An Analysis of Preferential Trade Agreements: A New Economic Geography Approach

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Abstract

This paper examines how preferential trade agreements (hereafter referred to as PTAs) affect industrial location and welfare. Taking tariff revenue into account in the new economic geography approach, we show that all firms are located in PTA countries when the external tariff is not high. The PTA country's welfare increases while that of those outside may increase or decrease. We also examine the hub and spoke to show that the hub has more firms compared with the spokes, and however welfare increases in all countries.

JEL classification: F12; F15; R12

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1 Introduction

Many countries are currently making preferential trade agreements (hereafter referred to as PTAs). The WTO recently reported 194 PTAs in 2007.[1] It has been recently reported that the US and South Korea came to a PTA in 2007. At present, Japan has successfully established economic partnership agreements (hereafter referred to as EPAs) with Singapore, Mexico and Malaysia. Furthermore, Japan is attempting to reach EPAs with many Asian countries, not only to decrease tariffs, but also to harmonize economic policies.

Generally speaking, a PTA promotes trade between countries within the agreement. However, it excludes other countries from its benefits. Although the WTO recognizes PTAs, under GATT Article XXVI, it prohibits countries within a PTA (insiders) from increasing tariff rates of other countries (outsiders). Under this rule, GATT ensures that those outside the PTA will not be at a disadvantage.

Various effects of PTAs on resource allocation and welfare have been analyzed from a theoretical perspective after the Viner (1950)'s classic work on the trade creation and trade diversion effects. Panagariya (2000) gave a comprehensive survey on the theoretical and empirical analysis of PTAs. The effects of PTAs on firms location, however, had been rather neglected until the new economic geography (hereafter referred to as NEG) appeared.[2] Puga and Venables (1997), Hur (2003) and Baldwin et al. (2003) utilize the NEG approach to investigate PTAs in terms of firms location.

Puga and Venables (1997) uses 'three-country input–output linkage model', and shows that if any two countries conclude a PTA, then the firms will agglomerate to the insiders (production shifting effect).[3] Welfare of one insider will increase but, that of other insider

[1] See following web site, www.wto.org/english/tratop_e/region_e/summary_e.xls, viewed on October 2, 2007

[2] Krugman (1991) is known as the pioneer of NEG. His analysis showed that transport costs between regions have great effects on industrial location. Fujita, Krugman, and Venables (1999) and Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud (2003) have reviewed NEG.

[3] Under input–output linkage, each firm produces both final and intermediate goods under monopolistic competition. Krugman and Venables (1995) is original version of 'two-country input–output linkage model.'

may rise or not. The welfare of the outsider will decrease. In a hub and spoke configuration, the hub country always has the largest share of firms while the spoke countries always have the smaller share. The hub country increases its welfare, whereas the welfare of spoke countries may increase or decrease. Hur (2003) also extends Krugman (1991)'s model to three countries, and shows the possibility of production shifting effect. Baldwin et al. (2003) analyzes PTAs using the footloose capital model as illustrated in Martin and Rogers (1995a).[4] Their analysis shows that the flow of firms into the insiders exists, and that welfare of the insiders increase, welfare of the outsider decreases. With respect to the hub and spoke configuration, firms move to the hub when transport cost is sufficiently high. However, firms move to the spoke when transport cost is sufficiently low. The welfare of the hub rises while that of the spoke countries falls.

In this paper, we seek to analyze how PTAs affect industrial location by using the three-country footloose capital model, with the assumption that tariff revenue is redistributed to consumers under the quasi-linear Dixit–Stiglitz utility function as demonstrated in Martin and Rogers (1995b). The previous papers in the NEG approach treat trade barriers as the transport cost and have not explicitly incorporated tariff revenue. However, according to Stiglitz (2006), Mexico losted its tariff revenue after NAFTA. This makes its public investment insufficiently. Accordingly, this paper contributes to demonstrate the tariff revenue effect in the NEG model. In particular, the tariff revenue effect plays an important role in the welfare analysis of PTA.

The main results of this paper are as follows: if external tariffs imposed by the insider are not high, an imperfect PTA could locate all firms in the insider.[5] The PTA increases the welfare of insiders. In the case of imperfect PTAs, welfare of the outsider may either increase or decrease. In contrasting Baldwin et al. (2003), we will demonstrate the case where the welfare of outside increases. In the hub and spoke configuration, the hub has more firms than the spokes. Welfare may increase in both hub and spoke countries. This

[4] Under the footloose capital model, capital needed to operate a firm moves to the high reward country. As a result, firms move to that country following the capital movement.

[5] In this paper, we use 'the perfect PTA' if tariffs eliminate completely. On the other hand, we use 'the imperfect PTA' if all tariffs do not fully eliminate.

is also contrasting result to Baldwin et al. (2003) where of spoke countries decreases.

The rest of this paper is organized as follows: Section 2 illustrates our basic model. Sections 3 and 4 expand the basic model to the existing PTA and hub and spoke, respectively. We conclude our findings in Section 5.

2 The basic model

In this section, we set up the basic model following Baldwin et al. (2003). There are three countries in this economy, 1, 2 and 3. There are production factors, labor (L) and physical capital (K). Labor cannot move internationally, but capital is allowed international movement. However, capital owners are immobile. Consequently, capital returns are remitted to the owner's country. Production takes place in a numeraire sector and the industrial sector. The numeraire sector is assumed to be perfectly competitive, with constant returns to scale and where one unit of numeraire production requires one unit of labor. There is no tariff on the numeraire. The industrial sector is characterized by Dixit–Stiglitz monopolistic competition and increasing returns to scale. Each firm requires one unit of capital as a fixed cost, and a_M units of labor to produce one unit of output. That is, a firm located in country R faces the following unit cost function:

$$r_R + wa_M x_R, \tag{1}$$

where $R = 1, 2, 3$ is an index of countries, and x_R is the quantity of output. In this sector, international movement needs iceberg type transport cost (τ). We consider this cost to be a tariff.

