Gradual Tariff Adjustment with Imperfect Capital Mobility between Countries

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Abstracts: In this paper, our focus is to see the impact of imperfect international capital mobility on tariff adjustment process between two countries. Assuming complete specialization of each country, the results show that the existence of an imperfect international capital market may trigger a gradual tariff adjustment. That is, when it takes time and causes idle capital in reallocating capital between countries, tariff negotiations between two countries may end up with a different tariff combination, rather than reaching a long run welfare maximizing tariff combination immediately at the first period. The results also include where immediate adjustment is the Nash bargaining negotiation result. The model also shows that the short run tariff rate of a country may be even lower that its long run tariff rate, i.e., the first period tariff rate is lower than the long run welfare maximizing tariff rate that is imposed at the second period.

Keywords: tariff adjustment, imperfect capital mobility, tariff negotiation

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Ⅰ. Introduction

One of the most prominent features in the world economy after World War II is the tremendous reduction of tariff rates. However, this reduction has taken more than a half century to reach. The main question, then, is why did the reduction in tariff rates require such a long period of time, if mutual tariff reduction or multilateral trade liberalization can provide gains for both countries involving the negotiation process. Why is trading negotiations a gradual process rather than an immediate one time tariff adjustment? This question has interested economists' attention since the late 1970s, and many studies have been done to explain it.

The early literature on trade liberalization has mainly focused on the analysis of unilateral liberalization with costs of adjustment. These analyses are based on the traditional neoclassical standpoint and various types of market failures within the domestic economy. It is called unilateral gradualism because the theory views gradual reduction of import tariff as a result of the market fracture within an economy, which is independent of the behavior of other countries. In such models, the optimal liberalization can take gradual steps if adjustment costs are convex with respect to the magnitude of tariff reduction(Mussa, 1986).

Instead of looking inside its own economy and finding out the cause of gradualism an economy has from market fracture, the second generation of gradualism examines a two way, game-theory based interaction. In this view, trade has to be self-enforcing. Staiger(1995) attributes gradualism in trade liberalization to self-enforceability of agreements. He assumes there are three types of labor in economies: workers who are particularly well suited to work in the import-competing sector, workers who are endowed with no sector-specific skills, and workers who have special skills only for export sector of the economy. The existence of factor specific labor in an import competing sector gives each government an incentive to deviate from an agreed tariff reduction path and it acts as a deterrence to trade liberalization. However, if the decrease in the tariff occurs gradually, governments lose their incentive to back to a tariff war as time goes on. Therefore, the way to liberalization has to have gradual steps, rather than immediate movement towards free trade.

In another approach, Furusawa and Lai (1999) point out that Staiger does not take into account the issue of adjustment costs of liberalization, which they argue, is a major concern for countries facing negotiation. In their paper, they assume that each worker has to pay a fixed adjustment cost not only when workers switch from importing industry sector to numeraire sector, but also when they move in the opposite direction. Therefore, once a country deviates from the liberalization agreement, it would enjoy temporary benefits from setting the optimum tariff while its partner imposes the tariff rate on importing goods according to the agreed tariff schedule. But in the deviation-punishment phase followed by deviation, the deviating country has to incur adjustment costs for expanding the importable sector. This strengthens both countries' incentive to following the liberalization agreement and as each country moves toward smaller importable sector, the value of staying in the agreement is increased while the gains from deviation are decreased. These factors relax the incentive constraint, making it possible to cut tariffs further in the future. Furusawa and Lai's approach is similar to Staiger's in its view that gradual tariff reduction has to be based on self-enforcement constraint, and shares the idea with earlier unilateral gradualists in that they try to find out the reason for gradualism from the market fracture, especially, from the imperfect labor market. However, by adopting self-enforcement condition, they can reach the gradual liberalization procedure even without the assumption of convex adjustment cost of labor, which was critical in earlier models.

The more recent research done by Bond and Park (2001) looks at the self-enforcing trade agreements between countries of asymmetric size. In addition to size effect on gradual tariff reduction, the study also shows how consumption smoothing and sunk investments affect the trade negotiation.

The latest generation of gradual tariff reduction literature used to be called perpetual trade liberalization, which has proposed by Lockwood, Whalley and Zissimos (2001). They believe that process is triggered by political costs at the international level, and look at the impact of the institutional constraints, like WTO, on the agreed tariff adjustment path. It shows that no efficient tariff level exists at which liberalization stops and some liberalization must occur in every period along the liberalization path. Lockwood and Thomas (2002) introduces another interesting approach toward gradualism. It shows that irreversibility can be a factor of gradualism in a dynamic partial cooperation model. As they mentioned in the paper, such framework can be applicable to previous literature, including Staiger (1995) and Furusawa and Lai (1999)

In this paper, we investigate another factor that may cause gradual trade liberalization under the general equilibrium framework. Focusing on capital markets, we introduce an imperfect international capital market; the total amount of capital available is allocated between countries according to the differences in returns on capital between countries. However, adjustment takes times. We assume that when tariff rate(s) changes, reallocating capital between countries takes exactly one period to complete. Given the imperfect capital mobility, we look at how tariff rates adjust as two countries cooperate to find out mutually beneficial tariff combination.

In section II, we start with the model description and look at the perfect capital market as a reference point. Imperfect capital market is introduced in section IV and show how tariff adjustment paths may occur. Section V concludes the paper.

Ⅱ. Model

A two-good, two-country world is postulated in which both the home and foreign countries are large enough to affect the terms of trade. Each country is assumed to be completely specialized in one good; the home country specializes in good Y and the foreign specializes in good X. Therefore, the home country exports good Y and imports good X, while foreign country exports good X and imports good Y. Assuming no international labor mobility between home and foreign country, production function in each country can be specified as

$$Q_Y = f(\overline{K}+k, \overline{L}) \textit{ and } Q_X{}^* = f^*(\overline{K^*}-k, \overline{L^*}). \tag{1}$$

where $\overline{K}$ and $\overline{K^*}$ are the initial endowment of capital for the home and foreign country, respectively, and k represents the amount of capital inflow form the foreign to home country. The variables with asterisks denote the foreign country. The production function is assumed to be continuous, increasing, twice differentiable, and concave. The amount of capital flow will be determined at the point where the world capital market clears. Assume that $k>0$, that is, the home country is a net capital importing country and pays $r\cdot k$ per period, according to home country's return on capital. Denote p^w be the world relative price of good X with respect to good Y and p

and p^* be the domestic relative price of good X. Therefore p^w is terms of trade of foreign country, and $1/p^w$ is for foreign country.

