country 1, due to low plant-specific fixed cost ($\rho < \rho^0$), there is no possibility for both national firms, n_1 and n_2, to coexist with $m_2 > 0$, because only two types of firms can survive in any equilibrium regime. Note that $1-(d_{12})^{\varepsilon}(d_{21})^{\varepsilon}=1-t^{-2\varepsilon}>0$, and that $1-(d_{12})^{\varepsilon}=1-(w_{12})^{-\varepsilon}t^{-\varepsilon}>0$. We assume $1-(d_{21})^{\varepsilon}(w_{12})^{-1}=1-(w_{12})^{\varepsilon-1}t^{-\varepsilon}>0$.

Applying Proposition 1, we obtain the type of convergence. Defining η as an index of relative expenditure, $\eta \equiv E_1/E_2$. Suppose that $\eta=1$. When $\rho > \rho^0$, the economies are located at some point along the $\eta=1$ line in Figure 1. If we consider a large wage differential, then it is cheaper to produce in country 2 and export for country 1 (Regime II). When the wage differential becomes smaller and approaches unity, the economies move towards $\sigma=1$ and enter Regime IV, where intra-industry trade occurs. Similarly, when, $\rho < \rho^0$, $\eta = 1$ is depicted as line AB in Figure 2. When wage rates in country 2 are low, it is economical to produce all manufacturing goods in country 2 and to export some part of outputs to country 1. The economies are located at point A in Regime II. With a reduction in the wage differential the economies move along line AB towards point B, where $\sigma=1$, and into Regime VI, where multinational firms appear in country 2. Further wage equalization tends to reduce the cost advantage for multinational firms in country 2 and moves the economies into Regime III, where multinational firms prevail in both countries.

Corollary 1

When the two economies become similar, two types of convergence occur.

(1) *For $\rho < \rho^0$, the economies enter the regime of active multinationals (Markusen and Venables, 1998).*

(2) *For $\rho > \rho^0$ the economies enter the regime of intra-industry trade (Ethier, 1982).*

Finally, from equation (14), we find the effects in changes in either the wage differential or the trade cost on the threshold relative fixed cost ratio.

Proposition 2

An increase in the wage differential w_{12} around $w_{12}=1$ and/or an increase in trade costs t raises the threshold relative fixed cost ratio ρ^0.

Proof. *First, consider an increase in w_{12}. Equation (14) is rewritten as*

$$\rho^0 = \frac{V}{1-t^{-2\varepsilon}},$$

where $V = (1-(w_{12})^{\varepsilon-1}t^{-\varepsilon})(1-(w_{12})^{-\varepsilon}t^{-\varepsilon})$. *Since the denominator is independent of* w_{12}, *we are only concerned with the sign of the derivative of* V *with respect to* w_{12}. *We have*

$$\frac{1}{V}\frac{\partial V}{\partial w_{12}} = \frac{(1-\varepsilon)(w_{12})^{\varepsilon-2}t^{-\varepsilon}}{1-(w_{12})^{\varepsilon-1}t^{-\varepsilon}} + \frac{\varepsilon(w_{12})^{-\varepsilon-1}t^{-\varepsilon}}{1-(w_{12})^{-\varepsilon}t^{-\varepsilon}}, \tag{15}$$

whose sign is generally ambiguous. At $w_{12}=1$, *however,*

$$\left.\frac{1}{V}\frac{\partial V}{\partial w_{12}}\right|_{w_{12}=1} = \frac{(1-\varepsilon)t^{-\varepsilon}}{1-t^{-\varepsilon}} + \frac{\varepsilon t^{-\varepsilon}}{1-t^{-\varepsilon}} = \frac{t^{-\varepsilon}}{1-t^{-\varepsilon}} > 0.$$

Thus, around $w_{12}=1$, $\partial\rho^0/\partial w_{12} > 0$.