All consumers have the same preference of the following form:

$$U_R = C_A + \mu \ln C_M, \tag{2}$$

$$C_M \equiv \left(\int_{i=0}^{N} c(i)^{1-\frac{1}{\sigma}} di \right)^{1/(1-\frac{1}{\sigma})}, \ 0 < \mu, \ 1 < \sigma,$$

where C_M is the consumption of composite industrial variety, C_A is the consumption of the numeraire, N is the mass of firms in all countries, μ is the degree of preference for industrial goods and σ is the elasticity of substitution between any two varieties. The budget constraint for an individual is:

$$p_A C_A + \int_{i=0}^{N} p(i)c(i)di = E_R, \tag{3}$$

where $p(i)$ is the price for any variety i, $c(i)$ is the consumption for any variety i and E_R is the per capita income of country R. The per capita income of country R can be written as:

$$E_R = w + r\frac{K_R}{L_R} + TR_R,$$

where TR_R is tariff revenue, which is defined as $(\tau_{SR}-1)n_S c_{SR}+(\tau_{TR}-1)n_T c_{TR}$, $R, S, T = 1, 2, 3$; $R \neq S, R \neq T, S \neq T$ where c_{SR} means the per capita demand which is produced in country S and sold in country R.[6]

We solve the consumer's utility maximizing equation (2) subject to their budget constraint equation (3). Then, the individual demand function for the numeraire good, composite goods and any one variety are:

$$C_A = E_R - \mu, \tag{4}$$

$$C_M = \frac{\mu}{\int_{i=0}^{N} p(i)^{1-\sigma} di^{\frac{1}{1-\sigma}}}, \tag{5}$$

$$c(i) = \frac{\mu p(i)^{-\sigma}}{\int_{i=0}^{N} p(i)^{1-\sigma} di}, \tag{6}$$

respectively.

[6] In the same way, Baldwin and Robert-Nicoud (2000) redistributed consumer's utility as public services.

2.1 Short run equilibrium

Physical capital cannot move to foreign countries in the short run. In other words, firms do not move internationally. Then we assume that international industrial location is given. Under this condition, we describe profit maximization for both sectors.

First, we check the numeraire sector firm's behavior. Demand for the numeraire good is described in equation (4). Profit for this firm can be written as follows:

$$\pi_A = (p_A - a_A w)x_A. \tag{7}$$

We can easily show that $p_A = a_A w$ for any quantity x_A in equilibrium. Under our assumption, $a_A = 1$, and there is no tariff; the price is equal to one. Consequently, the wage rate is also one in all countries. We additionally assume that the numeraire good is produced in every country.[7]

Next, we want to check the behavior of the producers of any variety i in country R. The profit function can be written as:

$$\Pi_R = \pi_R - r_R, \tag{8}$$

where Π_R is the pure profit, π_R is the operating profit and r_R is the return to capital.

We define p_R as mill price for this firm, which is common for all firms located in country R. International transport implies iceberg costs, so we can write the price of the industrial goods produced in country R and sold in country S as:

$$p_{RS} = p_R \tau_{RS}, \tag{9}$$

where τ_{RS}, $R, S = 1, 2, 3$, and if $R = S$, then $\tau_{RS} = 1$.

We also assume that the price of industrial goods produced in any country R is equal

[7] This assumption is called the nonfull specialization condition. Under this assumption, full specialization is never allowed in any country, and producing agricultural goods in only one or two countries will never satisfy worldwide demand.

to p_R in all countries. We can rewrite the denominator of equation (6) as:

$$\Delta_S \equiv \int_{i=0}^{N} p_S(i)^{1-\sigma} di = \sum_{R=1}^{3} n_R (p_R \tau_{RS})^{1-\sigma}. \tag{10}$$

Using equation (10), demand for output produced in country R and sold in country S can be written as follows:

$$c_{RS} = \mu \frac{p_R^{-\sigma} \tau_{RS}^{-\sigma}}{\Delta_S}. \tag{11}$$

Using equation (11), the total output of any variety produced in country R can be written as:

$$x_R = \mu \sum_{S=1}^{3} p_R^{-\sigma} \tau_{RS}^{1-\sigma} \Delta_S^{-1} L_S, \tag{12}$$

where L_s is the population of country S. Equation (12) corresponds to x_R in equation (1). Operating profit for the firm located in country R is:

$$\pi_R = x_R (p_R - a_M w). \tag{13}$$

Using the profit maximizing problem for this firm, we can easily show that the optimal price for this firm is:

$$p_R = \frac{\sigma}{\sigma - 1} a_M w. \tag{14}$$

Given this optimal price, the firm's operating profit can be rewritten as:

$$\pi_R = \frac{1}{\sigma} p_R x_R. \tag{15}$$

We normalize $a_M = 1 - \frac{1}{\sigma}$. Then $p_R = 1$, and from equations (8), (10) and (14), the

pure profit for the firm located in country 1, we obtain:

$$\begin{aligned}\Pi_1 =& \frac{\mu}{\sigma}\frac{L}{N}\left\{\frac{s_{L1}}{s_{n1}+\phi_{21}s_{n2}+\phi_{31}(1-s_{n1}-s_{n2})}\right.\\ &+\frac{\phi_{21}s_{L2}}{\phi_{12}s_{n1}+s_{n2}+\phi_{32}(1-s_{n1}-s_{n2})}\\ &\left.+\frac{\phi_{31}(1-s_{L1}-s_{L2})}{\phi_{13}s_{n1}+\phi_{23}s_{n2}+(1-s_{n1}-s_{n2})}\right\}-r_1,\end{aligned} \tag{16}$$

where $\phi_{RS}=\tau_{RS}^{1-\sigma}$, $\phi_{RS}\in(0,1)$, $s_{LR}=L_R/L$ is the share of labor in country R, which we interpret as market share, and $s_{nR}=n_R/N$ is the proportion of firms in country R, respectively. By the free entry condition, we obtain the return to capital in country 1:

$$\begin{aligned}r_1 =& \frac{\mu}{\sigma}\frac{L}{N}\left\{\frac{s_{L1}}{s_{n1}+\phi_{21}s_{n2}+\phi_{31}(1-s_{n1}-s_{n2})}\right.\\ &+\frac{\phi_{21}s_{L2}}{\phi_{12}s_{n1}+s_{n2}+\phi_{32}(1-s_{n1}-s_{n2})}\\ &\left.+\frac{\phi_{31}(1-s_{L1}-s_{L2})}{\phi_{13}s_{n1}+\phi_{23}s_{n2}+(1-s_{n1}-s_{n2})}\right\}\\ &= bB_1\frac{L}{K},\end{aligned} \tag{17}$$

where:

$$\begin{aligned}b &\equiv \frac{\mu}{\sigma},\\ B_1 &\equiv \frac{s_{L1}}{\Delta_1}+\frac{\phi_{21}s_{L2}}{\Delta_2}+\frac{\phi_{31}s_{L3}}{\Delta_3},\\ \Delta_1 &\equiv s_{n1}+\phi_{21}s_{n2}+\phi_{31}(1-s_{n1}-s_{n2}),\\ \Delta_2 &\equiv \phi_{12}s_{n1}+s_{n2}+\phi_{32}(1-s_{n1}-s_{n2}),\\ \Delta_3 &\equiv \phi_{13}s_{n1}+\phi_{23}s_{n2}+(1-s_{n1}-s_{n2}).\end{aligned}$$

In deriving the second equality in equation (17), we use $N=K$ since we assume that a

firm needs one unit of capital. Similarly, those in countries 2 and 3 can be written as:

$$r_2 = bB_2\frac{L}{K}, \tag{18}$$

$$r_3 = bB_3\frac{L}{K}, \tag{19}$$

where:

$$B_2 \equiv \frac{\phi_{12}s_{L1}}{\Delta_1} + \frac{s_{L2}}{\Delta_2} + \frac{\phi_{32}s_{L3}}{\Delta_3},$$
$$B_3 \equiv \frac{\phi_{13}s_{L1}}{\Delta_1} + \frac{\phi_{23}s_{L2}}{\Delta_2} + \frac{s_{L3}}{\Delta_3}.$$

Finally, for simplicity, we normalize $K = 1$.

2.2 Long run equilibrium

In long run equilibrium, capital can move internationally, so it is possible to change industrial location. There are two types of equilibrium. The first type is called the interior equilibrium in which returns to capital in every country is equal, i.e.,:

$$r_1 = r_2 = r_3. \tag{20}$$

The other type is called the core-periphery outcome (hereafter referred to as CP). Under this type, the return to capital is not equal internationally. That is, equation (20) is not satisfied. This means that firms all move to the country that has the highest return to capital.

For simplicity, we assume that tariffs are the same in every country, i.e., $\phi_{RS} = \phi$. In the interior equilibrium, the share of firms located in country R is:

$$s_{nR} = \left(\frac{1+2\phi}{1-\phi}\right)\left(s_{LR} - \frac{1}{3}\right) + \frac{1}{3}. \tag{21}$$

We use equation (21) to find the long run equilibrium. Figure 1 illustrates this clearly.

[Figure 1 around here]

From Figure 1, as long as s_{LR} is equal to 1/3, the s_{nR} curve passes through $s_{nR} = 1/3$ for any tariff. Consequently, every country's share of firms is 1/3 under our symmetry condition.

Notice that the gradient of the s_{nR} curve is higher than the 45 degree curve. According to Krugman (1980), this is known as the home market effect.[8] If there is no symmetry assumption, when the market share of country R is more than $s_{LR} = 1/(1+2\phi)$, all firms move to country R. On the other hand, when $s_{LR} = \phi/(1+2\phi)$, no firms exist in country R.

3 The analysis of PTA

We assume that countries 1 and 2 form a PTA. We define the tariff level after the PTA as τ_{RS}^{PTA}, so we can write $\tau_{RS} > \tau_{RS}^{PTA}$, or:

$$1 \geq \alpha > \phi,$$

where $\alpha \equiv \tau_{RS}^{PTA\,1-\sigma}$. In order to describe the share of firms in any country after the PTA, we use α in place of ϕ_{12} and ϕ_{21}. Then we can solve for the share of firms in each country that satisfies equation (20). Now, we use the symmetry assumption, $s_{L1} = s_{L2} = s_{L3} = 1/3$, so that a firm's share in the interior equilibrium is:

$$s_{n1}^{PTA} = s_{n2}^{PTA} = \frac{\phi^2 - 3\phi + \alpha + 1}{3(1+\alpha-2\phi)(1-\phi)}, \tag{22}$$

$$s_{n3}^{PTA} = 1 - s_{n1}^{PTA} - s_{n2}^{PTA} = \frac{4\phi^2 - 3\alpha\phi - 3\phi + \alpha + 1}{3(1+\alpha-2\phi)(1-\phi)}. \tag{23}$$

If the share of firms in one of the insider countries exceeds 1/2, then the outsider has no firms. This leads to the following proposition.