When home and foreign country impose tariffs τ and τ^* on the importing goods, the domestic prices of each country are respectively,

$$p = p^w(1+\tau) \quad and \quad p^* = \frac{p^w}{(1+\tau^*)}. \tag{2}$$

Denote the home social utility function by $u = u(C_X, C_Y)$, where u is the utility level and C_i is the consumption of good $i\,(i = X, Y)$. The social utility function is continuous, increasing, twice differentiable, and quasi-concave. Now define the following reduced form indirect utility function

$$v(p^w, \tau, k; b) = \underset{C_X,\, C_Y}{\mathrm{Max}}\left\{u(C_X, C_Y); p^w(1+\tau)C_X + C_Y = f(\overline{K}+k, \overline{L}) + b\right\}. \tag{3}$$

In (3), b is the transfer revenue the government receives from abroad and defined as $b \equiv \tau p^w M_X - rk$, where M_X and r denote the home country's import of good X and rate of return on capital evaluated by good Y. The derivatives of the indirect trade utility function, which are denoted by subindices, are

$$v_p = -\lambda C_X = -\lambda M_X(p^w, \tau, k; b) \tag{4.1}$$

$$v_k = \lambda f_k = \lambda r \tag{4.2}$$

$$v_b = \lambda \tag{4.3}$$

where λ is the marginal utility of income. The production function of good X and social utility function of the foreign country can be defined in a similar way, and are denoted by $Q_X^* = f^*(\overline{K^*}+k^*, \overline{L^*})$ and $u^* = u^*(C_X^*, C_Y^*)$. Similarly its indirect utility function is denoted by

$$v^*(p^w, \tau^*, k^*; b^*) = \underset{C_X^*,\, C_Y^*}{\mathrm{Max}}\left\{u^*(C_X^*, C_Y^*); p^w C_X^* + (1+\tau^*)C_Y^* = p^w f^*(\overline{K}^* + k^*, \overline{L}^*) + b^*\right\} \tag{5}$$

$$where \quad b^* \equiv \tau^* M_Y^* - p^w r^* k^*.$$

M_Y^* and r^* denote the foreign country's import of good Y and rate of return on capital evaluated by good X. Assuming that all transfer revenue go to consumers, Eq. (3) and (5) can be expressed in terms of p^w, τ, τ^*, and k(or k^*).

$$M_X(\equiv C_X) = M_X(p^w, \tau, k), \quad where \frac{\partial M_X}{\partial p^w} < 0, \ \frac{\partial M_X}{\partial \tau} < 0, \ \frac{\partial M_X}{\partial k} > 0, \tag{6.1}$$

$$M_Y^*(\equiv C_Y^*) = M_Y^*(p^w, \tau^*, k^*), \quad where \ \frac{\partial M_Y^*}{\partial p^w} > 0, \ \frac{\partial M_Y^*}{\partial \tau^*} < 0, \ \frac{\partial M_Y^*}{\partial k^*} > 0. \tag{6.2}$$

The market clearing condition includes

$$M_Y^*(p^w, \tau^*, k^*) = p^w M_X(p^w, \tau, k) + r(k)k, \tag{7.1}$$

$$r(k) = p^w r^*(k^*), \tag{7.2}$$

$$k + k^* = 0. \tag{7.3}$$

Eq. (7.1) shows the good market equilibrium condition and Eq. (7.2) and Eq. (7.3) provide capital market conditions. When capital moves perfectly across countries, these market equilibrium conditions are all satisfied. Using Eq. (7.2) and (7.3), k can be written in terms of p^w. Defining $\partial k/\partial p^w$ as γ,

$$k = k(p^w), \quad where \quad \gamma\left(\equiv \frac{\partial k}{\partial p^w}\right) = \frac{r^*}{r_k + p^w r^*_{k^*}} < 0. \tag{8}$$

Substituting $k = k(p^w)$ from (8) into (7.1), we obtain

$$M_Y^*(p^w, \tau^*, k^*(p^w)) = p^w M_X(p^w, \tau, k(p^w)) + r(k(p^w))k(p^w), \tag{9}$$

which can be solved for the equilibrium $p^w = p^w(\tau, \tau^*)$. Totally differentiate (9) to give, after rearranging the terms,

$$dp^w = -\frac{1}{\Delta}\frac{1}{M_X}p^w\frac{\partial M_X}{\partial \tau}d\tau + \frac{1}{\Delta}\frac{1}{M_X}p^w\frac{\partial M_Y^*}{\partial \tau^*}d\tau^* \tag{10}$$

where

$$\varDelta \equiv 1-\epsilon_X-\epsilon_Y{}^*\frac{M_Y{}^*}{p^w M_X}+\frac{\gamma}{M_X}\left(r_k k+r+p^w\frac{\partial M_X}{\partial k}+\frac{\partial M_Y{}^*}{\partial k^*}\right)<0. \tag{11}$$

$\epsilon_X\left(\equiv -d\ln M_X/d\ln p^w\right)$ and $\epsilon_Y{}^*\left(\equiv d\ln M_Y{}^*/d\ln p^w\right)$ are the price elasticity of import demands for good X and Y, respectively, and γ measures the change in capital inflow into the home country as world relative of good X changes. Assume that the price elasticities of import demands are elastic for both countries so that $\epsilon_X>1$ and $\epsilon_Y{}^*>1$. Graphically, these assumptions eliminate possible cases where two offer curves meet at the bend-over portion of offer curve(s). Also, we assume that total payment of using foreign capital is positively related with the amount of capital inflow. That is, $\frac{\partial(r\cdot k)}{\partial k}=r_k k+r>0$. With these assumptions, $\varDelta<0$ therefore $\frac{\partial p^w}{\partial\tau}<0$, $\frac{\partial p^w}{\partial\tau^*}>0$.

