No.11

Intra-Industry Investment and Imperfect Markets

A Geometric Approach in Simple General Equilibrium

Laixun Zhao

October 1994

Department of Economics
Otaru University of Commerce

Preliminary, October 1994
Comments Welcome

INTRA-INDUSTRY INVESTMENT AND IMPERFECT MARKETS
A Geometric Approach in Simple General Equilibrium

Laixun Zhao*

This paper studies intra-industry foreign direct investment in a 2x2x2 general equilibrium model with bilateral monopoly in the factor market and unilateral monopoly in the product market. Intra-industry investment is presented as the endogenous result of the interactions between multinational firms and national unions. Robustness of results, welfare implications and distribution of income are also studied.

JEL Classification: F2, J5

Key Words: Intra-Industry Investment, Labor Unions, Nash Bargaining

Address: Dept. of Economics
Otaru University of Commerce
Otaru, Hokkaido 047
JAPAN
E-Mail: zhao@canal.otaru-uc.ac.jp
Fax: 81 (134) 22-0467

* I wish to thank Junichi Itaya, Kenji Yamamoto and seminar participants at Otaru University of Commerce for helpful suggestions.

1. Introduction

There exists a large literature on foreign direct investment (FDI), most of which belongs to two approaches. The first is based on factor endowment differentials and perfect competition, in which FDI is simply a form of factor movements chasing higher returns in other countries. The second is based on firm-specific advantages and imperfect competition. By becoming multinationals, firms employ these advantages in other markets (sometimes called 'internalization'). Recent papers in the latter approach are Markusen (1984), Helpman (1984) and Ethier (1986).

However, both of the above approaches are concerned with one-way FDI. Empirical evidence suggests that cross FDI is becoming more important, especially the phenomenon of intra-industry FDI, i.e. cross investment in the same industry in different countries. Jones et al. (1983) modelled cross-hauling investment, but in different sectors and with perfect competition. Many other writers discussed this phenomenon, but so far have not rigorously modelled it.

In an one-sector model, Zhao (1994) proposed an explanation for cross-hauling FDI: factor market imperfections. Specifically, firms become multinationals to gain an edge over the labor unions in the negotiations for wage rate and employment. He examined a two-stage game of international duopoly and showed that due to intensified competition in the product market, firms going multinational is a unique Nash perfect equilibrium.

This paper builds on Zhao (1994) in the sector-specific factors model with two identical countries. We apply cooperative Nash bargaining to study the interactions between firms and unions. The conventional equilibria for wage and employment determination are shown to be special cases of this model, using geometry. Intra-industry FDI is generated endogenously as the equilibrium result of the interactions between multinational corporations and national unions, i.e. bilateral monopoly in the factor market and unilateral monopoly in the product market. We show that with intra-industry FDI, union utility decreases and firm profits increase. These results are robust when countries differ in size. However, the smaller country tends to have a lower negotiated wage rate. The paper also demonstrates the welfare implications and distribution of income of unionization and of intra-industry FDI.

The present paper has the following features. First, intra-industry FDI exists in two countries that are completely identical, which is in line with empirical evidence that the larger part of actual FDI is between countries with relatively similar factor endowments; second, imperfections exist in both the factor and product markets. Thus the paper follows closely the literature on market distortions and wage differentials (see Bhagwati, 1971, Feenstra, 1980, Magee, 1973, Markusen and Robson, 1980, and McCulloch and Yellen, 1980), as well as the general equilibrium models of monopoly in international trade (e.g. Melvin and Warne, 1973, and Markusen, 1981, 1984); last but certainly not the least, the model and results are shown in simple geometry, taking advantage of the specific factors model.

The remainder of the paper is organized as follows. Section 2 presents the basic model, section 3 derives intra-industry FDI, section 4 introduces endowment differences, section 5 studies welfare and distribution of income, section 6 concludes.

2. The Basic Model

2.1 Assumptions

We use the simplest model and make the following assumptions to study this problem.

(a). There are two countries A and B producing two products x and y.

(b). The countries are initially assumed identical in every respect, including factor endowments, technology, and homothetic utility functions of representative consumers. This assumption is made to neutralize the conventional sources of foreign direct investment. Different endowments will be considered in section 4.

(c). y is produced competitively and is chosen as the numeraire good. The x sector is monopolized by a single firm and labor in this sector is unionized. We will show that the bilateral monopoly in the factor market and the unilateral monopoly in the product market are the sources of MNC (multinational corporation) creation and of intra-industry investment.

(d). x is produced with labor only, while y is produced with labor and a sector specific factor, k. This assumption ensures production on the efficient production possibility frontier (PPF), even though there exists factor market distortions.

(e). Both x and y are produced with constant returns to scale (CRS) technology. To simplify algebra, the x sector has an input-output ratio of one by choice of units. The CRS assumption ensures concavity of the PPF to origin in the specific factors model.

(f). The monopoly firm does not own factors of production but 'property rights' to produce x. Factors of production are immobile, but equity ownership may cross country borders.

(g). There are no barriers and transportation costs to trade. However, because countries are identical in all respects, trade will in fact not occur.

2.2. The Model without FDI

Since the two countries are identical in every respect, we will focus on one country, realizing that the same is happening in the other.

Profit of the monopoly firm in the x sector in each country

$$\pi(x,y,w) = p(v)x - wx \tag{1}$$

where p is the price of x relative to y, the numeraire good; $v = x/y$, for the assumption of homothetic utility removes distributional and income effects; w is the negotiated wage rate; and x is also equal to employment in this sector.

We assume the union has a Stone-Geary type utility function[1]

$$u = (w-w_y)^{\theta}x^{\gamma} \tag{2}$$

where w_y is the competitive wage rate prevailing in the y sector, θ and γ are the elasticities of union utility with respect to wage differentials $(w-w_y)$ and employment respectively. Hence they denote union preference for wages and employment.[2]

The employment and wage rate in the x sector are determined through an efficient Nash bargaining process between the firm and the union. As is usual to model labor-management negotiations, contracts in the present model are binding. If bargaining breaks down, the union strikes, and employment and wage rate go to zero. The conflict payoffs (threat points) are zero to both the union and the firm.[3] Nash bargaining has been applied to analyze trade policy by Brander and Spencer (1988) and Mezzetti and Dinopoulos (1991), in partial equilibrium models of one-country setting.

The union and the firm bargain to solve (Nash, 1950, 1953)

$$\max_{w,x} G(x,w) = u(w,x)^{\alpha}\ \pi(x,y,w)^{1-\alpha} \tag{3}$$

where $\alpha\in[0,1]$ is the relative bargaining power of the union. Equation (3) is the 'generalized' Nash product, in which different bargaining powers are assumed for the union and the firm. Binmore et al. (1986) and Roth (1979) discuss how different bargaining powers can be applied in Nash bargaining

---

[1] The union is generally assumed to have two types of utility functions. One is an additive function: a convex combination of wage rate and employment depending on the probability of being employed, the other is the Stone-Geary type. The latter has the property of being multiplicative, which in many cases allows explicit solutions.

[2] In Pemberton (1988), (2) is the bargained outcome between union membership and leadership, with the former emphasizing wage differentials and the latter union employment (size). The parameters $\theta\geq0$ and $\gamma\geq0$ correspond to the bargaining powers of workers and of leadership respectively. Mezzetti and Dinopoulos (1991) call the union wage (employment) oriented if $\theta>(<)\gamma$.

[3] Nash bargaining implies that the threat point, which is Pareto inefficient, is not realized.

when symmetry is removed.

The first order conditions to (3) are

$$w = \lambda p + (1-\lambda)w_y \tag{4a}$$

$$w = \delta p + (1-\delta)(1-1/\sigma)p \tag{4b}$$

where $\lambda = \alpha\theta/(1-\alpha+\alpha\theta)$, $\delta = \alpha\gamma/(1-\alpha+\alpha\gamma)$, and $\sigma = -(p/x)(dx/dp)$, is the elasticity of demand in the x sector, and hence $(1-1/\sigma)p$ is the MRP (marginal revenue product) of the monopoly firm. Conditions (4a) and (4b) implicitly determine the equilibrium wage and employment in the x sector in the absence of FDI.

In the competitive y sector, firms maximize profits choosing the level of labor such that the competitive wage is equal to the value marginal product (VMP) of labor:

$$y_1(l_y,k) = w_y \tag{5}$$

where y_1 is the VMP_y of labor, l_y is the level of employment in the y sector, and k is the fixed supply of the specific factor in each country.

In the labor market, full employment yields

$$x + l_y = l \tag{6}$$

where x is the level of employment in the unionized sector and l is the fixed endowment of labor in each country.

The model closes out with the determination of p. The representative consumer maximizes the homothetic utility function $\mu(x,y)$ subject to her constraint $px+y=wx+w_y l_y+\pi$. Then we obtain the inverse demand as a function of the ratio of x and y, i.e.

$$p=p(x/y) \qquad \text{where} \quad p_x<0,\ p_y>0 \tag{7}$$

In fact, p can be written as a function of x alone because production is on the efficient PPF, in which x and y are uniquely related.