[8] The home market effect means that a country with a larger global market share than another country will have a larger share of firms than that other country.

Proposition 1. *After the formation of a PTA between any two countries, industrial location changes in the range of α as follows:*

1. If $\phi \leq 1/2$, then it always leads to an interior equilibrium.

2. Suppose that $\phi > 1/2$.

(i) If

$$\alpha < \frac{\phi(4\phi - 3) + 1}{3\phi - 1}, \tag{24}$$

then the solution is an interior equilibrium.

(ii) If

$$\alpha \geq \frac{\phi(4\phi - 3) + 1}{3\phi - 1}, \tag{25}$$

then the solution is the CP outcome.

See the Appendix for the proof of Proposition 1.

[Figure 2 around here]

Figure 2 graphically shows Proposition 1. The vertical line shows the tariff level between insiders and the horizontal line shows the tariff level facing the outsider. The curve enclosing area III is the right hand side of (24) and (25). When the tariff facing the outsider is in area I, then there exist an interior equilibrium, and when the tariff facing the outsider is in areas II and III, then it satisfies Proposition 1-2.

To summarize, when the external tariff is sufficiently low, then all firms move to the PTA insider if a perfect PTA is realized. On the other hand, if an imperfect PTA is realized because of the higher external tariff, then some firms will choose to locate in the outsider. In Puga and Venables (1997), full agglomeration to the insider was not observed. Hur (2003) did not investigate imperfect PTAs. Our results, thus, differ from these earlier studies.

We can easily show the following proposition from equations (22) and (23).

Proposition 2. *Let the interior equilibrium of Proposition 1 hold. After formation of a*

PTA, the share of firms increases in any insider and decreases in the outsider, i.e.,:

$$s_{n1} = s_{n2} < s_{n1}^{PTA} = s_{n2}^{PTA},$$
$$s_{n3} > s_{n3}^{PTA}. \tag{26}$$

This result is called the product shifting effect. If the CP outcome is attained after the formation of a PTA, then the share of firms also increases. We see that a PTA has agglomeration force under any equilibrium condition. These results confirm the home market effect, which is mediated by the parameter α. On the other hand, increasing Δ_1 and Δ_2, and decreasing Δ_3, while B_1 and B_2 decrease and B_3 increases, means the favored insider's share of firms increases. This decreases the insider's returns to capital, while the outsider's returns increase. If excess agglomeration occurs, the returns of the insider decreases, so some firms want to remain in the outsider. This effect is detrimental to the home market, and dominates the home market when ϕ is small. Consequently, the higher the tariff rate facing the outsider, the weaker the home market effect. As such, imperfect agglomeration occurs.

Next, we want to analyze the effect on welfare. The indirect utility of country 1 from the demand functions in equations (4)-(6) is described as follows:

$$\begin{aligned} v_1 &= E_1 - \mu + \mu \ln \left\{ \frac{\mu}{\Delta_1^{\frac{1}{1-\sigma}}} \right\} \\ &= w + r \cdot \frac{K_1}{L_1} + \left[(\tau - 1) \frac{\mu n_2 \tau^{-\sigma}}{\Delta_1} + (\tau - 1) \frac{\mu n_3 \tau^{-\sigma}}{\Delta_1} \right] - \mu + \mu \ln \left[\frac{\mu}{\Delta_1^{\frac{1}{1-\sigma}}} \right]. \end{aligned} \tag{27}$$

Similarly, the indirect utility for the ex-ante PTA is:

$$v_1^{PTA} = w + r \cdot \frac{K_1}{L_1} + \left[\left(\tau^{PTA} - 1 \right) \frac{\mu n_2^{PTA} (\tau^{PTA})^{-\sigma}}{\Delta_1^{PTA}} + (\tau - 1) \frac{\mu n_3^{PTA} \tau^{-\sigma}}{\Delta_1^{PTA}} \right] - \mu + \mu \ln \left[\frac{\mu}{\Delta_1^{PTA \frac{1}{1-\sigma}}} \right]. \tag{28}$$

The other countries are analyzed in a similar fashion.

Here, labor has the same wage rate, one, and is internationally immobile so that the

number of workers is constant. In equilibrium, by substituting the firm's share into equation (17), we can derive the returns on capital as $L\mu/\sigma$, which is not dependent on the tariff. The capital owner remains in country 1. Therefore, the total amount of capital is constant. Consequently, the effect on welfare only depends on the change in square brackets in equations (27) and (28). The first square brackets show the tariff revenue effect, and the second is the effect from the price index of differentiated goods. We now examine these effects.

There are two effects on tariff revenue. First, tariff revenue is decreased by the production shifting effect, causing imports to decrease. As a result, tariff revenue also decreases. Another effect is caused by tariff reduction. This also decreases tariff revenue.

Next, we examine the price index effect. The denominator is the industrial goods price index. The price index effect can be divided into two effects. The first effect is the international movement of firms. If a firm enters any country, the price index decreases in that country. Tariff reduction reduces import prices. So, the price index also falls. As a result, the price index effect is positive.