Since $k(\tau,\tau^*)=k\left(p^w(\tau,\tau^*)\right)$ from Eqs. (8) and (10), the import demand function of home and foreign country can be reduced to

$$M_X=\widetilde{M}_X(\tau,\ \tau^*)=M_X\left[p^w(\tau,\tau^*),\ \tau,\ k(\tau,\tau^*)\right], \tag{12.1}$$

$$M_Y{}^*=\widetilde{M}_Y{}^*(\tau,\ \tau^*)=M_Y{}^*\left[p^w(\tau,\tau^*),\ \tau^*,\ k^*(\tau,\tau^*)\right]. \tag{12.2}$$

The derivatives of these functions are

$$\frac{\partial\widetilde{M}_X}{\partial\tau}=\frac{dM_X}{d\tau}=\frac{1}{\varDelta}\left(\epsilon_X-\frac{\gamma}{M_X}p^w\frac{\partial M_X}{\partial k}+\varDelta\right)\frac{\partial M_X}{\partial\tau} \tag{13.1}$$

$$\frac{\partial\widetilde{M}_X}{\partial\tau^*}=\frac{dM_X}{d\tau^*}=\frac{1}{\varDelta}\frac{1}{p^w}\left(-\epsilon_X+\frac{\gamma}{M_X}p^w\frac{\partial M_X}{\partial k}\right)\frac{\partial M_Y{}^*}{\partial\tau^*} \tag{13.2}$$

$$\frac{\partial\widetilde{M}_Y{}^*}{\partial\tau^*}=\frac{dM_Y{}^*}{d\tau^*}=\frac{1}{\varDelta}\left(\epsilon_Y{}^*\frac{M_Y{}^*}{p^w M_X}-\frac{\gamma}{M_X}p^w\frac{\partial M_Y{}^*}{\partial k^*}+\varDelta\right)\frac{\partial M_Y{}^*}{\partial\tau^*} \tag{13.3}$$

$$\frac{\partial\widetilde{M}_Y{}^*}{\partial\tau}=\frac{dM_Y{}^*}{d\tau}=\frac{1}{\varDelta}\left(-\epsilon_Y{}^*\frac{M_Y{}^*}{p^w M_X}+\frac{\gamma}{M_X}p^w\frac{\partial M_Y{}^*}{\partial k^*}\right)\frac{\partial M_X}{\partial\tau}. \tag{13.4}$$

Using equations (8), (10) and (12), the indirect trade utility functions of the countries reduce to

$$V = V(\tau, \tau^*) = v\left[p^w(\tau, \tau^*), \tau, k(\tau, \tau^*), b(\tau, \tau^*)\right] \tag{14.1}$$

$$V^* = V^*(\tau, \tau^*) = v^*\left[p^w(\tau, \tau^*), \tau^*, k^*(\tau, \tau^*), b^*(\tau, \tau^*)\right] \tag{14.2}$$

$$where \quad b(\tau, \tau^*) \equiv \tau p^w M_X - r \cdot k, \tag{14.3}$$

$$b^*(\tau, \tau^*) \equiv \tau^* M_Y^* - p^w r^* k^*. \tag{14.4}$$

The derivatives of these functions are

$$\frac{\partial V}{\partial \tau} = v_b \frac{1}{\Delta} \frac{\partial M_X}{\partial \tau} p^w \left\{ 1 + \frac{\gamma r_k k}{M_X} + \tau \left(\epsilon_X - \frac{\gamma}{M_X} p^w \frac{\partial M_X}{\partial k} + \Delta \right) \right\} \tag{15.1}$$

$$\frac{\partial V}{\partial \tau^*} = -v_b \frac{1}{\Delta} \frac{\partial M_Y^*}{\partial \tau^*} \left\{ 1 + \frac{\gamma r_k k}{M_X} + \tau \left(\epsilon_X - \frac{\gamma}{M_X} p^w \frac{\partial M_X}{\partial k} \right) \right\} \tag{15.2}$$

$$\frac{\partial V^*}{\partial \tau^*} = v^*_{b^*} \frac{1}{\Delta} \frac{\partial M_Y^*}{\partial \tau^*} \left\{ 1 + \frac{\gamma r_k k}{M_X} + \tau^* \left(\epsilon_Y^* \frac{M_Y^*}{p^w M_X} - \frac{\gamma}{M_X} \frac{\partial M_Y^*}{\partial k^*} + \Delta \right) \right\} \tag{15.3}$$

$$\frac{\partial V^*}{\partial \tau} = -v^*_{b^*} \frac{1}{\Delta} \frac{\partial M_X}{\partial \tau} p^w \left\{ 1 + \frac{\gamma r_k k}{M_X} + \tau^* \left(\epsilon_Y^* \frac{M_Y^*}{p^w M_X} - \frac{\gamma}{M_X} \frac{\partial M_Y^*}{\partial k^*} \right) \right\}. \tag{15.4}$$

Suppose that pre-negotiation situation, when two countries seek their own utility maximization without any cooperative behavior. This means that the governments choose their own tariffs to satisfy the following equations, taking the tariff rates of the other country as given:

$$V_\tau = 0 \;\; and \;\; V^*_{\tau^*} = 0. \tag{16}$$

Equations (16) define the two Nash tariff rates, (τ_N, τ_N^*), as follows.

$$\tau_N = -\frac{1 + \frac{\gamma}{M_X} r_k k}{1 - \epsilon_Y^* \frac{M_Y^*}{p^w M_X} + \frac{\gamma}{M_X} \left(r_k k + r + \frac{\partial M_Y^*}{\partial k^*} \right)} > 0 \tag{17.1}$$

$$\tau_N^* = -\frac{1 + \frac{\gamma}{M_X} r_k k}{1 - \epsilon_X + \frac{\gamma}{M_X} \left(r_k k + r + \frac{\partial M_X}{\partial k} \right)} > 0 \tag{17.2}$$

The Nash tariff rates in (17.1) and (17.2) are both positive and we consider τ_N and τ_N^* as initial tariff rates for the home and foreign country.