Similarly, we obtain the case where t increases. Differentiating ρ^0 *with respect to t, we have*

$$\frac{1}{\rho^0}\frac{\partial\rho^0}{\partial t} = \frac{\varepsilon(w_{12})^{\varepsilon-1}t^{-\varepsilon-1}}{1-(w_{12})^{\varepsilon-1}t^{-\varepsilon}} + \frac{\varepsilon(w_{12})^{-\varepsilon}t^{-\varepsilon-1}}{1-(w_{12})^{-\varepsilon}t^{-\varepsilon}} - \frac{\varepsilon t^{-\varepsilon-1}}{1-t^{-\varepsilon}} + \frac{\varepsilon t^{-\varepsilon-1}}{1+t^{-\varepsilon}},$$

$$= \varepsilon t^{-\varepsilon-1}\left(\frac{(w_{12})^{\varepsilon-1}}{1-(w_{12})^{\varepsilon-1}t^{-\varepsilon}} + \frac{(w_{12})^{-\varepsilon}}{1-(w_{12})^{-\varepsilon}t^{-\varepsilon}} - \frac{1}{1-t^{-\varepsilon}} + \frac{1}{1+t^{-\varepsilon}}\right).$$

Since the sum of the first and the third terms in the parenthesis is

$\dfrac{(w_{12})^{\varepsilon-1}-1}{(1-(w_{12})^{\varepsilon-1}t^{-\varepsilon})(1-t^{-\varepsilon})} > 0$, $\partial\rho^0/\partial t$ *is positive.* ■

Proposition 2 says that when ρ is near ρ^0, a small change in w_{12} may move the economies into a different regime and drastically affect the patterns of trade.[9]

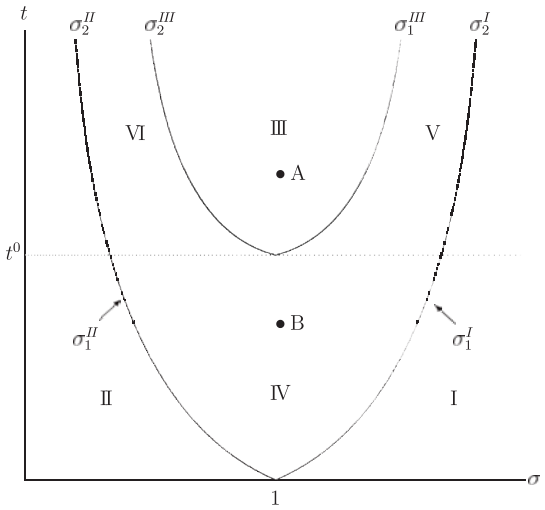

Figure 3. Trade patterns for $w_{12} = 1$

9. If wage differential is sufficiently large, the sign of equation (15) may be opposite for a large elasticity ε.

If agglomeration reduces trade costs, intra-industry trade will occur.

3.2 Equi-wage case

In order to complete our analysis, we consider the equi-wage case; *i.e.*, $w_{12}=1$. We can use the equilibrium values given in Table 1 by reading m_2 there as $m=m_1+m_2$. It should be noted that $\rho^0=\frac{1-t^{-\varepsilon}}{1+t^{-\varepsilon}}$. We then obtain the threshold level of trade costs

$$t^0 \equiv \left(\frac{1+\rho^0}{1-\rho}\right)^{1/\varepsilon}. \tag{16}$$

Note that $\rho>\rho^0$ implies $t<t^0$, and vice versa. Therefore, we can combine Figures 1 and 2 into Figure 3, where the vertical axis now measures trade costs.

Proposition 3
If $t<t^0$, multinational firms are active, and if $t<t^0$, intra-industry trade occurs.

Proposition 3 suggests that by reducing trade costs the economies move from Regime III to Regime IV (a movement from point A to point B in Figure 3). This suggests that agglomeration may result in intra-industry trade. Figure 3 shows that the trade patterns are fully demonstrated by (1) trade costs (t), (2) fixed cost ratio (ρ), and (3) relative market size (σ). Finally, differentiating equation (16) with respect to ρ and ε, we have Proposition 4.

Proposition 4
(1) *An increase in the relative fixed cost ratio ρ raises the threshold trade cost t^0.*
(2) *An increase in the price elasticity ε lowers t^0.*

Proposition 4 says that an increase in ρ enlarges the regime of intra-industry trade. On the other hand, if market demand is price elastic, consumers are sensitive to price levels. Since the multinational firms can provide manufacturing goods without trade costs, the equilibrium regime of multinational firms will become large.