Now we have a complete system of five unknowns x, w, l_y, w_y and p in five equations (4a), (4b), (5), (6) and (7). The output of y is determined once l_y is known, according to the CRS production function $y(l_y,k)$.

2.3. The Equilibrium in the Product Market

The equilibrium is found by a comparison of the marginal rate of substitution (MRS) in consumption and the marginal rate of transformation (MRT) in production.

$$MRT = MC_x/MC_y \tag{8}$$

where MC_i denotes the marginal cost of production in sector i. MC_x is simply the negotiated wage rate because labor is the only mobile factor of production of x. MC_y is equal to one (the price of y) due to perfect competition in the y sector. Solving conditions (4a) and (4b) for w and substituting into (8) to obtain

$$MRT = p\{1-(1-\delta)/\sigma\} < p = MRS \tag{8'}$$

Condition (8') implies that in equilibrium, MRT and MRS will not be equalized due to monopoly power in the production of the x sector. More specifically, too little of x is produced. If the union does not possess any bargaining power at all, then $\alpha=\delta=0$, condition (8') collapses to[4]

$$MRT = p\{1-1/\sigma\} < p = MRS \tag{8''}$$

which implies that the equilibrium in this model is identical to those in the literature, namely, of Melvin and Warne (1973) and Markusen (1981,1984), where there are no factor market distortions but monopoly in the product market.

In general, $\alpha>0$. As in condition (8'), our equilibrium is different. A

---

[4] If $\gamma=0$, then $\delta=0$, too. But this is a different equilibrium from $\alpha=0$, since if $\theta>0$, then $w>w_y$ by condition (4a).

comparison is made in figure 1. Our equilibrium, M_1, lies to the right (downhill) of the one (M_0) of Melvin and Warne and Markusen on the PPF, implying a smaller difference between MRS and MRT. This is caused by the labor union, interested in higher employment as well as higher wages, which raised the production cost of the monopoly firm. Thus unionization increases allocation efficiency. Further MRS=MRT if $\alpha=1$. This can be seen from figure 1. Note that here allocation efficiency does not necessarily imply Pareto welfare improvement. It only implies that monopoly power in the product market is reduced since MC_x is getting closer to p. But this may be offset by a different monopoly power, i.e. union monopoly power in the factor market. Welfare issues are studied in section 5.

(Figure 1)

2.4 Geometry

Next, we use the familiar sector-specific factors model to characterize the equilibrium wages, employment, labor allocation and profits in the present model.

2.4.1 Some Special Cases

Let us first study several special cases, which to my knowledge have not been dealt with geometry in the context of the present model. These cases are obtained by giving special values (1 or 0) to corresponding parameters in conditions (4a) and (4b). Incidentally, they are well-known models in the literature.

(I). Monopoly without unions in the x sector (α=0), ceteris paribus

In this case, wages will be equalized across sectors and the monopoly firm maximize profits choosing the level of employment (output), implying a first order condition of

$$p\{1-/\sigma\} - w_y = 0 \tag{9}$$

which simply states that the firm employs labor up to the point where the marginal revenue product (MRP_x) of the monopoly firm is equal to the wage rate. Notice the difference between conditions (9) and (5). The wage rate is equalized to VMP in the latter, but to MRP_x (less than VMP) in the former because the y sector is perfectly competitive while the x sector is monopolized.

Condition (9), together with conditions (5), (6) and (7) characterizes the equilibrium of special case (I), which is illustrated in figure 2. The horizontal axis denotes employment and the vertical axises wage rates. The conventional equilibrium where both x and y are produced competitively and the labor market is not unionized is characterized by the intersection of the VMP curves, namely point E_c. In this equilibrium ol_c of labor is employed in the x sector and l_cl of labor is employed in the y sector. Wage rate is equalized in both sectors at w_y. Profit is zero for $p = w_y$ at E_c.

(Figure 2)

With the x sector monopolized and the y sector competitive, the equilibrium moves down the curve $VMP_y = y_1$ to point E_m, where MRP_x cuts VMP_y. The employment in sector x decreases to ol_m and that in the other sector increases by l_ml_c. The wage rate is equalized in both sectors and is forced down to w_m. Moreover, positive profits emerge as the area of WNE_mw_m.

(II). Industry-wide union vs monopolistic firms (α=1), ceteris paribus

In this case, the wage rate in the x sector is equalized to the price and the equilibrium is the segment of VMP_x above (to the left of) VMP_y. The competitive wage in the y sector is found at the corresponding employment point on the curve $VMP_y=y_1$.

(III). Union sets wage rate and monopoly firm determines employment in the x sector ($\gamma=0$), ceteris paribus

This was the dominant model of wage and employment setting before bargaining and search were formally introduced. The equilibrium is the segment of MRP_x above VMP_y, which is the so called labor demand curve. The wage rate in the y sector is found in the same way as in special case (II).

(IV). Union not interested in wages but employment ($\theta=0$), ceteris paribus

This case is more likely during economic recession. The equilibrium is the segment of VMP_y between VMP_x and MRP_x and the wage rate is equalized across sectors. Note that even though the union is not interested in higher wages, the equilibrium wage rate in this case is different from (generally higher than) case (I) where $\alpha=0$.

2.4.2 Bargaining Equilibrium without FDI

Now we are in a position to analyze the equilibrium without FDI in the more general case, i.e. $\alpha\in(0,1)$ and θ, $\gamma>0$. From the analysis in the special cases, one can imply that the bargaining equilibrium must lie inside the area enclosed by the three curves: VMP_x, VMP_y and MRP_x.

Combining conditions (4a) and (4b) yields

$$w_y = (1-\theta/\gamma)w + \theta/\gamma p\{1-1/\sigma\} \qquad (10)$$

Equation (10) determines the efficient Nash bargaining locus, which represents the tangential points between the isoprofit curves and union utility curves (McDonald and Solow, 1981, Dinopoulos and Mezzetti, 1991, here the curves are not drawn for the purpose of clarity). In figure 3a, condition (10) represents the locus of the intersection points of curves CC_{ni} and DD_{ni}, drawn respectively according to conditions (4a) and (4b) for different values of θ and γ. If θ is fixed, then condition (9) can be represented by the line CC_{ni}

for varying γ; if γ is fixed, then condition (10) can be represented by the line DD_{ni} for varying θ.

Notice that the efficient bargaining locus is independent of the bargaining powers. This is because the efficient bargaining locus is Pareto efficient. It does not tell how the parties should divide the gains or losses. Of course a change in the bargaining powers affects the distribution of income, but not the underlying efficient allocation of resources.

(Figures 3a and 3b)

In general, θ and γ are changing depending on union preference. From condition (10), we can differentiate three cases, as illustrated in figure 3b.

(i). If $\theta=\gamma$, then the first term on the RHS of condition (10) is zero. Then $w_y=MRP_x$, which implies the efficient bargaining locus is vertical and goes through the intersection point (E_m) of the two curves MRP_x and VMP_y;

(ii). If $\theta>\gamma$, then the first term on the RHS of condition (10) is negative. We have $w_y < MRP_x$, which implies that the efficient bargaining locus must lie to the left of point E_m and is negatively sloped;

(iii). If $\theta<\gamma$, then the first term on the RHS of condition (10) is positive. We have $w_y > MRP_x$, which implies that the efficient bargaining locus must lie to the right of point E_m and is positively sloped.

Thus given union preference, the equilibrium is represented by the efficient Nash bargaining locus, on which the negotiated wage rate, employment, profits and labor allocation in the whole economy are uniquely determined.

From figure 3b, we can also show that both the union and the monopoly firm gain under efficient Nash bargaining than under special case (III). This was pointed out by McDonald and Solow (1981), though in a partial equilibrium framework. To see this in figure 3b, suppose the union chooses wage rate w_u

on the curve MRP_x above E_m in special case (III), then the firm would employ l_u of labor. But on the efficient bargaining locus (any of the three), w_u corresponds to a higher level of employment. Both the union and the firm are unambiguously better off.

3. Intra-Industry Investment

In this section, we show that firm profits increase if they undertake symmetric intra-industry investment and unions stay nationally independent. Again we focus on one country.

We assume that if firms become multinationals, then there is one bargaining game in each country, in which the wage and employment are determined by the three players (the union and the two firms). The bargains are independent and simultaneous.[5] Firm participation in bargaining is represented by the headquarters, not branches. For simplicity, we rule out any coalition other than the one involving all three players. For Nash bargaining games among n >= 3 players, see Roth (1979).