This shows that, for a large open country, there is an optimum tariff τ_N ($\tau_N{}^*$ for the foreign country) at which the marginal gain from improved terms of trade just equals the marginal efficiency loss in production and consumption. At this tariff combination, no country has an incentive to change its own tariff rate. Denote the corresponding utility levels of the countries by

$$\overline{V} = \overline{V}(\tau_N, \tau_N{}^*) \quad and \quad \overline{V^*} = \overline{V^*}(\tau_N, \tau_N{}^*). \tag{18}$$

Ⅲ. Perfect Capital Mobility

Now we consider cooperative Nash bargaining tariff rates for the home and foreign country. Consider first the case in which capital can move perfectly and costlessly between the two countries. Both countries negotiate to get new tariffs. It is assumed that the objective function they want to maximize is

$$\begin{aligned} &\underset{\tau, \tau^*}{\text{Max}} (V - \overline{V})^{\psi} (V^* - \overline{V^*})^{1-\psi} \\ &s.t. \quad V \geq \overline{V}, \quad V^* \geq \overline{V^*}, \quad \tau \geq 0, \quad \tau^* \geq 0, \end{aligned} \tag{19}$$

given the initial tariff rates of $\tau_0 = \tau_{N,}$ and $\tau_0{}^* = \tau_N{}^*$. In (19), ψ is negotiation power factor that is $0 \leq \psi \leq 1$. $\overline{V}$ and $\overline{V^*}$ are reservation utility levels for home and foreign country and they are the utility level the home and foreign country receive if they stick to the initial tariff rates, τ_N and $\tau_N{}^*$.

If either of $\overline{V}$ of $\overline{V^*}$ is binding, i.e., $V = \overline{V}$ or $V^* = \overline{V^*}$, it never is the maximized value of the objective function. Thus we focus on the case where both $V > \overline{V}$ and $V^* > \overline{V^*}$. The Lagrangian set up for this maximization problem is

$$L(\tau, \tau^*) = (V - \overline{V})^{\psi} (V^* - \overline{V^*})^{1-\psi} + \widetilde{\mu_1}(\tau) + \widetilde{\mu_2}(\tau^*), \tag{20}$$

and two first order conditions are

$$\psi \frac{\partial V}{\partial \tau}\frac{1}{\Omega}+(1-\psi)\frac{\partial V^*}{\partial \tau}+\mu_1=0 \tag{21.1}$$

$$\psi \frac{\partial V}{\partial \tau^*}\frac{1}{\Omega}+(1-\psi)\frac{\partial V^*}{\partial \tau^*}+\mu_2=0 \tag{21.2}$$

where

$$\Omega(\tau,\tau^*)\equiv\frac{V-\overline{V}}{V^*-\overline{V^*}}, \tag{22.1}$$

$$\mu_1 \geq 0,(=0,\ \text{if } \tau>0), \tag{22.2}$$

$$\mu_2 \geq 0,(=0,\ \text{if } \tau^*>0). \tag{22.3}$$

Let us denote $\hat{\tau}$ and $\hat{\tau^*}$ as the Nash bargaining tariff rates simultaneously satisfy the two first order conditions described above. The chosen tariff rates depend on the initial Nash equilibrium and the countries' bargaining power. Nash bargaining tariff combination in Eq. (19) is a point in which both home and foreign country are better off than the reservation utility level and each country's welfare contours are tangent each other.

In Figure 1, the possible Nash bargaining tariff combination occurs along the line between point A and B. Contract curve, which represents all possible Nash bargaining solutions, is negatively sloped and goes through the origin. At least one country can be better off if new tariff combination occurs at points inside home and foreign country's reservation utility level. However, at any point other than on the contract curve, there exists import tariff combination in which at least one country can be better off without hurting the other. Therefore, Nash bargaining tariff combination occurs along the contract curve, along the line between point A and B, if negative tariff rates are allowed.

Where the final Nash bargaining point occur depends on the negotiation power between two countries. That is, an increase in home country's negotiation power, i.e., an increase in the value of ψ, will lead to an equilibrium point closer to point B so that it gets a bigger share of the gain. However, since negative tariff rates are ruled out by assumption, the Nash bargaining solution cannot be on AB except point O, the origin, and the possible Nash bargaining solution is bounded by the vertical axis (OC) the horizontal axis (OD), and the reservation utility level for home and foreign country.[1)]

To find out the Nash bargaining solution with no negative tariff assumption, first rewrite Eq. (21.1) and (21.2) using (15.1)-(14.4);

$$\frac{1}{\Delta}\frac{\partial M_X}{\partial \tau}p^w \times \left[\begin{array}{l}\left(1+\frac{\gamma r_k k}{M_X}\right)X + V_b\psi\frac{1}{\Omega}\tau\left(\epsilon_X - \frac{\gamma}{M_X}p^w\frac{\partial M_X}{\partial k}+\Delta\right) \\ - V_{b^*}^*(1-\psi)\tau^*\left(\epsilon_Y{}^*\frac{M_Y{}^*}{p^w M_X}-\frac{\gamma}{M_X}\frac{\partial M_Y{}^*}{\partial k^*}\right)\end{array}\right] + \mu_1 = 0 \tag{23.1}$$

$$\frac{1}{\Delta}\frac{\partial M_Y{}^*}{\partial \tau^*}\times \left[\begin{array}{l}-\left(1+\frac{\gamma r_k k}{M_X}\right)X - V_b\psi\frac{1}{\Omega}\tau\left(\epsilon_X - \frac{\gamma}{M_X}p^w\frac{\partial M_X}{\partial k}\right) \\ + V_{b^*}^*(1-\psi)\tau^*\left(\epsilon_Y{}^*\frac{M_Y{}^*}{p^w M_X}-\frac{\gamma}{M_X}\frac{\partial M_Y{}^*}{\partial k^*}+\Delta\right)\end{array}\right] + \mu_2 = 0 \tag{23.2}$$

where $X \equiv \psi V_b \frac{1}{\Omega} - (1-\psi) V_{b^*}^*$. We first consider a case where both τ and τ^* are zeros. This is the free trade case as a Nash bargaining solution between the two countries. We can derive following proposition for free trade to be a Nash bargaining solution.