4. Effects of Policies

In this section, we investigate how the state of economies are affected by policies. We examine first how intra-industry and multinational activities will be affected by a change in policy. Moreover, we check the effects on the boundary of the region and the critical value ρ^0 and explain the probability that these policies affect trade patterns. We only consider the wage-differential case throughout this section; thus, assume $w_{12}>1$.

Before starting our analysis, we define both an index of intra-industry trade and that of activities by multinational firms. First, assume the economies are in Regime IV, where intra-industry trade occurs. The index of intra-industry trade I_t is defined as follows:

$$I_t \equiv 1 - T, \tag{17}$$

$$\textit{where} \quad T \equiv \frac{|n_1 x_{12} - n_2 x_{21}|}{n_1 x_{12} + n_2 x_{21}}. \tag{18}$$

Since $n_1 x_{12}$ is the exports of country 1 and $n_2 x_{21}$ is the exports of country 2, which corresponds to the import in country 1, I_t is a simplified version of the Grubel-Lloyd index for country 1. We can express T in terms of n_1, n_2, y_{12} and y_{21}. By referring to the values for Regime IV shown in Table 1, equation (18) is rewritten as

$$T = \frac{|T_1 - T_2|}{|T_1 + T_2|}, \tag{19}$$

$$\textit{where} \quad T_1 = T_1(w_{12}, \ \sigma, \ t) \equiv \frac{\sigma}{\sigma_1^{II}} - 1$$

$$\textit{and} \quad T_2 = T_2(w_{12}, \ \sigma, \ t) \equiv \left(\frac{\sigma_1^I}{\sigma} - 1 \right) w_{12}^2 \sigma,$$

with $\partial T_1 / \partial w_{12} < 0$, $\partial T_1 / \partial \sigma > 0$ *and* $\partial T_1 / \partial t > 0$; $\partial T_2 / \partial w_{12} > 0$, $\partial T_2 / \partial \sigma < 0$ *and* $\partial T_2 / \partial t > 0$.

Next, assume the economies are located in Regime V, where national firms and multinational firms exist in country 1. We measure activities by multinational firms in country 1 as I_m:

$$I_m = \frac{m_2 x_{21}^m}{n_1 x_{11}^n + m_2 x_{21}^m} = \frac{m_2}{n_1 + m_2}. \tag{20}$$

Referring to the values for Regime V given in Table 1, equation (20) is rewritten as

$$I_m = \frac{\sigma_2^V - \sigma}{\sigma((d_{12})^{1-\varepsilon} - 1)}, \tag{21}$$

where $\sigma_2^V(w_{12}, \ t, \ \rho) = \sigma_2^I(w_{12}, \ t, \ \rho) \equiv (d_{12})^{1-\varepsilon} \dfrac{1 - (d_{12})^{\varepsilon}(1 + w_{12}\rho)}{1 + w_{12}\rho - w_{12}}$,

with $\partial \sigma_2^V / \partial w_{12} > 0$, $\partial \sigma_2^V / \partial t > 0$, and $\partial \sigma_2^V / \partial \rho < 0$.

4.1 Employment promoting policy

First, we consider a policy to promote employment by subsidizing wages. Since the wage rate of country 1 is higher than that of country 2, we consider the case where country 1 subsidizes wages.[10]

10. Similarly, we can examine the effect of the employment promoting policy taken by country 2, which is omitted here.

Suppose that the economies are located in Regime IV. Using the sign condition for T_1 and T_2, we obtain Proposition 5.

Proposition 5

(1) If $n_1x_{12}-n_2x_{21}>0$, then $\partial I_t/\partial w_{12}>0$.

(2) If $n_1x_{12}-n_2x_{21}<0$, then $\partial I_t/\partial w_{12}<0$.