Let $x=x_A+x_B$, and $x^*=x_A^*+x_B^*$, where x_i and x_i^* denote the employment (output) of firm i (=A,B) in the two countries respectively. Due to symmetry, $x_B=x_A^*$ and $x_A=x_B^*$. Each firm's profit is the sum of its profits from two countries, which can be written again as in equation (1). Then the 'generalized' Nash product for the bargaining game in one country can be written as:

$$\max_{w,x} H(x,w)=u(w,x)^{\alpha}\{(p-w)(x_A+x_A^*)-(P^{o}-w)x_A^*\}^{\beta}\{(p-w)(x_B+x_B^*)-(P^{o}-w)x_B^*\}^{1-\alpha-\beta} \quad (11)$$

where u(x,w) is given by equation (2); $\alpha\in[0,1]$ and $\beta\in[0,1]$ are the relative bargaining powers of the union and the firm in country A; $(P^{o}-w)x_A^*$ is firm A's conflict payoff in country A's bargaining game, which is equal to the profits of A's branch in country B in case the union in A strikes; $(P^{o}-w)x_B^*$ is firm B's

[5] One can think of a situation in which every firm sends an agent to each country to participate in the bargains. The agents from the same firm in two different games are not allowed to communicate during bargaining.

conflict payoff in country A's bargaining game. Note that $P^o=p(x/2y)$ is the price of x if one country strikes and only the other country produces, thus $P^o(>p)$ is a constant.

The two firms and one union in each country choose w, $x_A(=x_B^*)$ and $x_B(=x_A^*)$ to maximize the 'generalized' Nash product in (11). The first order conditions are

$$\alpha\theta/(w-w_y) - \beta x_A/\{\pi-(P^o-w)x_A^*\} - (1-\alpha-\beta)x_B/\{\pi-(P^o-w)x_B^*\} = 0 \quad (12a)$$

$$\alpha\gamma/x + \beta\{p(1-1/\sigma)-w\}/\{\pi-(P^o-w)x_A^*\} - (1-\alpha-\beta)(p/\sigma)/\{\pi-(P^o-w)x_B^*\} = 0 \quad (12b)$$

$$\alpha\gamma/x - \beta(p/\sigma)/\{\pi-(P^o-w)x_A^*\} + (1-\alpha-\beta)\{p(1-1/\sigma)-w\}/\{\pi-(P^o-w)x_B^*\} = 0 \quad (12c)$$

Substituting and rearranging, we obtain the following two conditions for wage and employment determination

$$w = \lambda(2p-P^o) + (1-\lambda)w_y \quad (13a)$$

$$w = \delta(2p-P^o) + (1-\delta)\{p(1-1/\sigma)\} \quad (13b)$$

where $\lambda=\alpha\theta/(1-\alpha+\alpha\theta)$ and $\delta=\alpha\gamma/(1-\alpha+\alpha\gamma)$. Note that in conditions (12) and (13b), $p(1-1/\sigma) = p+(x+x^*)p'$, for all firms (hence all outputs) are involved in the bargaining game in (11). Apparently $2p-P^o>0$ since $w-(1-\lambda)w_y>0$.

Conditions (13a) and (13b) are comparable to conditions (4a) and (4b). The only difference is the first term on the RHS, which is smaller in the first two equations. We will employ figure 4 to illustrate this. Draw curves CC_{ii} and DD_{ii} respectively according to conditions (13a) and (13b). They must lie below CC_{ni} and DD_{ni}, for given values of θ and γ, since $p-P^o<0$.

(Figure 4)

Combining conditions (13a) and (13b), we obtain

$$w_y = (1-\theta/\gamma)w + \theta/\gamma p(1-1/\sigma) \quad (14)$$

Condition (14) is identical to condition (10), except that it is the efficient bargaining locus of three players, i.e. the two firms and one union. Thus the efficient bargaining locus with intra-industry FDI will have the same shape as the one without FDI. But there is one big difference between the two loci: the equilibrium with FDI lies below the one without, as can be seen from conditions (13a) and (13b), and correspondingly curves CC_{ii} and DD_{ii}.

In general, under intra-industry FDI, we have the following three cases.

(i'). If $\theta=\gamma$, then the equilibrium level of employment is identical to that without FDI, but the wage rate is lower;

(ii'). If $\theta>\gamma$, then the level of employment is higher than that without FDI, but the wage rate is lower;

(iii'). If $\theta<\gamma$, then both the level of employment and the wage rate are lower than without FDI.

Thus with intra-industry FDI, the bargaining equilibrium moves closer to E_m, the monopoly firm and competitive labor equilibrium. The union is unambiguously worse off if $\theta\leq\gamma$, since the negotiated wage rate decreases, and the level of employment decreases if $\theta<\gamma$ and stays unchanged if $\theta=\gamma$. What if $\theta>\gamma$? We claim: union utility decreases with intra-industry FDI if[6] $MMRP_x < MRP_y$, where $MMRP_x=MRP_x+xd(MRP_x)/dx$, $MRP_y=w_y+dw_y/dx$.

Proof: Substituting (14) into (2) to get rid of w, we obtain

$$u(x)=\{\theta/(\theta-\gamma)\}^{\theta}\{p(1-1/\sigma)-w_y\}^{\theta}x^{\gamma} \tag{15}$$

Differentiating with respect to x yields

$$u_x = u/\{(MRP_x-w_y)x\}\ \{\theta x[d(MRP_x)/dx-dw_y/dx] + \gamma(MRP_x-w_y)\} \tag{16}$$

We use figure 5 to interpret condition (16). $MMRP_x$ lies below MRP_x since $d(MRP_x)/dx < 0$ is the slope of MRP_x; MRP_y lies above VMP_y since $dw_y/dx>0$ is

[6] Let me clarify the meaning of the terminology here. MRP_y is not equal to the marginal revenue product in the y sector, but defined as in proposition two, for the real marginal revenue product in the y sector is w_y.

the slope of w_y. The two curves $MMRP_x$ and MRP_y intersect at point E_0, to the left of point E_m, i.e. $\theta>\gamma$. It is clear that between E_0 and E_m, $MMRP_x < MRP_y$ even if $\theta=\gamma$ (the expression in the last curled brackets). Thus if $\theta>\gamma$, condition (16) is negatively signed. (QED)

(Figure 5)

To the left of E_0, $MMRP_x > VMP_y$. Condition (16) may still be negative if $(\theta-\gamma)$ is big enough to make the expression in the last curled brackets negative.

To show that firms will in fact undertake intra-industry FDI, we need to prove that profits increase if they become multinationals. From figure 5, it is not hard to see that firm profits increase with FDI if $\theta\geq\gamma$, for the negotiated wage rate decreases, and the level of employment increases $(\theta>\gamma)$ or stays unchanged $(\theta=\gamma)$. To see the profit changes in the third case $(\theta<\gamma)$, substitute condition (14) into (1) to obtain

$$\pi(x,y)=x/(\gamma-\theta)\{\gamma(p-w_y)-\theta p/\sigma\} \tag{17}$$

Differentiating with respect to x yields

$$\pi_x=1/(\gamma-\theta)\{\gamma(MRP_x-MRP_y)+\theta x d(MRP_x)/dx\} \tag{18}$$

If $\theta<\gamma$ (to the right of E_m), then condition (18) is negatively signed, implying that firm profits increase when x decreases. Referring back to case (iii'), one immediately sees that FDI increases firm profits.

Why do wage rates decrease and firm profits increase with intra-industry FDI? The reason lies in the threat points in the bargaining games. In the basic model where firms do not undertake FDI, the threat points are zero for both the firms and the unions, if bargaining breaks down and the union strikes. However, with intra-industry FDI, if nationally independent unions strike in one country and the other country keeps producing, then one branch of each firm is earning profits, hence the threat points for the firms are positive but zero for the unions. In fact, since the bargains are simultaneous and no rebargaining is allowed, production in the non-striking country stays unchanged and world output of x decreases. Thus p and the profit of the branch that produces increase. This puts the unions in a more conservative position and the firms in a more aggressive one in the bargaining games.

To elaborate the above points, we employ figure 6, where in the absence of FDI, (0,0) is the threat point in the bargaining game. The area inside and on curve $u_0\pi_0$ is the payoff space. The Nash bargaining equilibrium is B_0. When firms become multinationals, the threat point moves to (n,0) with n>0. To satisfy the individual rationality constraint of the multinational firm, the payoff space is truncated by the vertical line going through (n,0) and the left portion is thrown out. The new equilibrium is point B_1, in which firm profits increased and union utility decreased.

(Figure 6)

We have just shown the equilibrium of intra-industry FDI. Firm profits increase due to an improvement in the threat points. It is not hard to imagine that if one firm undertakes FDI while the other does not, then the profit of the multinational increases while that of the national decreases, because the union as well as the national firm have to yield to the multinational firm in the bargaining games. This was in fact proven by Zhao (1994), in a one-sector setting, who also showed that the negotiated wage rates decrease in both countries. Thus intra-industry FDI is the unique Nash perfect equilibrium.