Proposition 1: Let's define Φ as $\Phi(\tau,\tau^*) = \frac{V_{b^*}^*}{V_b\frac{1}{\Omega}+V_{b^*}^*}$. If $\psi = \overline{\Phi}(\equiv \Phi(0,0))$, then the Nash bargaining outcome of tariff negotiation will have $\hat{\tau} = \hat{\tau^*} = 0$.

pf. With (0,0), the first order condition, $\mu_1 > 0, \mu_2 > 0$, holds. Evaluating the first order conditions, (23.1) and (23.2), at the $\hat{\tau} = \hat{\tau^*} = 0$, we have $X\cdot\left(1+\frac{\gamma r_k k}{M_X}\right) \le 0$, and $X\cdot\left(1+\frac{\gamma r_k k}{M_X}\right) \ge 0$. In order for both countries to reach the free trade Nash bargaining outcome, these two equations should be satisfied simultaneously. Since $1+\frac{\gamma r_k k}{M_X}$ is positive, these equations are fulfilled if and only if $X = 0$ or $\psi = \overline{\Phi}$. Therefore $\hat{\tau} = \hat{\tau^*} = 0$ if $\psi = \overline{\Phi}$. □

On the other hand, Nash bargaining equilibrium may occur along the

1) It is worthwhile to note that given perfect international capital mobility, the positive tariff rate for both countries can never be a Nash bargaining outcome.

vertical axis, OC, or along the horizontal axis, OD. Where it occurs depends on the negotiation power between home and foreign country; if home country has more negotiation power, that is if ψ is closer to 1, home country will obtain more gains from cooperation. On the other hand, if foreign has more power in tariff negotiation (i.e., ψ is close to 0), foreign country will try to obtain more trade gains.

This implies that if negotiation parameter, ψ, lies between 0 and $\overline{\Phi}$, the Nash bargaining solution will end up with free trade for home country and positive tariff for foreign country, that is, $\hat{\tau}=0$ and $\widehat{\tau^*}>0$. On the other hand, if ψ is a value between $\overline{\Phi}$ and 1, home country can lead the tariff negotiation and final Nash bargaining outcome will be $\hat{\tau}>0$ and $\widehat{\tau^*}=0$. Analyzing these, we derive following lemma that relates the value of $\psi\neq\overline{\Phi}$ to the Nash bargaining outcome.

lemma 1: Suppose that $\psi\neq\overline{\Phi}$. Given $V(0,0)>\overline{V}$ and $V^*(0,0)>\overline{V^*}$, if two countries negotiate cooperatively, they end up with the Nash bargaining solution, $(\hat{\tau},\ \widehat{\tau^*})$, such that

$$\hat{\tau}=\frac{\psi v_b\frac{1}{\Omega}-(1-\psi)v^*_{b^*}}{\psi V_b\frac{1}{\Omega}}\tau_N>0,\quad \widehat{\tau^*}=0\quad \text{if}\quad \psi\in(\Phi(0,0),1) \tag{24.1}$$

$$\widehat{\tau^*}=\frac{-\psi v_b\frac{1}{\Omega}+(1-\psi)v^*_{b^*}}{(1-\psi)V^*_{b^*}}\tau_N^*>0,\quad \hat{\tau}=0\quad \text{if}\quad \psi\in(0,\Phi(0,0)) \tag{24.2}$$

pf. In case of $\widehat{\tau^*}=0$, $\hat{\tau}>0$, the relevant first order conditions are $\mu_1=0$, $\mu_2\geq 0$. Rewriting these first order conditions, replacing $\widehat{\tau^*}=0$, we have

$$\frac{1}{\Delta}\frac{\partial M_X}{\partial\tau}p^w\left[\left(1+\frac{\gamma r_k k}{M_X}\right)X+v_b\psi\frac{1}{\Omega}\tau\left(\epsilon_X-\frac{\gamma}{M_X}p^w\frac{\partial M_X}{\partial k}+\Delta\right)\right]=0 \tag{25.1}$$

$$\frac{1}{\Delta}\frac{\partial M_Y^*}{\partial\tau^*}\left[-\left(1+\frac{\gamma r_k k}{M_X}\right)X-v_b\psi\frac{1}{\Omega}\tau\left(\epsilon_X-\frac{\gamma}{M_X}p^w\frac{\partial M_X}{\partial k}\right)\right]\leq 0 \tag{25.2}$$

We can derive $\hat{\tau}$ from Eq. (25.1), $\hat{\tau}\,|_{\hat{\tau}^*=0} = \dfrac{\psi v_b \dfrac{1}{\Omega} - (1-\psi)v^*_{b^*}}{\psi v_b \dfrac{1}{\Omega}}\tau_N$. From this, it can be shown that $\dfrac{\partial \hat{\tau}}{\partial \psi}\Big|_{\hat{\tau}^*=0} > 0$, meaning that $\hat{\tau}$ is strictly increasing function in ψ. According to Proposition 1, $\hat{\tau}=0$ at $\psi=\overline{\Phi}$. Therefore, $\hat{\tau}\,|_{\hat{\tau}^*=0} > 0$ if $\overline{\psi} < \psi < 1$. and $\hat{\tau}\,|_{\hat{\tau}^*=0}$ satisfies Eq. (25.2). The case in which $\hat{\tau}=0$ can be proven in similar way.□

As Eq. (24.1) and (24.2) indicate, the Nash bargaining tariff rates of each country, $\hat{\tau}$ and $\hat{\tau}^*$, depend on the initial Nash tariff rate and the weighted difference between the home and foreign country's marginal utility of income. For example, if $\psi v_b \dfrac{1}{\Omega} - (1-\psi)v^*_{b^*} > 0$, Nash bargaining tariff rate for the home country is positive and must have the value of between zero and τ_N. Therefore, it always the case that $\hat{\tau} < \tau_N$ and $\hat{\tau}^* < \tau_N{}^*$. The above proposition and lemma show that when the countries negotiate, they have an incentive for trade liberalization. And proposition 1 also show the conditions for having free trade as the negotiation outputs.

When capital moves perfectly and immediately between countries, we conclude that the Nash bargaining output must be either immediate movement to the free trade or immediate change from Nash tariff rate to the new tariff combination in which only one country imposes a positive and the other has a zero tariff rate.

Ⅳ. Imperfect Capital Mobility

1. Imperfect Capital Mobility and Welfare

Suppose two countries negotiate for mutual tariff rates for importing goods for two time periods, $t=1, 2$. Unlike the perfect capital mobility case, in this section, we assume that the capital market is imperfect in two senses. First, the adjustment of capital takes time to be relocated between countries; there is no legal barrier imposed on inflows or outflow of capital across countries. However, its process requires time and we assume that it takes one period to complete. Second, we also assume that the amount of capital that is in transition between countries is idle; it is unproductive in both countries.