It is difficult, however, to solve these effects analytically. We use numerical methods to understand these effects.[9] The result is described in Figure 3.

[Figure 3 around here]

Figure 3 plots welfare before and after the PTA. The vertical line shows the welfare level for the insider, and the horizontal line shows the tariff between insiders. The dashed line shows the ex-ante PTA welfare level that is not dependent on tariff level. The solid line shows the ex-post PTA welfare level. From this figure, we see that the insiders' welfare will not fall. This is because, for insiders, the tariff revenue effect is smaller than the price index effect.

Similarly, Figure 4 shows welfare change for the outsider.

[Figure 4 around here]

[9] We set $\mu = 0.9$, $\sigma = 6$ in our numerical example throughout this paper. We also set $\tau = 1.7996$, except in Figure 5.

Each line has almost the same meaning as for Figure 4. The only difference is that these lines show the outsider's welfare. For the imperfect PTA, the price index does not rise, but tariff revenue will increase more than the price index, because imports increase. In this case, the outsider's welfare increases. If the external tariff approaches the perfect PTA, the price index effect is larger than the tariff revenue effect. Our result is described in Figure 5.[10]

[Figure 5 around here]

From Figure 5, welfare is always reduced. In this case, the increasing tariff revenue effect is dominated by the decreasing price index effect. In both Figures 4 and 5, the outsider's welfare decreases under a perfect PTA.

4 The analysis of Hub and spoke

In this section, we analyze the hub and spoke configuration. To do this, we change the assumption used earlier. Here, the PTA consists of country 1, the hub, and both countries 2 and 3, the spokes. Similarly to Section 3, we define the tariff between hub and spokes as $\phi_{12} = \phi_{21} = \phi_{13} = \phi_{31} = \alpha$.

Let us focus on the interior equilibrium. We obtain:

$$s_{n1}^{hub} = \frac{4\alpha^2 - 3\alpha(1+\phi) + \phi + 1}{3(1-\alpha)(1+\phi-2\alpha)}, \tag{29}$$

$$s_{n2}^{spoke} = s_{n3}^{spoke} = \frac{\alpha^2 - 3\alpha + \phi + 1}{6\alpha^2 - 9\alpha - 3\alpha\phi + 3\phi + 3}. \tag{30}$$

The condition for the interior equilibrium is $s_{n1} < 1$. That is, $\alpha = (3 - \sqrt{5-4\phi})/2$ is the threshold. We obtain the next proposition.

Proposition 3. *In the interior equilibrium, the hub country's share of firms increases if*

$$\alpha \geq \frac{3 - \sqrt{5-4\phi}}{2},$$

[10] $\tau = 1.1984$ in Figure 5.

in which case all firms move to the hub country.

See the Appendix for the proof of Proposition 3.

α always exists for any ϕ. If the perfect hub and spoke configuration is realized, then all firms locate in the hub.[11] Puga and Venables (1997) do not observe full agglomeration in the hub.[12]

We analyze the welfare in the hub. The numerical example is shown in Figure 6.

[Figure 6 around here]

According to Figure 6, hub welfare rises under an imperfect PTA. The tariff revenue effect is always dominated by the price index effect. As a result, welfare always rises. When all firms are located in the hub, there are no imports (both the tariff revenue effect and the price index effect disappear). Consequently, the perfect hub and spoke PTA does not require the hub to maximize its welfare.

We can also obtain a numerical example for the spokes in Figure 7.

[Figure 7 around here]

Under an imperfect PTA, the tariff revenue effect is always larger than the price index effect. As a result, welfare rises. In the case of full agglomeration to the hub, tariff revenue disappears and the tariff revenue effect vanishes. As a result, welfare depends only on the price index effect. Approaching free trade, the price index effect gradually decreases.

5 Conclusion

In this paper, we have analyzed the industrial location and welfare consequences of PTAs for three countries under the footloose capital model. We have shown that insiders have

[11] Perfect and imperfect have the same meaning as for previous sections

[12] In Baldwin et al. (2003), all firms are located in spoke countries. This result comes from the interior equilibrium, i.e., they focused only on equation (29). Let us remember our footloose capital model assumption. Capital moves to the highest reward country. We obtain this proposition under this assumption.

agglomeration force after the PTA while the outsider shows dispersion. Welfare analysis using a numerical example shows that insiders increase their welfare. Under an imperfect PTA, welfare may or may not increase. A perfect PTA decreases their welfare as a result of two different forces. One is the price index effect on industrial goods, the other is the tariff revenue effect. We have found that the insiders' price index effect is larger than the tariff revenue effect. The opposite is the case for the outsider.

We have also analyzed the hub and spoke configuration. In this case, we saw agglomeration to the hub. This is because locating in the hub gives easy access to both spoke markets. Welfare increases in both hub and spokes. For the hub, increases in the price index exceeded tariff revenue under imperfect agglomeration. Under perfect agglomeration, both the tariff revenue and price index effects disappear. As a result, welfare does not increase any further. When firms do not all move to the hub, welfare increase is caused by tariff revenue. However, for perfect agglomeration into the hub, the price index causes the increase in welfare.

In this paper, however, uses a simple footloose capital model we ignore asymmetry among countries, imperfect capital movement. We also use specific utility function therefore we have to examine in the robustness of our result by taking these features into account. In addition, the analysis of endogenous PTA formation could be an important future research.