Proof. *Suppose that* $n_1x_{12}-n_2x_{21}>0$. *Then, equation (17) is rewritten as* $I_t=\dfrac{2T_2}{T_1+T_2}$. *Differentiating this with respect to* w_{12}, *we find that*

$$\frac{1}{I_t}\frac{\partial I_t}{\partial w_{12}}=\frac{T_1}{T_2(T_1+T_2)}\frac{\partial T_2}{\partial w_{12}}-\frac{1}{T_1+T_2}\frac{\partial T_1}{\partial w_{12}}.$$

Since $\partial T_1/\partial w_{12}<0$ *and* $\partial T_2/\partial w_{12}>0$, $\partial I_t/\partial w_{12}>0$. *We can examine the other case in a similar fashion.* ■

Proposition 5 says that an employment promoting policy implemented by country 1 may or may not have positive effects on I_t depending on whether the manufacturing sector in country 1 has a trade surplus or a trade deficit. If it enjoys a trade surplus, I_t reduces the ratio of imports to total trade. When wage rates are reduced through subsidization and w_{12} decreases, the relative share of imports among total tradable will be decreased. On the other hand, if country 1 suffers trade deficits, the index of intra-industry trade reduces the ratio of exports to total trade. An employment promoting policy lowers wage rates in country 1 increasing competitiveness in the world market and raising the ratio of exports.

Next, let us examine the effect of an employment promoting policy on trade patterns. As shown in Appendix, we can calculate the effect of a change in wage rates. If $\rho>\rho^0$, where intra-industry trade occurs, then $\partial\sigma_1^I/\partial w_{12}>0$, $\partial\sigma_1^{II}/\partial w_{12}>0$. And if $\rho<\rho^0$, where multinational firms exist, then $\partial\sigma_2^I/\partial w_{12}>0$, $\partial\sigma_2^{II}/\partial w_{12}>0$. These sign conditions imply that if an economy is near the boundary, it can change the equilibrium regime by providing subsidies. For example, suppose country 1's economy is in Regime II. Then, if country 1 implements an employment promoting policy, it can create national firms or invite multinational firms.

Finally, we briefly touch upon the effect of the employment promoting policy on the threshold fixed cost ratio, ρ^0. As the wage differential moves towards one, the economies converge to a regime with either active multinationals or to active intra-industry trade depending on the relationship between ρ and ρ^0 (see Corollary 1). Furthermore, when $w_{12}\approx 1$, Proposition 2 says that the employment promoting policy conducted by country 1 lowers the value of ρ^0. Therefore, when ρ is near to ρ^0, employment promoting policies may drastically change the patterns of trade.

4.2 Market-growth policy

Second, we examine the effect of a policy that stimulates expenditure, such as distributing coupons to households. We call such a policy "market-growth policy". Now, assume that country 1 carries out this policy. By increasing the expenditure in country 1, e_1, for a given w_{12}, relative market size σ also expands. Then, we can determine the effect on the economy as described in the following Proposition.

Proposition 6
In Regime IV,
(1) If $n_1x_{12}-n_2x_{21}>0$, then $\partial I_t/\partial\sigma<0$.
(2) If $n_1x_{12}-n_2x_{21}<0$, then $\partial I_t/\partial\sigma>0$.
In Region V, $\partial I_m/\partial\sigma<0$.

Proof. *Consider the first result. Similar to the proof of Proposition 5, we find that*

$$\frac{1}{I_t}\frac{\partial I_t}{\partial\sigma}=\frac{T_1}{T_2(T_1+T_2)}\frac{\partial T_2}{\partial\sigma}-\frac{1}{T_1+T_2}\frac{\partial T_1}{\partial\sigma}.$$

Since $\partial T_1/\partial\sigma>0$ and $\partial T_2/\partial\sigma<0$, we have $\partial I_t/\partial\sigma<0$. The second result is obtained by a similar method. For the third result, differentiating equation (21) with respect to σ demonstrates that $\partial I_m/\partial\sigma<0$. ■

As shown in Section 4.1, when $n_1x_{12}-n_2x_{21}>0$, I_t is simply the ratio of imports to the total volume of trade. At first sight, it seems to be counter-intuitive that an expansion of σ reduces the import ratio. However, for a given w_{12}, the expansion of σ moves the economy horizontally into Regime IV in Figure 1 and Regime V in Figure 2, respectively. In both cases the economies move toward Regime I with increasing n_1 and decreasing n_2. That is, the market-growth policy stimulates activities by domestic firms.