This case consists of infinite number of time periods, which are indexed by variable t, $t=0,1,2,...\infty$. All relevant variables will be time-indexed by subscripts; for example, τ_i is the tariff rate imposed by the Home government at $t=i$. At time $t=0$, the governments are imposing their Nash tariffs, $\tau_0=\tau_N$, $\tau_0{}^*=\tau_N{}^*$, which are defined in the previous section, and are negotiating for cooperative tariff rates. We assume that the governments can set their tariffs twice. Subject to the negotiation, first when $t=1$ and then $t=2$. In other words, $(\tau_1, \tau_1{}^*)$ and $(\tau_2, \tau_2{}^*)$ are the results of the negotiation. In periods $t\geq 3$, the tariff rates remain at those at $t=2$; i.e., $(\tau_2, \tau_2{}^*)=(\hat{\tau}, \widehat{\tau^*})$.

The analysis can be simplified by noting that since the governments are required to maintain their tariff rates at $t\geq 3$ to be the same as those at $t=2$, as long as the time discount rates of the countries are not too high, the tariff rates $(\tau_2, \tau_2{}^*)$ are assumed to be chosen to be the same as those determined in the one-period case described in the previous section. Thus we can focus on the determination of $(\tau_1, \tau_1{}^*)$, and examine whether they will be chosen to be equal to $(\tau_2, \tau_2{}^*)$.

Given these conditions, suppose the initial tariff rate of $(\tau_N, \tau_N{}^*)$, the initial amount of capital inflow into the home country, k_0, and the initial world relative price of good X that clears both good and capital market, p_0^w. When new tariff rates, $(\tau_1, \tau_1{}^*)$, are in effect at the beginning of time 1, the amount of capital cannot respond immediately to clear the capital market due to the imperfect capital market. A change in tariff combinations triggers capital owners to reallocate their portfolios between countries. Assuming that the return on importing capital is determined by an importing country's return, the direction of capital flow as a result of new tariff rates depends on the domestic relative price for the foreign country.

When new tariff combination, $(\tau_1, \tau_1{}^*)$, is announced at the beginning of period 1, it causes the change in relative price of period 1. It creates the difference in returns on capital between countries so that gives capital owners an incentive to reallocate their capital from one country to another. Denoting the relation between capital and relative price at period 1 as γ_1, it can be written as following;

$$k_1 = k_1(p_1^w), \quad where \quad \gamma_1 = \frac{\partial k_1}{\partial p_1^w} < 0. \tag{26}$$

We assume that transfer of capital takes time but the financial cost is negligible. More specifically, suppose that an amount of capital k_1 is moved from foreign to home at the beginning of period 1, as a result of change in tariffs. Capital market is imperfect because this piece of capital will be non-productive in the entire period. It will arrive home country at the end of the period and is back to be productive at the beginning of period 2.

Therefore, the amount of capital for home country in period 1 ($\overline{K_1}$) is unchanged from its initial capital stock.($\overline{K_1} = \overline{K_0}$). On the other hand, for foreign country, the amount of capital used in period 1 ($\overline{K_1}*$) is its initial capital stock minus the amount of capital that is on transfer from foreign to home country ($\overline{K_1}* = \overline{K_0}* - k_1$).

Thus the owner of the moving capital will lose income in period 1, but will be able to earn the market rental rate starting from period 2. In other words, the cost of capital from one country to another is the forgone income in the period it moves. As a result, the rental rates in the two countries may not be equal.

Assuming such imperfect capital market, the first period indirect utility function for home and foreign country can be written as following;

$$v_1\left(p_1^w, \tau_1, k_0; b_1\right) = \underset{C_{X1},\, C_{Y1}}{Max}\left\{u_1(C_{X1}, C_{Y1}) : p_1^w(1+\tau_1)C_{X1} + C_{Y1} = f_1(\overline{K_0}, \overline{L_0}) + b_1\right\} \tag{27}$$

$$where \quad b_1 \equiv \tau_1 p_1^w C_{X1} - r_1(k_0)k_0$$

$$v_1*\left(p_1^w, \tau_1*, k_1; b_1*\right)$$

$$= \underset{C_{X1}*,\, C_{Y1}*}{Max}\left\{u_1*(C_{X1}*, C_{Y1}*) : p_1^w C_{X1}* + (1+\tau_1*)C_{Y1}* = p_1^w f_1*(\overline{K_0}* - k_1, \overline{L_0}) + b_1*\right\} \tag{28}$$

$$where \quad b_1* \equiv \tau_1* M_{Y1}* + r_1(k_0)k_0$$

As shown in Eq. (27) and (28), the first period indirect utility functions are asymmetric. That is, the first period indirect utility function is a function of capital movement (k_1), while that for home country is not affected by k_1. It is due to sluggish capital mobility we assume in the model; foreign country's production of good X depends on the amount of capital available at period 1, however, home country's production of good Y is fixed during the first period.

Assuming government's transfer revenue goes back to consumers, the import demand function for home and foreign country at period 1 are;

$$M_{X1}(\equiv C_{X1}) = M_{X1}(p_1^w, \tau_1, k_0), \quad where \frac{\partial M_{X1}}{\partial p_1^w} < 0, \ \frac{\partial M_{X1}}{\partial \tau_1} < 0, \tag{29}$$

$$M_{Y1}^*(\equiv C_{Y1}^*) = M_{Y1}^*(p_1{}^w, \tau_1^*, k_1), \ where \ \frac{\partial M_{Y1}^*}{\partial p_1^w} > 0, \ \frac{\partial M_{Y1}^*}{\partial \tau_1^*} < 0, \ \frac{\partial M_{Y1}^*}{\partial k_1} < 0. \tag{30}$$

The good market clearing condition for period 1 is,

$$M_{Y1}^*(p_1^w, \tau_1^*, k_1) = p_1^w M_{X1}(p_1^w, \tau_{1,} k_0) + r_1(k_0) k_{0,} \quad where \ \gamma_1 = \frac{\partial k_1}{\partial p_1^w} < 0. \tag{31}$$

From Eq. (31), we have $p_1^w = p_1^w(\tau_{1,} \tau_1^*)$. Totally differentiate $p_1^w(\cdot)$ to gain

$$dp_1^w = -\frac{1}{\Delta_1}\frac{1}{M_{X1}} p_1^w \frac{\partial M_{X1}}{\partial \tau_1} d\tau_1 + \frac{1}{\Delta_1}\frac{1}{M_{X1}}\frac{\partial M_{Y1}^*}{\partial \tau_1^*} d\tau_1^* \tag{32}$$

$$where \ \Delta_1 \equiv 1 - \epsilon_{X1} - \epsilon_{Y1}^* \frac{M_{Y1}^*}{p_1^w M_{X1}} - \frac{\gamma_1}{M_{X1}}\frac{\partial M_{Y1}^*}{\partial k_1}.$$

where $\frac{\partial p_1^w}{\partial \tau_1} < 0$, $\frac{\partial p_1^w}{\partial \tau_1^*} > 0$. Arranging Eq. (26), (32) and $p_1^w = p_1^w(\tau_{1,} \tau_1^*)$, k_1 also can be expressed as a function of tariff combination in period 1, $(\tau_{1,}\ \tau_1^*)$.