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Appendix

Proof of Proposition 1

When equation (22) is smaller than 1/2, the equilibrium will be the interior equilibrium, i.e.,:

$$\frac{\phi^2 - 3\phi + \alpha + 1}{3(1 + \alpha - 2\phi)(1 - \phi)} < \frac{1}{2}.$$

Solving this inequality, we obtain:

$$\alpha(3\phi - 1) < \phi(4\phi - 3) + 1. \tag{31}$$

If the left hand side is $3\phi - 1 > 0 \Leftrightarrow \phi > 1/3$, then:

$$\alpha < \frac{\phi(4\phi - 3) + 1}{3\phi - 1}.$$

On the other hand, if the left hand side is $3\phi - 1 < 0 \Leftrightarrow \phi < 1/3$, then:

$$\alpha > \frac{\phi(4\phi - 3) + 1}{3\phi - 1}.$$

Where equation (22) is greater than or equal to 1/2, we can solve this in the same way as for the interior equilibrium. If $3\phi - 1 \geq 0 \Leftrightarrow \phi \geq 1/3$, then:

$$\alpha \geq \frac{\phi(4\phi - 3) + 1}{3\phi - 1}.$$

In the range of $1/3 < \phi < 1/2$, left hand side of this inequality are greater than 1. then, there is no CP.

If $3\phi - 1 \leq 0 \Leftrightarrow \phi \leq 1/3$, then α, which satisfies

$$\alpha \leq \frac{\phi(4\phi - 3) + 1}{3\phi - 1},$$

must be negative. In this case, there is no CP. □

Proof of Proposition 3

The share of firms for each country is obtained from equation (29). If $s_{n1} \geq 1$, then the interior equilibrium does not exist. We obtain:

$$\alpha \geq \frac{3 - \sqrt{5 - 4\phi}}{2}. \tag{32}$$

In this case, the return is $r_1 > r_2 = r_3$, and all firms locate in the hub country.

The return is shown by equations (17), (18) and (19). We assume that $s_{n1} = 1,\ s_{n2} = s_{n3} = 0$. Under this condition, by differentiating equations (17) and (18) with respect to α satisfying (32), we obtain:

$$\left.\frac{\partial r_1}{\partial \alpha}\right|_{s_{n1}=1,\ s_{n2}=s_{n3}=0} = 0,$$

and:

$$\left.\frac{\partial r_2}{\partial \alpha}\right|_{s_{n1}=1,\ s_{n2}=s_{n3}=0} = \frac{1}{3}\left(1 - \frac{1+\phi}{\alpha^2}\right).$$

In the practical range of this paper, this must be negative. Therefore, the return to capital in the hub is always greater than for the spokes. □

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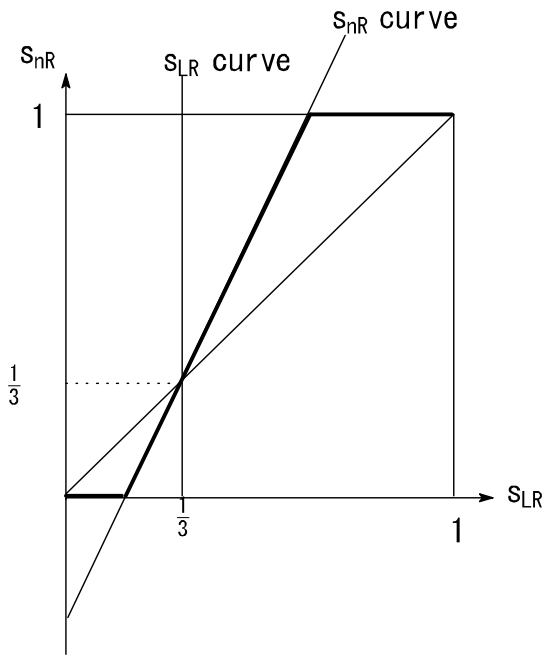