4. Difference in Country Size

In this section, we consider the case where country B is $s\in(0,1]$ times the size of country A, but identical in all other aspects. To distinguish our model from those on FDI caused by different endowment ratios (e.g. the HOS type), we assume the countries have the same ratio of $x/y=v$.

In the absence of FDI, since there is no change in country A, then the bargaining equilibrium in A is the same as the one in section 2.4.2. Not surprisingly, the negotiated wage rate and the ratio of labor allocation in B is the same as in A, for p and v are the same in the two countries. Firm profits in B is s times that of A.

The more interesting case is when both countries undertake intra-industry FDI. By solving the bargaining problem in country A, applying the technique of section 3, we obtain (* denotes variables in B)

$$w = \lambda\{(1+s)p-sP^{o}\} + (1-\lambda)w_y \tag{19a}$$

$$w = \delta\{(1+s)p-sP^{o}\} + (1-\delta)\{p(1-1/\sigma)\} \tag{19b}$$

where $p(1-1/\sigma)=p+(1+s)xp'$ and $P^{o}=p(x^*)$. Combining the above to obtain

$$w_y = (1-\theta/\gamma)w + \theta/\gamma p(1-1/\sigma) \tag{20}$$

In country B, by solving its bargaining game, we obtain corresponding first order conditions

$$w^* = \lambda/s\{(1+s)p-\wp^{o}\} + (1-\lambda)w_y \tag{21a}$$

$$w^* = \delta/s\{(1+s)p-\wp^{o}\} + (1-\delta)\{p(1-1/\sigma)\} \tag{21b}$$

where $p(1-1/\sigma)=p+(1+s)xp'$, w^* is the negotiated wage rate in B, and $\wp^{o}=p(x)$. Combining the above to obtain

$$w_y = (1-\theta/\gamma)w^* + \theta/\gamma p(1-1/\sigma) \tag{22}$$

Now we can interpret the above results of intra-industry FDI with difference in country size. First, from conditions (20) and (22), the efficient bargaining locus in the two countries has the same shape as when the countries are completely identical (s=1), and again the locus can be studied in three cases depending on union preference; second, the negotiated wage rates with FDI in both countries are lower than that of no FDI; third, if we carry out the same analysis as in section 3, it is not hard to find that firm profits increase and union utility decreases in both countries. The above results in section 3 are robust when countries differ in size.

To see the changes in the negotiated wage rates, substituting $P^o=p(sx)$ and $\wp^o=p(x)$ into conditions (19a) and (21a) and differentiating respectively with respect to s, we obtain

$$dw/ds=\lambda\{p-(P^o+sxP^{o\prime})\} \quad (23a)$$

$$dw^*/ds=\lambda/s^2(\wp^o-p) \quad (23b)$$

where p is the world 'regular' (as opposed to threat point) price and does not depend on s in the above differentiation. Condition (23b) is positively signed, implying that the negotiated wage rate in country B increases if B's size rises relative to A's size. The reason is, the proportion of firm profits from B increases as s does and firms have more to lose if bargaining breaks down. Condition (23a) can be interpreted in similar fashion. It is negatively signed if the 'regular' world price (p) is less than firm A's marginal revenue product at the threat point. This is very likely if s is sufficiently small. Since in this case if bargaining breaks down in A, world output is only a small proportion of the 'regular' level of output, price and the marginal revenue product will be high.

Are the wage rates different? Subtracting condition (23a) from (23b) yields

$$df(s)/ds=d(w^*-w)/ds > 0 \quad (24)$$

where $f(s)=w^*-w$. Condition (24) is apparent from the discussions following conditions (23a) and (23b). Remembering that f(s)=0 if s=1, then as illustrated in figure 7, f(s) is a positively sloped curve below 0. Thus in equilibrium, the negotiated wage rate in the smaller country B is lower. This again attributes to the threat point. A firm in the smaller country has a higher conflict payoff (firm's loss is smaller) in case bargaining breaks down, which puts the firm in a more aggressive position and the union in a more conservative one.

(Figure 7)

5. Welfare and Distribution of Income

As is well known, the first best social optimum is point E_c in figures 2-5, where VMP_x and VMP_y intersect and there are no distortions in either the factor markets or the product market. The total welfare at equilibrium E_c is represented by the area under the two VMP curves and bounded by the vertical and horizontal axises. Any deviation from E_c will decrease social welfare and not result in first best. In the present model, deviations involve two effects: the output effect and the price (wage) effect. For instance, monopoly in the product market moves the equilibrium to point E_m, at which too little of x is produced and the wage rate is too low while price is too high. This causes a welfare loss associated with monopoly power, as well as redistribution of income from labor to firms.

What are the effects of unionization? In figure 3b, unionization moves the equilibrium away from E_m along the efficient bargaining locus. We can differentiate three cases.

(i"). If $\theta=\gamma$, unionization results in the same level of employment but a higher wage rate than pure monopoly, social welfare is the same as at E_m, i.e. the total welfare at E_c subtracted by the area NE_cE_m in figure 3b. The increase in wages simply redistributes income from the firm to the union;

(ii"). If $\theta>\gamma$, then unionization decreases the output of x but increases the wage rate compared with E_m, and social welfare is decreased;

(iii"). If $\theta<\gamma$, then unionization increases both the output of x and the wage rate. As a result, social welfare increases compared with E_m. But social welfare will not reach the level at E_c unless the union has all the bargaining power ($\alpha=1$) and it does not care about wage rate at all ($\theta=0$).

Intra-industry FDI in the present model does exactly the opposite of unionization to social welfare, since it moves the bargaining equilibrium closer to E_m along the efficient bargaining locus in figure 4. Thus, if $\theta=\gamma$, then there is no change in social welfare; if $\theta>\gamma$, then welfare increases; if $\theta<\gamma$, then welfare decreases. In all three cases, the negotiated wage rate decreases and income is redistributed to firms.

6. Conclusions

This paper studied intra-industry FDI in completely identical countries in a standard international trade model, by applying Nash bargaining to analyze the interaction between multinational firms and national unions. Though we assumed one firm in each country (duopoly in the world), the mechanism is similar if the x industry has many firms, as long as unions stay nationally independent. Collusion on the part of the firms, however, may create a new equilibrium, which will increase the tendency for firms to go multinational.

There are many other factors that can determine the pattern of FDI, including trade costs, commercial policy, firm specific advantages, etc. A particular fruitful avenue might be to include technology development to create firm specific advantages. Hopefully the present paper will stimulate some interests to study these issues in connection with intra-industry FDI.

References

Bhagwati, Jagdish N., 1971, The generalized theory of distortions and welfare, in: Bhagwati et al., *Trade, the balance of payments and growth: essays in honor of Charles P. Kindleberger* (North-Holland, Amsterdam).

Bhagwati, Jagdish N., 1982, Shifting comparative advantage, protectionist demands, and policy response, in: Jagdish Bhagwati, ed., *Import competition and response*, University of Chicago Press, Chicago.

Binmore, Ken, Ariel Rubinstein and Asher Wolinsky, 1986, The Nash bargaining solution in economic modeling, *Rand Journal of Economics* 17, 178–188.

Brander, James A. and Paul Krugman, 1983, A 'reciprocal dumping' model of international trade, *Journal of International Economics* 15, 313–321.

Brander, James A. and Barbara J. Spencer, 1988, Unionized oligopoly and international trade policy, *Journal of International Economics* 24, 217–234.

Brecher, R. and N.V. Long, 1989, Trade unions in an open economy: A general equilibrium analysis, *Economic Record* 65, 234–239.

Dinopoulos, Elias and Timothy Lane, 1993, Liberalization and structural reform in a transitional economy, unpublished manuscript.

Dunning, J.H., and G., Norman, 1986, Intra-industry investment, in H.P. Gray, ed., *Research in international business and finance*, Vol. 5: Uncle Sam as Host, JAI press.

Enderwick, Peter, 1985, *Multinational business & labor*, St. Martin's Press, New York.

Ethier, W.E., 1986, The multinational firm, *Quarterly journal of economics*, 805–833.

Feestra, Robert, 1980, Monopsony distortions in an open economy: a theoretical analysis, *Journal of International Economics* 10, 213–235.

Helpman, Elhanan, 1984, A simple theory of international trade with multinational corporations, *Journal of political economy* 92, 451–471.

Horstmann, Ignatius and James Markusen, 1987, Strategic investment and the development of multinationals, *International economic review* 28, 1, 109–121.

Horstmann, Ignatius and James Markusen, 1992, Endogenous market structures in international trade, *Journal of international economics* 32, 109–129.

Johnson, Harry and Peter Mieszkowski, 1970, The effects of unionization on the distribution of income: a general equilibrium approach, *Quarterly Journal of Economics*, 539–561.

Jones, R.W, J. Peter Neary and Frances P. Ruane, 1983, Two way capital flows: Cross- hauling in a model of foreign investment, *Journal of International Economics*, 357–366.

Magee, S.P., 1973, Factor market distortions: a survey, *Oxford Economic Papers* 25, 1–43.