4.3 Trade cost policy

Third, we explore the effect of trade cost policies, for example, a change in the tariff rate.[11] Since $\partial T_1/\partial t>0$ and $\partial T_2/\partial t>0$, the effect of a change in tariffs on I_t is generally ambiguous. The direction of the effect depends on the amount of T_1, T_2, $\partial T_1/\partial t$ and $\partial T_2/\partial t$.

We also point out the possibility that in Regime IV, when country 1 imposes a tariff to protect domestic industry, the economies may move to a regime where multinational firms appear in country 2, because an increase in t raises ρ^0 and provides an incentive for multinational firms to invest in country 1.

4.4 FDI promoting policy

Finally, we examine a policy where country 1 invites FDI. In reality, many

11. We may treat both quotas and VERs as a special case of the prohibitive tariff.

countries offer land at cheap prices and/or preferential tax rates to potential multinational firms who are interested in building plants. Since these policies reduce the value of ρ, the FDI promoting policy has two implications. First, suppose that the economies are located at some point in Regime II. The FDI promoting policy exercised by country 1 reduces ρ and pushes the economies into Regime VI. Second, when the economies are already in Region V, the FDI promoting policy increases the index of multinational activities in country 1, I_m, because $\partial\sigma_2^V/\partial\rho < 0$.

Proposition 7
Suppose that the economies are in Regime II. Then country 1 may increase FDI through a FDI promoting policy. Furthermore, this policy raises multinational activities in country 1.

5. Concluding Remarks

We presented a model, which contains product differentiation, imperfect competition, increasing returns to scale, and the existence of trade costs. Pointing out the essential features of this model analytically, we have shown that there exists a critical value for the fixed cost ratio which depends upon wage differentials, relative market size and trade costs. Intra-industry trade appears only for the case where $\rho > \rho^0$. Under this condition, when economies become similar, the claim of Ethier (1982) seems to hold. On the other hand, multinational firms emerge under the condition that $\rho < \rho^0$. In this case, when economies converge, the claim of Markusen and Venables (1998) seems to hold. Since the critical fixed cost ratio depends upon wage differentials, relative market sizes, and trade costs, some policies which affect them may change trade patterns.

While this paper is based on a partial equilibrium analysis, we believe that our model is useful for understanding the actual economy. For instance, consider the post-war development of the Japanese automobile industry. In the 1970's, Japanese auto-exports to the U.S. market increased tremendously. This was related to the wage differentials and difference in market sizes between the U.S. and Japan. The automobile industry requires a large amount of fixed costs. The VER and FDI by Japanese automakers in the mid 1980's may be explained by trade cost policy and FDI-promoting policy.

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Appendix: Equilibrium Analysis

(1) Regime I: $(n_1, 0)$

Equations (11) imply that $n_1 = \frac{1}{y_{11}} = \frac{1}{y_{12}}$. Substituting these into equation (12), we obtain: $y_{11} = y_{12} = \frac{1}{S_1 + d_{12}S_2}$. The following two conditions must be satisfied.

(i) $\pi_2^n < 0$, which implies $S_2 y_{22} + S_1 d_{21} y_{21} < 1$ (see equation (12)). By using equations (10), y_{22} and y_{21} respectively are expressed in terms of y_{12} and y_{11}. Then, substituting these values into the above equation, the condition, $\pi_2^n < 0$, reduces to

$$\sigma > \frac{(d_{12})^{1-\varepsilon}(1-(d_{12})^{\varepsilon})}{1-(d_{21})^{\varepsilon}} \equiv \sigma_1^I(w_{12},\ t).$$

Note that $\partial\sigma_1^I/\partial w_{12} > 0$ and $\partial\sigma_1^I/\partial t > 0$.[12] Superscript I attached to σ shows the value of an exogenous variable in Regime I.