Figure 1: Scissors diagram

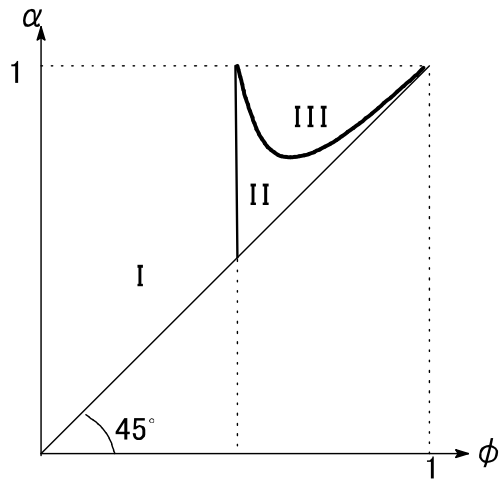

Figure 2: The range of equilibrium

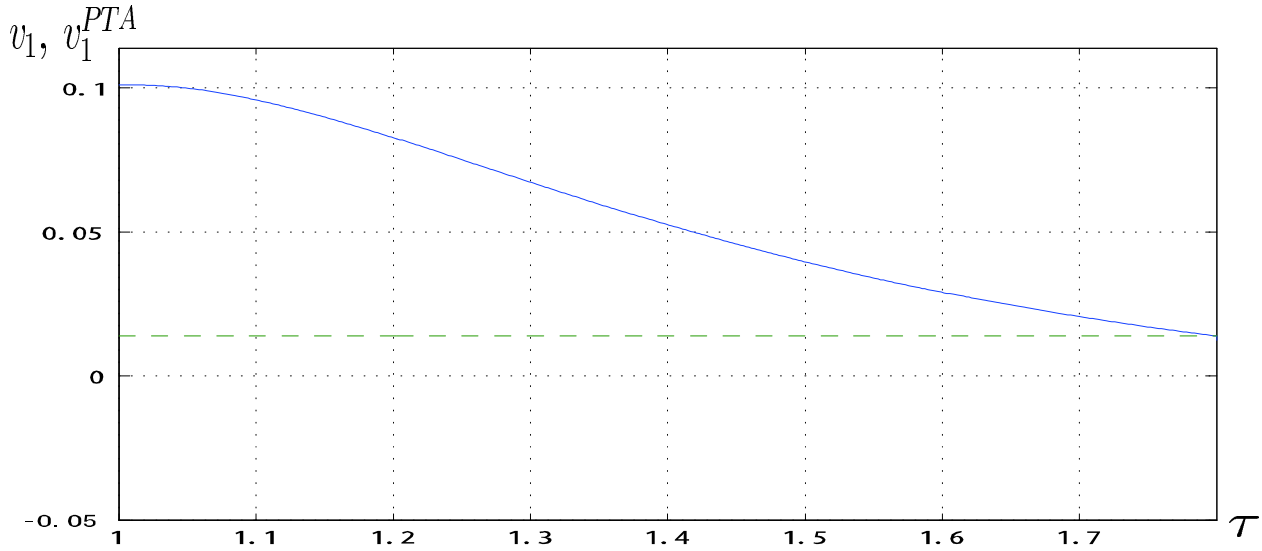

Figure 3: Welfare change of the PTA insider

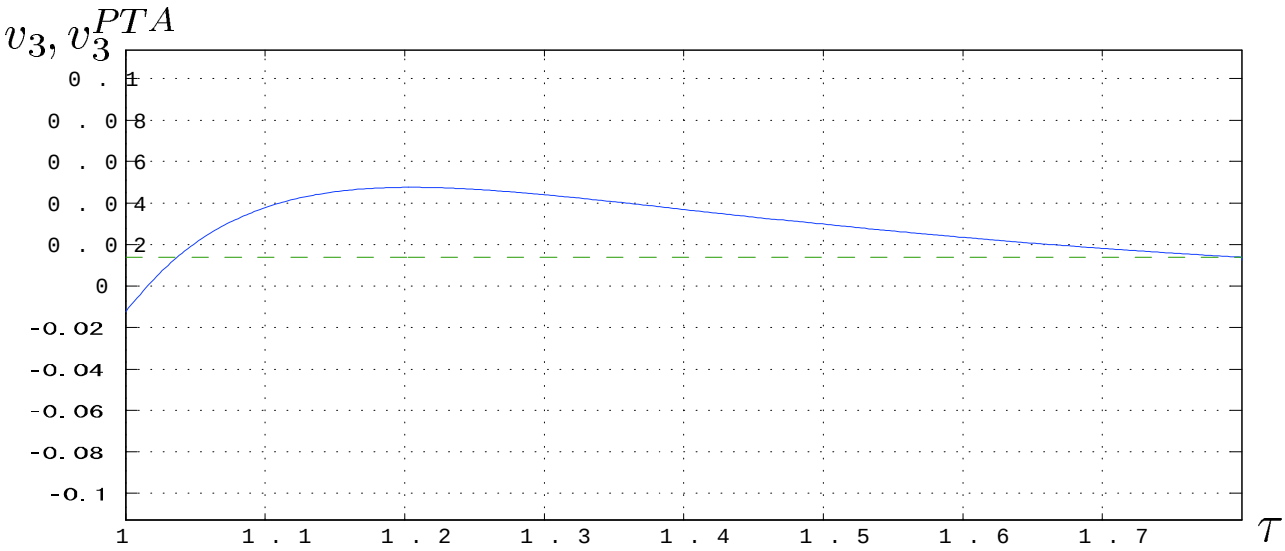

Figure 4: Welfare change of the PTA outsider: $\tau = 1.7996$