Magee, S.P., 1973, Factor market distortions: a survey, *Oxford Economic Papers* 25, 1–43.

Markusen, James, 1981, Trade and the gains from trade with imperfect competition, *Journal of International Economics* 11, 531–551.

Markusen, James, 1984, Multinationals, multiplant economies and the gains from trade, *Journal of International Economics* 16, 205–224.

Markusen, James and Arthur, Robson, 1980, Simple general equilibrium and trade with a monopsonized sector, *Canadian Journal of Economics* 13, 668–682.

McCulloch, R. and J.L., Yellen, 1980, Factor market distortions and the allocation of resources, *Journal of International Economics* 10, 237–247.

McDonald, Ian M. and Robert M. Solow, 1981, Wage bargaining and employment, *American Economic Review* 71, 897–908.

Melvin, James and Robert Warne, 1973, Monopoly and the theory of international trade, *Journal of International Economics* 3, 117–134.

Mezzetti, Claudio and Elias Dinopoulos, 1991, Domestic unionization and import competition, *Journal of International Economics* 31, 79–100.

Nash, John, 1950, The bargaining problem, *Econometrica* 28, 155–162.

Nash, John, 1953, Two-person cooperative games, *Econometrica* 21, 129–140.

Neary, Peter, 1978, Short run capital specificity and the pure theory of international trade, *Economic Journal* 88, 488–510.

Oswald, A.J., 1982, The microeconomic theory of the trade union, *Economic Journal* 92, 576–595.

Pemberton, James, 1988, A 'managerial' model of the trade union, *Economic Journal* 98, 755–771.

Roth, Alvin, 1979, *Axiomatic models of bargaining*, Springer-Verlag, New York.

Smith, Alasdair, 1987, Strategic investment, multinational corporation and trade policy, *European Economic Review* 31, 89–96.

Venables, A.J., 1985, Trade and trade policy with imperfect competition: The case of identical products and free entry, *Journal of International Economics* 19, 1–20.

Wong, Kar-Yiu, 1986, Are international trade and factor mobility substitutes? *Journal of International Economics* 21, 25–44.

Zhao, Laixun, 1994, Cross-hauling direct foreign investment and unionized oligopoly, *European Economic Review*, forthcoming.