(ii) $\pi_2^m < 0$, which implies $S_2 y_{22} + S_1 y_{11} w_{12} < 1 + \rho w_{12}$ (see equation (13)). Substituting the values of y_{11} and $y_{22} = (d_{12})^{1-\varepsilon} y_{12}$ into the above, we obtain the relationship

$$\sigma > \frac{(d_{12})^{1-\varepsilon}(1-(d_{12})^{\varepsilon}(1+w_{12}\rho))}{1+w_{12}\rho - w_{12}} \equiv \sigma_2^I(w_{12},\ t,\ \rho).$$

Note that $\partial\sigma_2^I/\partial w_{12} > 0$, $\partial\sigma_2^I/\partial t > 0$ and $\partial\sigma_2^I/\partial\rho < 0$.

We find that the relationship between σ_1^I and σ_2^I is related to that between ρ and ρ^0. A simple calculation shows

$$sign\,(\sigma_1^I - \sigma_2^I) = sign\,(\rho - \rho^0),$$

where $\rho^0 \equiv \frac{(1-(d_{12})^{\varepsilon})(w_{12}-(d_{21})^{\varepsilon})}{w_{12}(1-(d_{12})^{\varepsilon}(d_{21})^{\varepsilon})}$. Thus, $\sigma > \max\{\sigma_1^I,\ \sigma_2^I\}$ must hold for Regime I to be in an equilibrium. That is, when $\rho > \rho^0$, $\sigma > \sigma_1^I$. On the other hand, when $\rho < \rho^0$, $\sigma < \sigma_2^I$.

(2) Regime II: $(n_2, 0)$

Referring to the value of $y_{22} = y_{21} = \frac{1}{n_2}$ in Table 1 and using equation (10), we find the following.

(i) $\pi_1^n < 0$, which implies $S_1 y_{11} + S_2 d_{12} y_{12} < 1$. Substituting the values of y_{11} and y_{12} into the above, we obtain the following inequality.

$$\sigma < \frac{(d_{21})^{\varepsilon-1}(1-(d_{12})^{\varepsilon})}{1-(d_{21})^{\varepsilon}} \equiv \sigma_1^{II}(w_{12},\ t) = (d_{12})^{\varepsilon-1}(d_{21})^{\varepsilon-1}\sigma_1^I < \sigma_1^I.$$

(ii) $\pi_2^m < 0$,which implies

$$\sigma < \frac{(d_{12})^{\varepsilon-1} w_{12}\rho}{w_{12} - (d_{21})^{\varepsilon} - (d_{21})^{\varepsilon} w_{12}\rho} \equiv \sigma_2^{II}(w_{12},\ t,\ \rho)$$

with $\partial\sigma_2^{II}/\partial w_{12} > 0$, $\partial\sigma_2^{II}/\partial t < 0$, $\partial\sigma_2^{II}/\partial\rho > 0$. Simple calculation also derives that when

12. We assume that price elasticity ε is not extremely large.

$\rho > \rho^0$, then $\sigma_1^{II} > \sigma_2^{II}$, and vice versa. $\sigma < \min\{\sigma_1^{II},\ \sigma_2^{II}\}$ must hold for Regime II to be in an equilibrium. That is, when $\rho > \rho^0$, $\sigma < \sigma_1^{II}$. On the other hand, when $\rho < \rho^0$, $\sigma < \sigma_2^{II}$.

(3) Regime III: $(m_2, 0)$

Referring to the value of $y_{11} = y_{22} = \dfrac{1}{m_2}$ and using equation (10), we obtain the value of y_{12} and y_{21} as well.

(i) $\pi_1^n < 0$, which implies $y_{11}S_1 + y_{12}d_{12}S_2 < 1$. Substituting the value of y_{11} and y_{12} into the above equation, we have

$$\sigma < \frac{1-(d_{12})^{\varepsilon}(1+w_{12}\rho)}{1+w_{12}\rho-w_{12}} \equiv \sigma_1^{III} = (d_{12})^{\varepsilon-1}\sigma_2^{I} < \sigma_2^{I}.$$