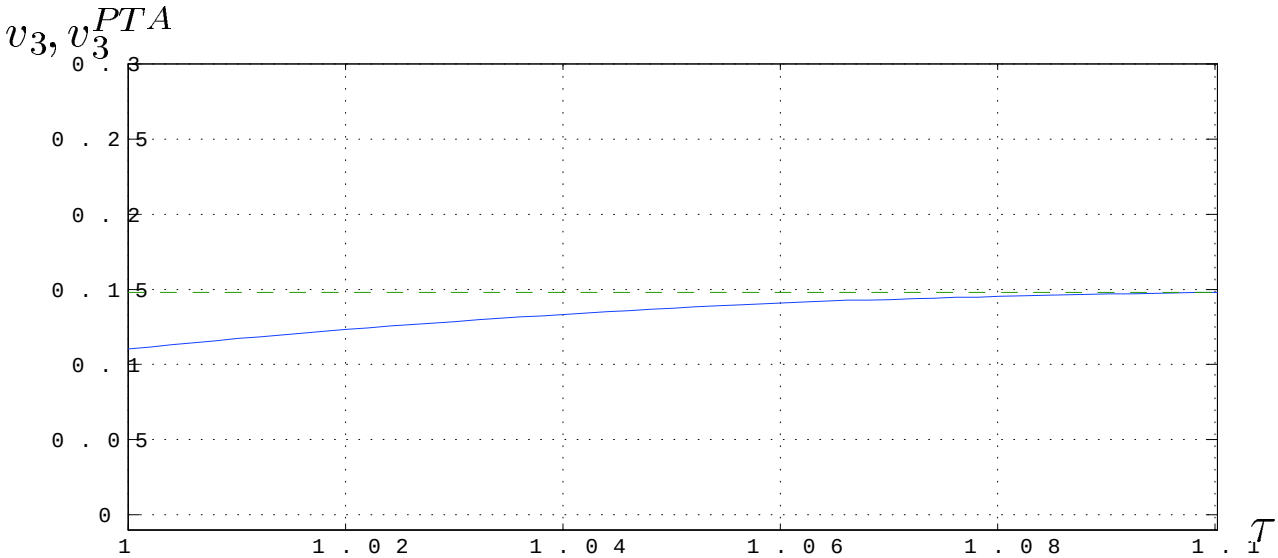

Figure 5: Welfare change for the PTA outsider: $\tau = 1.1984$

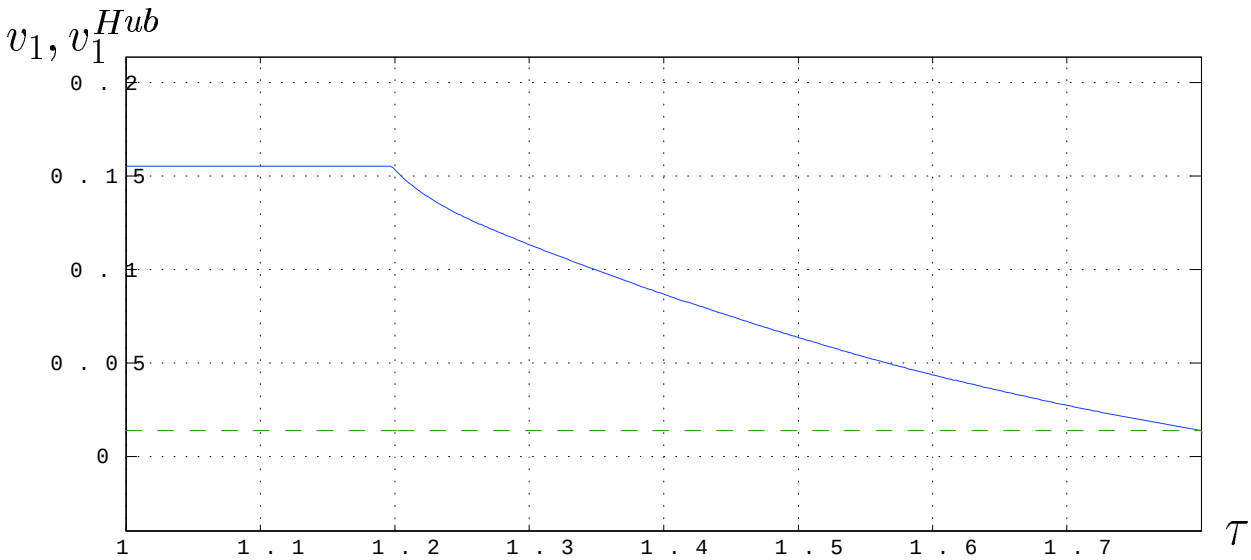

Figure 6: Welfare change of the hub country

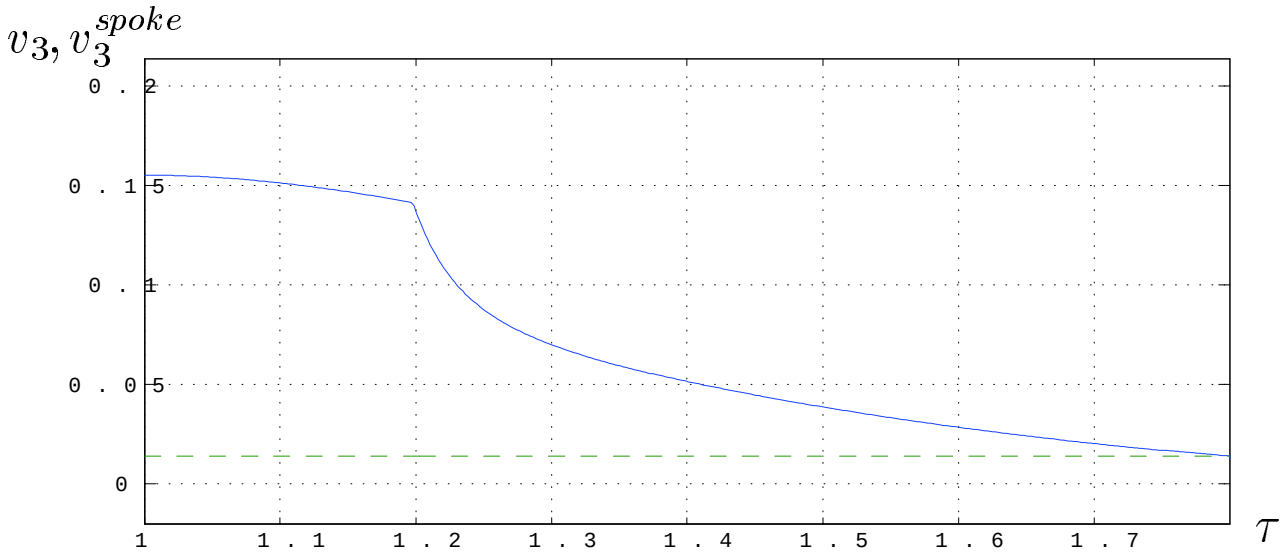

Figure 7: Welfare change of the spoke country