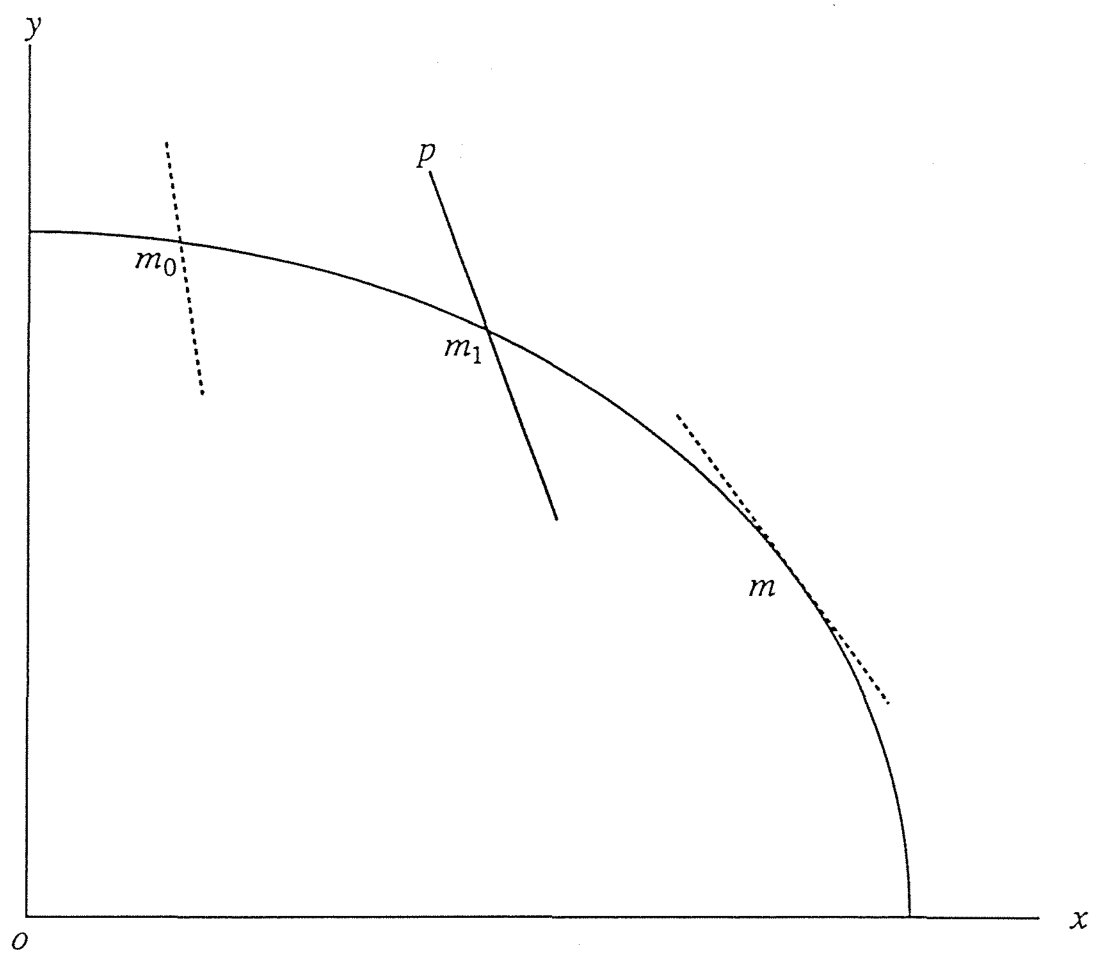

Figure 1: Equilibrium on the PPF

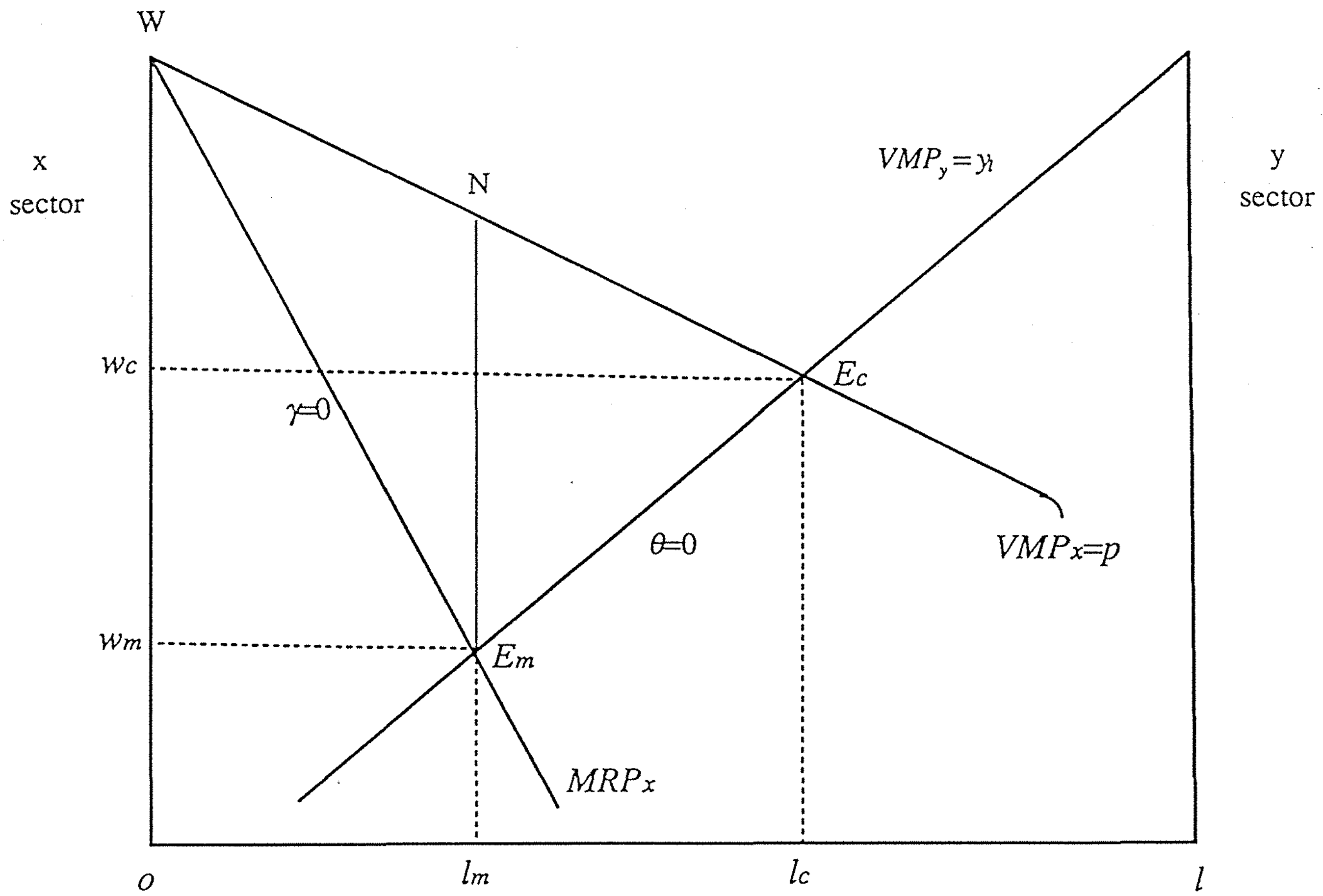

Figure 2: Equilibrium in Special Cases

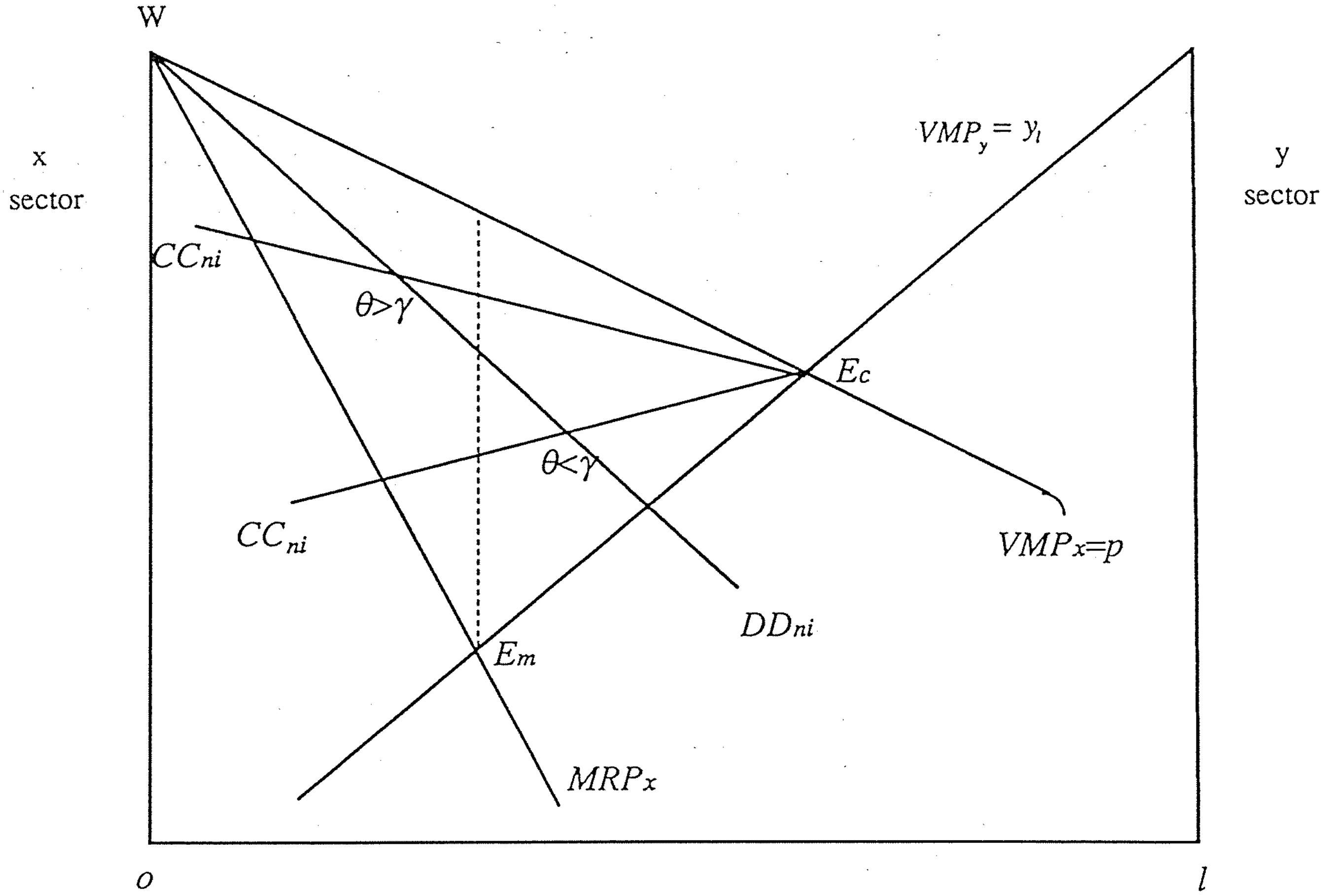

Figure 3a: The General Case without FDI

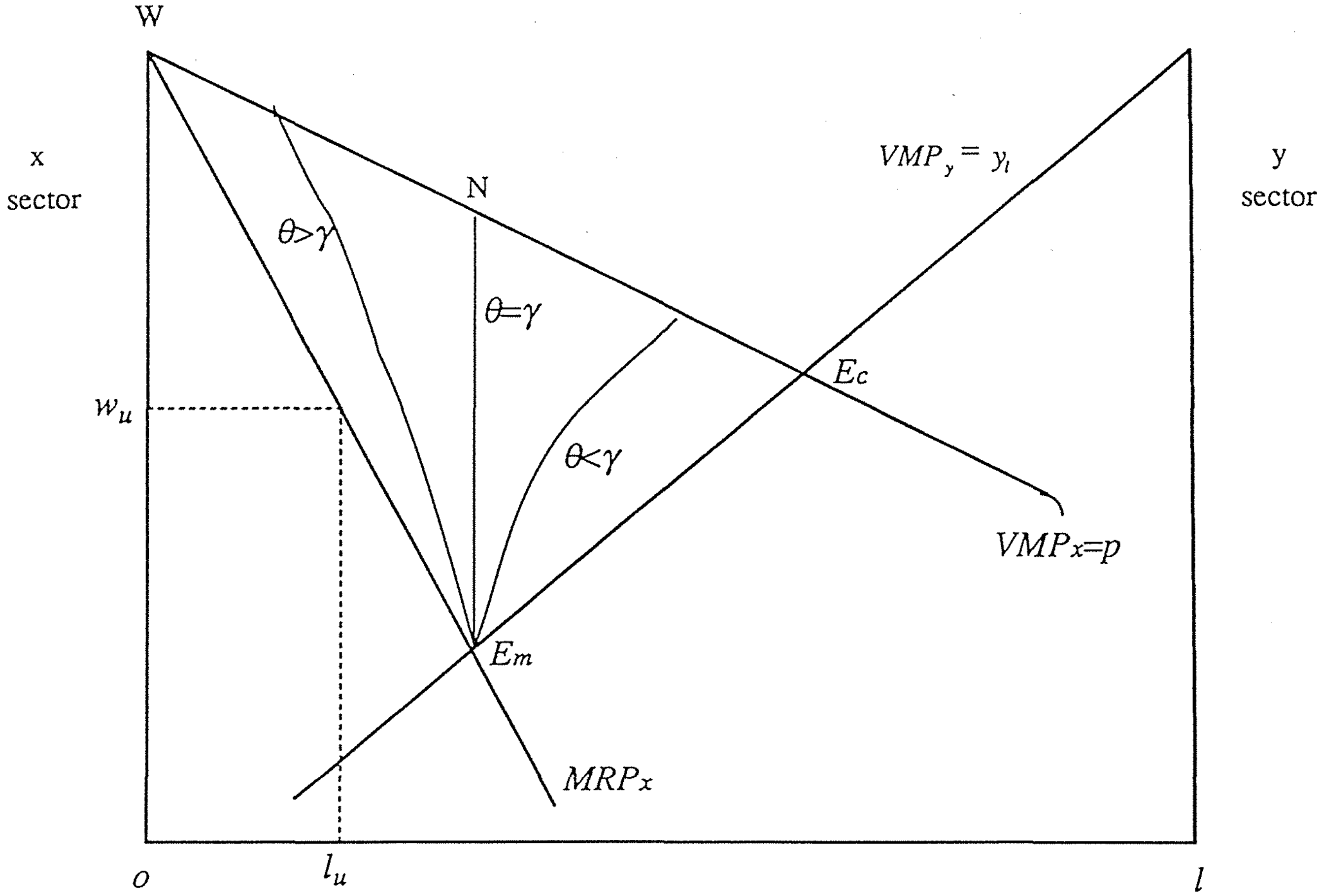

Figure 3b: The General Case without FDI

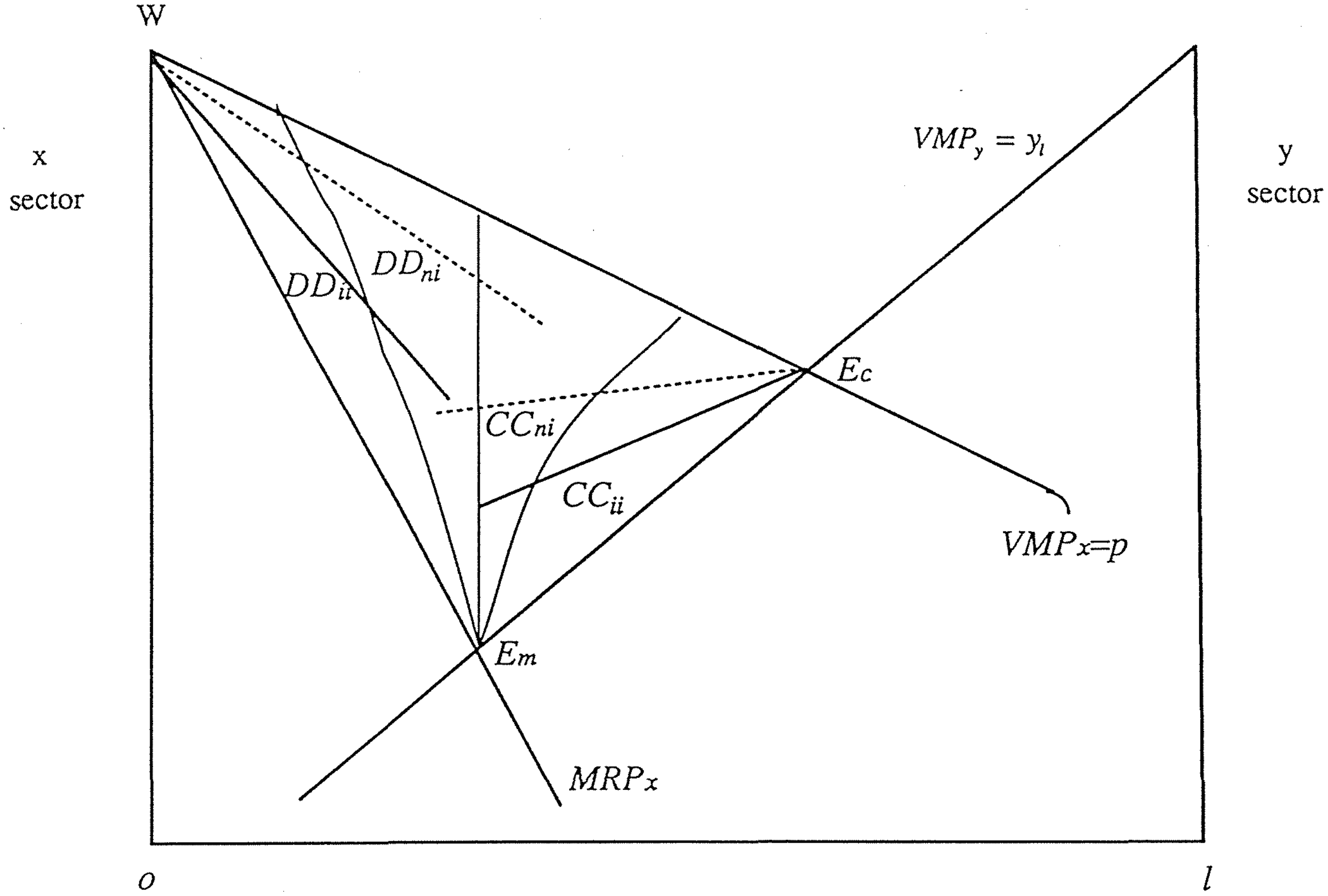

Figure 4: Equilibrium with Intra-Industry FDI

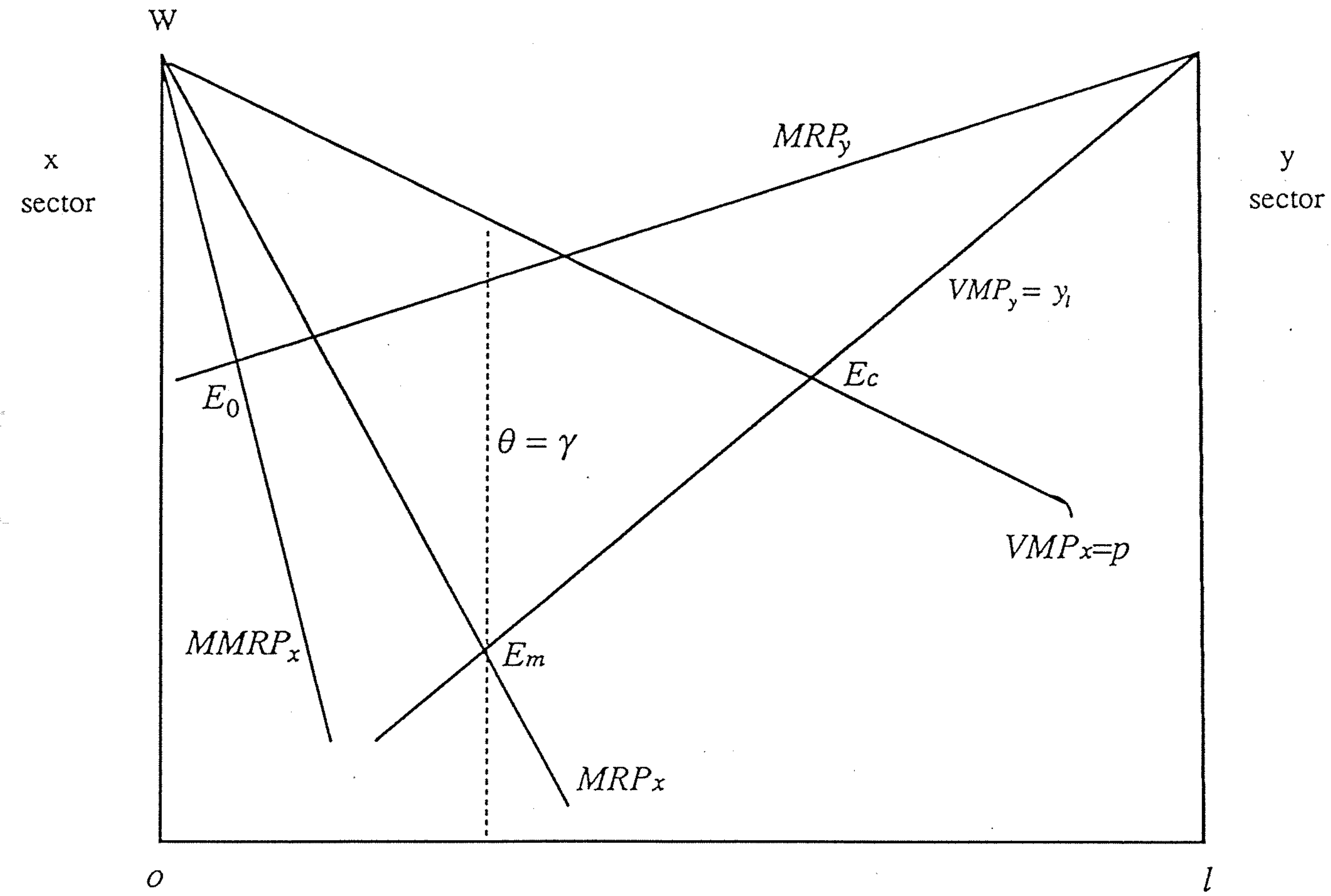

Figure 5: Changes in Union Utility and Firm Profits

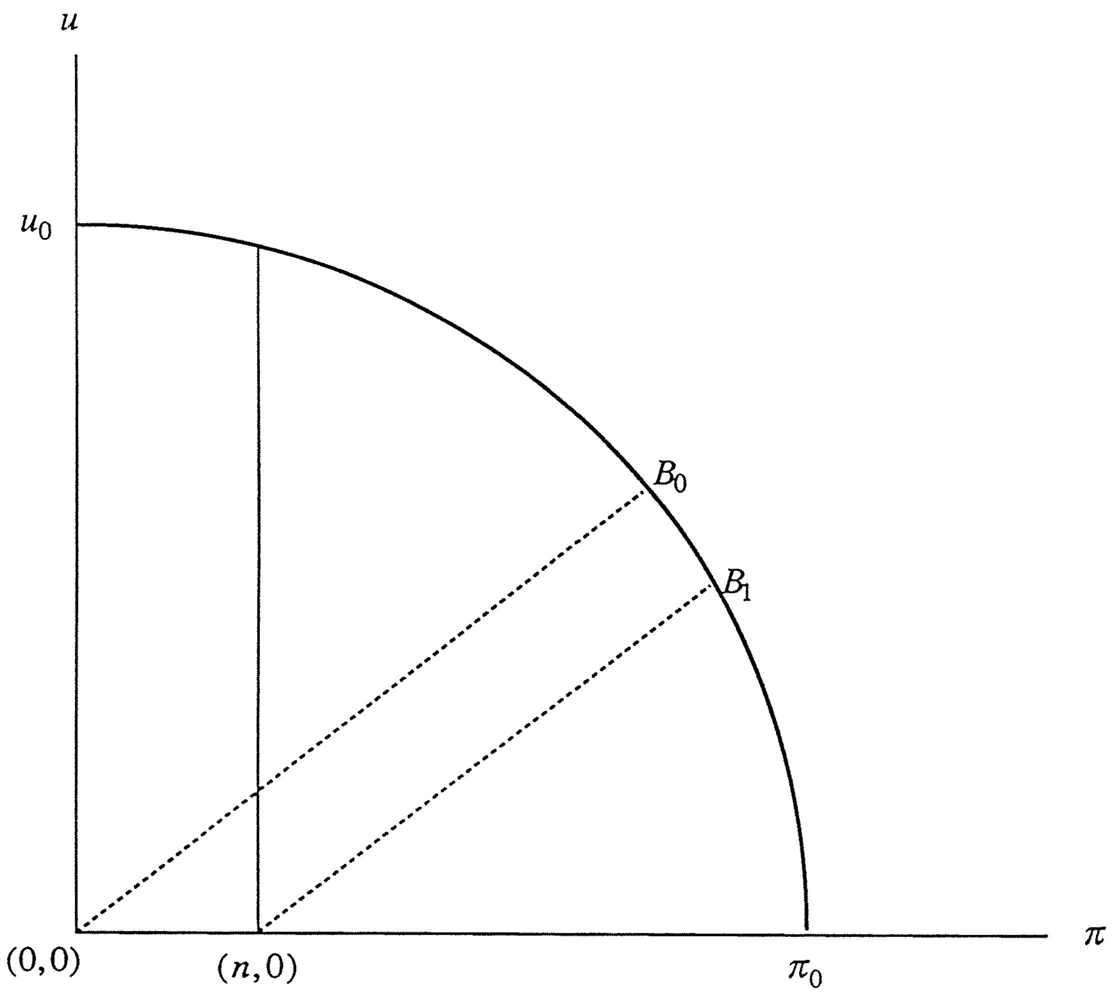

Figure 6: Effect of Threat Point Changes

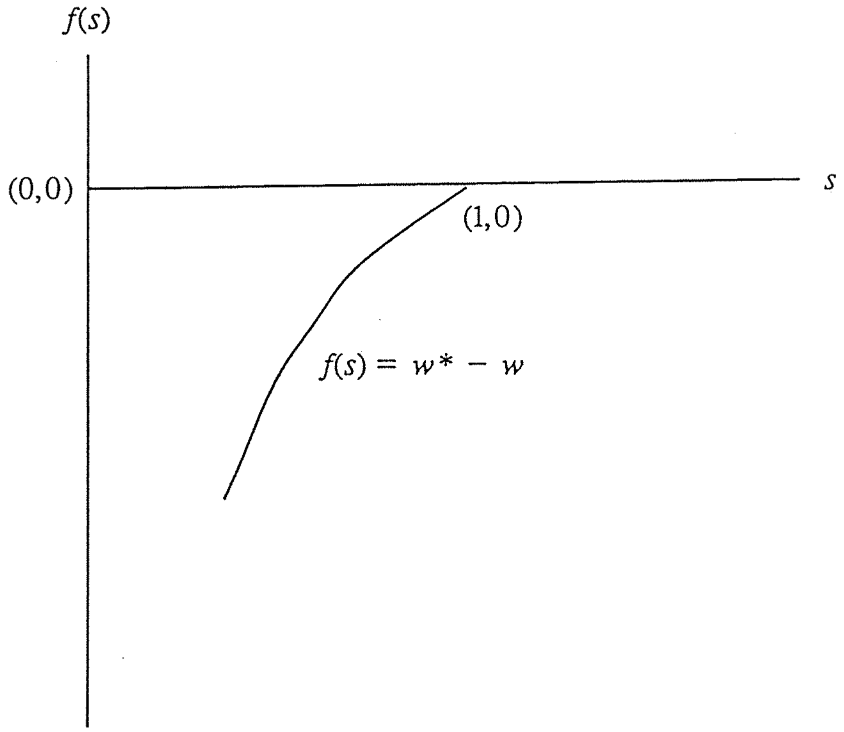

Figure 7: Different Wage Rates when Countries Differ in Size

This Discussion Paper Series is published by the Institute of Economic Research and integrates two old ones published separately by the Department of Economics and the Department of Commerce.

Discussion Paper Series
Institute of Economic Research
Otaru University of Commerce

No.	Title	Author/s	Date
1.	ﾎｰｷﾝｽﾞ=ｻｲﾓﾝの条件に関する諸説の統合について	ﾀﾞｽｸﾞﾌﾟﾀ,ﾃﾞｨﾊﾟﾝｶｰ	Jul.1992
2.	Motivation and Causal Inferences in the Budgetary Control	Yoshihiro Naka	Aug.1992
3.	Проблемы управления рабочей силой на предприятиях Дальнего Востока(социологические аспекты)	Анатолий Михайлович Шкуркин	Nov.1992
4.	Dynamic Tax Incidence in a Finite Horizon Model	Jun-ichi Itaya	Jan.1993
5.	Business Cycles with Asset Price Bubbles and the Role of Monetary Policy	Hiroshi Shibuya	Jun.1993