(ii) $\pi_2^n < 0$, which implies $y_{22}S_2 + y_{21}d_{21}S_1 < 1$, which reduces to

$$\sigma > \frac{w_{12}\rho}{w_{12}-(d_{21})^{\varepsilon}(1+w_{12}\rho)} \equiv \sigma_2^{III} = (d_{12})^{1-\varepsilon}\sigma_2^{II} > \sigma_2^{II}.$$

The relationship between σ_1^{III} and σ_2^{III} is stated by

$$\sigma_1^{III} - \sigma_2^{III} = \frac{C}{AB}(\rho^0 - \rho),$$

where $A = 1+w_{12}\rho-w_{12}$, $B = w_{12}-(d_{21})^{\varepsilon}(1+w_{12}\rho)$, and $C = (1+w_{12}\rho)w_{12}(1-(d_{12})^{\varepsilon}(d_{21})^{\varepsilon})$.

When the economies are in Regime III, then $\sigma_2^{III} < \sigma < \sigma_1^{III}$. However, if $\rho < \rho^0$, there is no ρ which satisfies the equilibrium condition. That is, for $m_2 > 0$ must take a smaller value than ρ^0.

(4) Regime IV: (n_1, n_2)

Referring to Table 1, we have the value of y_{11}, y_{12}, y_{22} and y_{21}.

(i) $n_1 > 0$ implies $y_{22} > y_{21}$, which reduces to

$$\sigma > \frac{(d_{21})^{\varepsilon-1}(1-(d_{12})^{\varepsilon})}{1-(d_{21})^{\varepsilon}} \equiv \sigma_1^{IV} = \sigma_1^{II}.$$

(ii) $n_2 > 0$ implies $y_{11} > y_{12}$, which reduces to:

$$\sigma < \frac{(d_{21})^{1-\varepsilon}(1-(d_{12})^{\varepsilon})}{1-(d_{21})\varepsilon} \equiv \sigma_1^{IV} = \sigma_1^{I}.$$

(iii) $\pi_2^m < 0$, which implies: $y_{22}S_2 + y_{11}S_1w_{12} < 1+\rho w_{12}$. Note that $y_{22}S_2 + y_{21}d_{21}S_1 = 1$. Then, the condition $\pi_2^m < 0$ reduces to the condition, $\rho > \rho^0$.

(5) Regime V: (n_1, m_2)

(i) $n_1 > 0$ implies: $y_{22} > y_{11}$. Using the values of y_{22} and y_{11} given in Table 1, we have:

$$\sigma > \frac{1-(d_{12})^{\varepsilon}(1+w_{12}\rho)}{1+w_{12}\rho-w_{12}} \equiv \sigma_1^{V} = \sigma_1^{III}.$$

(ii) $m_2 > 0$ implies $y_{11} > y_{12}$. Then, we obtain

$$\sigma < \frac{(d_{12})^{1-\varepsilon}(1-(d_{12})^{\varepsilon}(1+w_{12}\rho))}{1+w_{12}\rho-w_{12}} \equiv \sigma_2^{V} = \sigma_2^{I}.$$

Note that $\sigma_2^V = \sigma_2^I > \sigma_1^{II}$.

(iii) For $\pi_2^n < 0$, $y_{22}S_2 + y_{21}d_{21}S_1 < 1$, which reduces to $\rho < \rho^0$.

(6) Regime VI: (n_2, m_2)

(i) $n_2 > 0$ implies $y_{11} > y_{22}$, which reduces to

$$\sigma < \frac{w_{12}\rho}{w_{12} - (d_{12})^{\varepsilon}(1 + w_{12}\rho)} \equiv \sigma_1^{VI} = \sigma_2^{III}.$$

(ii) $m_2 > 0$ implies $y_{22} - y_{21} > 0$, which reduces to

$$\sigma > \frac{(d_{21})^{\varepsilon-1} w_{12}\rho}{w_{12} - (d_{21})^{\varepsilon} - (d_{21})^{\varepsilon} w_{12}\rho} \equiv \sigma_2^{VI} = \sigma_2^{II}.$$

(iii) For $\pi_1^n < 0$, $y_{11}S_1 + y_{12}d_{12}S_2 < 1$, which reduces to $\rho < \rho^0$.

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