$$k_1 = k_1(\tau_1, \tau_1^*) = k_1(p_1^w(\tau_{1,} \tau_1^*)) \quad where \quad dk_1 = \gamma_1 \frac{\partial p_1^w}{\partial \tau_1} d\tau_1 + \gamma_1 \frac{\partial p_1^w}{\partial \tau_1^*} d\tau_1^*. \tag{33}$$

Government transfer revenue function of each country, b_1 and b_1^*, are functions of tariff combination in period 1, that is

$$b_1 = b_1(\tau_1, \tau_1^*) = \tau_1 p_1^w(\tau_1, \tau_1^*) M_{X1}\left(p_1^w(\tau_1, \tau_1^*), \tau_1, k_0\right) - r_1(k_0)k_0 \tag{34.1}$$

$$b_1^* = b_1^*(\tau_1, \tau_1^*) = \tau_1^* M_{Y1}^*\left(p_1^w(\tau_1, \tau_1^*), \tau_1^*, k_1(\tau_1, \tau_1^*)\right) + r_1(k_0)k_0 \tag{34.2}$$

Plugging $p_1^w(\cdot)$, b_1 and b_1^* into indirect utility function, we can describe the indirect utility functions V_1, V_1^* as functions of τ_1 and τ_1^*. Those are

$$V_1(\tau_1, \tau_1^*) = v_1\left(p_1^w(\tau_1, \tau_1^*), \tau_1, k_0, b_1(\tau_1, \tau_1^*)\right), \tag{35.1}$$

$$V_1^*(\tau_1, \tau_1^*) = v_1^*\left(p_1^w(\tau_1, \tau_1^*), \tau_1^*, k_1(p_1^w(\tau_1, \tau_1^*)), b_1^*(\tau_1, \tau_1^*)\right). \tag{35.2}$$

Totally differentiating Eq. (35.1) and (35.2), we have,

$$dV_1 = -\frac{\partial v_1}{\partial b_1}\cdot\left[M_{X1}\{1+\tau_1(\epsilon_{X1}+\Delta_1)\}\frac{\partial p_1^w}{\partial \tau_1}d\tau_1 + M_{X1}(1+\tau_1\epsilon_{X1})\frac{\partial p_1^w}{\partial \tau_1^*}d\tau_1^*\right], \tag{36.1}$$

$$dV_1^* = \frac{\partial v_1^*}{\partial b_1^*}\cdot\left[\begin{array}{l} M_{X1}\left\{1+\tau_1^*(1-\epsilon_{X1}) + \dfrac{\gamma_1}{M_{X1}}p_1^w\dfrac{\partial f_1^*}{\partial k_1}\right\}\dfrac{\partial p_1^w}{\partial \tau_1^*}d\tau_1^* \\ + M_{X1}\left\{1+\tau_1^*\epsilon_{Y1}^*\dfrac{M_{Y1}^*}{p_1^w M_{X1}} + \dfrac{\gamma_1}{M_{X1}}\left(p_1^w\dfrac{\partial f_1^*}{\partial k_1} + \tau_1^*\dfrac{\partial M_{Y1}^*}{\partial k_1}\right)\right\}\dfrac{\partial p_1^w}{\partial \tau_1}d\tau_1 \end{array}\right]. \tag{36.2}$$

From the equations above, we can derive the second proposition.

Proposition 2; 1) At period 1, country's welfare is positively related to its own tariff rates. That is,

$$\left(\frac{dV_1}{d\tau_1}\right)_{\tau_1=0} = -\frac{\partial v_1}{\partial b_1}M_{X1}\frac{\partial p_1^w}{\partial \tau_1} > 0 \tag{37.1}$$

$$\left(\frac{dV_1^*}{d\tau_1^*}\right)_{\tau_1^*=0} = \frac{\partial v_1^*}{\partial b_1^*}M_{X1}\left(1+\frac{\gamma_1}{M_{X1}}p_1^w\frac{\partial f_1^*}{\partial k_1}\right)\frac{\partial p_1^w}{\partial \tau_1^*} > 0 \tag{37.2}$$

2) On the other hand, it is negatively related to other country's tariff rates.

$$\frac{dV_1}{d\tau_1^*} = -\frac{\partial v_1}{\partial b_1}M_{X1}(1+\tau_1\epsilon_{X1})\frac{\partial p_1^w}{\partial \tau_1^*} < 0 \tag{38.1}$$

$$\frac{dV_1^*}{d\tau_1} = \frac{\partial v_1^*}{\partial b_1^*}M_{X1}\left\{1+\tau_1^*\epsilon_{Y1}^*\frac{M_{Y1}^*}{p_1^w M_{X1}} + \frac{\gamma_1}{M_{X1}}\left(p_1^w\frac{\partial f_1^*}{\partial k_1} + \tau_1^*\frac{\partial M_{Y1}^*}{\partial k_1}\right)\right\}\frac{\partial p_1^w}{\partial \tau_1} < 0 \tag{38.2}$$

The first property of Proposition 2 implies that a country has an incentive to increase its own tariff rate, if it concerns only the first period welfare. On the other hand, country's welfare is inversely related to the other country's tariff.

We now move to the indirect utility function for the second period. Since it takes one period for moving capital between countries, decision on tariff rates, (τ_1, τ_1*), at period 1 affects countries' welfare and market equilibrium at period 2. Again, when the second period's tariff rates, (τ_2, τ_2*), are announced, capital owners would like to shift capital from home to foreign country. Let us denote the amount of capital that shifts from home to foreign country at period 2 as k_2. k_2 is unproductive during period 2 and begin to be used to produce outputs starting from period 3.