6.	Continuous Double-Sided Auctions in Foreign Exchange Markets	Ryosuke Wada	Aug.1993
7.	The Existence of Ramsey Equilibrium with Consumption Externality	Sadao Kanaya & Tomoichi Shinotsuka	Sep.1993
8.	Money, Neutrality of Consumption Taxes, and Growth in Intertemporal Optimizing Models	Jun-ichi Itaya	Nov.1993
9.	Product Returns in the Japanese Distribution System:A Case Study of a Japanese Wholesaler's Return Reduction Efforts	Jeffery Alan Brunson	Mar.1994
10.	Dynamics, Consistent Conjectures and Heterogeneous Agents in the Private Provision of Public Goods	Jun-ichi Itaya & Dipankar Dasgupta	Jun.1994
11.	Intra-Industry Investment and Imperfect Markets A Geometric Approach in Simple General Equilibrium	Laixun Zhao	Oct.1994

Discussion Paper Series
Department of Economics
Otaru University of Commerce

No.	Title	Author/s	Date
1.	Monetary Policy in a Model of International Trade with a Sector Sticky Wage Rate	Takashi Fukushima & Hideki Funatsu	Feb.1985
2.	Export Credit Insurance	Hideki Funatsu	Feb.1985
3.	Asset Trading in an Overlapping-Generations Model:Efficiency of Competitive Equilibrium	Kenji Yamamoto	Oct.1985
4.	Asset Trading in an Overlapping-Generations Model with Production Shocks	Kenji Yamamoto	Oct.1985
5.	Immiserizing Investment in a Vertically Related International Trade	Masao Satake	Mar.1986

6.	Dynamic Tax Incidence in a Two-Class Economy	Jun-ichi Itaya	May 1986
7.	A Three Factor Model of International Trade with Minimum Wage Rates	Hideki Funatsu	May 1986
8.	A Note of the Maximum Number of Firms with Equal Market Share in a Quantity Setting Supergame	Masaru Uzawa	Nov.1986
9.	Tax Incidence in a Two-Sector Growing Economy with Perfect Foresight	Jun-ichi Itaya	May 1987
10.	Two Kinds of Information in Price Search	Kaoru Endo & Teruya Nagao	Aug.1987
11.	On the Hedging and Investment Behavior of the Competitive Firm under Price Uncertainty	Jun-ichi Itaya	Oct.1987
12.	Tax Incidence in a Two-Sector Growing Economy with Perfect Foresight:Long-Run Analysis	Jun-ichi Itaya	Mar.1988
13.	Comparative Statics for the Private Provision of Public Goods in a Conjectural Variations Model with Heterogeneous Agents	Dipankar Dasgupta & Jun-ichi Itaya	Mar.1991
14.	Capital Accumulation Game of Multifirms with External Adjustemnt Costs	Jun-ichi Itaya	Mar.1991
15.	Using the Correct Economic Interpretation to Prove the Hawkins-Simon-Nikaido Theorem:One More Note	Dipankar Dasgupta	Jul.1991
16.	Transversality Condition in Infinite Time Horizon Concave Problems	Tomoichi Shinotsuka	Oct.1991

Discussion Paper Series
Department of Commerce
Otaru University of Commerce

No.	Title	Author/s	Date
1.	分権化組織における部門間調整と情報ｲﾝｾﾝﾃｨﾌﾞ･ｼｽﾃﾑの設計	井上正 & 鵜野好文	Apr.1985
2.	日本的雇用慣行とその経済合理性	井上正 & 鵜野好文	May 1989

Institute of Economic Research, Otaru University of Commerce
3-5-21, Midori, Otaru, Hokkaido 047, Japan Tel.0134-23-1101

小樽商科大学経済研究所
〒047 北海道小樽市緑3丁目5番21号 Tel.0134-23-1101㈹