In this paper, we assume two periods model. It is two periods model in the sense that tariff changes only period 1 and 2 and the second period tariff combination lasts thereafter. Assuming time discount rates for both home and foreign country are big enough (i.e. closer to 1), it implies the second period tariff rates will be the Nash bargaining tariff combination that we looked at with perfect capital mobility. Given this fact, tariff rate that each country has to choose is the only first period's tariff rate. Also, the total amount of capital moving from foreign to home country is predetermined. We call the total amount of capital as k_L. Then, the amount of capital that moves in period 2 is equal to $k_2 = k_L - k_1$. Therefore, the amount of capital for home and foreign country that is used to produce output in period 2 can be written as following;

$$\overline{K_2} = \overline{K_1} + k_1 = \overline{K_0} + k_1, \tag{39.1}$$

$$\overline{K_2}* = \overline{K_1}* - k_2 = \overline{K_0}* - (k_1 + k_2) = \overline{K_0}* - k_L. \tag{39.2}$$

Using Eq. (39.1) and (39.2), indirect utility functions for the second period are;

$$v_2\left(p_2^w, \tau_2, k_1; b_2\right) = \underset{C_{X2},\, C_{Y2}}{Max}\left\{u_2(C_{X2}, C_{Y2}) : p_2^w(1+\tau_2)C_{X2} + C_{Y2} = f_2(\overline{K_0} + k_1, \overline{L_0}) + b_2\right\} \tag{40.1}$$

$$where \quad b_2 \equiv \tau_2 p_2^w C_{X2} - r_2(k_1)k_1$$

$$v_2*\left(p_2^w, \tau_2*, k_L; b_2*\right)$$

$$= \underset{C_{X2}*,\, C_{Y2}*}{Max}\left\{u_2*(C_{X2}*, C_{Y2}*) : p_2^w C_{X2}* + (1+\tau_2*)C_{Y2}* = p_2^w f_2*(\overline{K_0}* - k_L, \overline{L_0}) + b_2*\right\} \tag{40.2}$$

$$where \quad b_2^* \equiv \tau_2^* M_{Y2}^* + r_2(k_1)k_1$$

and import demand functions for home and foreign country are (See Appendix for formal derivation);

$$M_{X2}(\equiv C_{X2}) = M_{X2}(p_2^w, \tau_2, k_1), \quad where \ \frac{\partial M_{X2}}{\partial p_2^w} < 0, \ \frac{\partial M_{X2}}{\partial k_1} > 0, \tag{41.1}$$

$$M_{Y2}^*(\equiv C_{Y2}^*) = M_{Y2}^*(p_2^w, \tau_2^*, k_1), \quad where \ \frac{\partial M_{Y2}^*}{\partial p_2^w} > 0, \ \frac{\partial M_{Y2}^*}{\partial k_1} > 0. \tag{41.2}$$

Movement of capital at period 1 has positive relation with import demand for both home and foreign country. In case of home country, movement of capital (k_1) causes the increase in capital stock and decrease in return on capital. It means the unit payment for renting capital decreases and it can leads increase in income so that increase in demand for importing goods. On the other hand, as a result of movement of capital, it brings increase in total rent payment, $r_2 k_1 + r_2$, and such increase in payment makes import demand to rise.

Market equilibrium condition for the second period ;

$$M_{Y2}^*(p_2^w, \tau_2^*, k_1) = p_2^w M_{X2}(p_2^w, \tau_{2,} k_1) + r_2(k_1) k_1. \tag{42}$$

Since the second period tariff combination is set to be the long run (i.e. perfect capital market) Nash bargaining tariff outcome ($\tau_2 = \tau_L$, $\tau_2^* = \tau_L^*$), the second period's relative price can be expressed in terms of capital mobility at period 1, $p_2^w = p_2^w(k_1)$. Totally differentiating $p_2^w(\cdot)$, we can get gain,

$$\frac{dp_2^w}{dk_1} = -\frac{1}{\Delta_2}\frac{1}{M_{X2}}\left\{\left(p_2^w \frac{\partial M_{X2}}{\partial k_1} - \frac{\partial M_{Y2}^*}{\partial k_1}\right) + r_2' k_1 + r_2\right\} > 0, \tag{43}$$

$$where \ \Delta_2 \equiv 1 - \epsilon_{X2} - \epsilon_{Y2}^* \frac{M_{Y2}^*}{p_2^w M_{X2}} < 0,$$

where the parenthesis in Eq. (43) has positive value. (See Appendix) Eq. (43) reveals that increase in capital mobility in period 1 rises the relative price in period 2. The first term inside parenthesis represents the change in total payment for foreign exporting goods and the rest is the change in total payment for capital inflow. That is, the second term is the direct impact of capital movement, while the first term shows its indirect impact due to change in income that results from capital movement. The direct impact always dominates the indirect impact so that $dp_2^w/dk_1 > 0$.

Transfer revenue for second periods can be written in terms of k_1,

$$b_2(k_1) \equiv \tau_2 p_2^w(k_1) C_{X2}\big(p_2^w(k_1), \tau_2, k_1\big) - r_1(k_1)k_1, \tag{44.1}$$

$$b_2^*(k_1) \equiv \tau_2^* M_{Y2}^*\big(p_2^w(k_1), \tau_2^*, k_1\big) + r_2(k_1)k_1. \tag{44.2}$$

Considering Eqs. (43), (44.1), and (44.2), we can describe the indirect utility function V_2, V_2^* as functions of k_1;

$$V_2(k_1) = v_2\big(p_2^w(k_1), \tau_2, k_1; b_2(k_1)\big), \tag{45.1}$$

$$V_2^*(k_1) = v_2^*\big(p_2^w(k_1), \tau_2^*, k_L; b_2^*(k_1)\big). \tag{45.2}$$

Since k_1 depends on the first period decision on tariffs, (τ_1, τ_1^*) has an impact on second period's welfare level through capital mobility in period 1, k_1. Differentiating Eq. (45.1) and (45.2), we get Eq. (46.1) and (46.2).

$$dV_2 = \frac{\partial v_2}{\partial b_2} \cdot \left[-(1+\tau_2 \epsilon_{X2}) M_{X2} \frac{dp_2^w}{dk_1} + \left(\tau_2 p_2^w \frac{\partial M_{X2}}{\partial k_1} - r_2' k_1 \right) \right] dk_1, \tag{46.1}$$

$$dV_2^* = \frac{\partial v_2^*}{\partial b_2^*} \cdot \left[M_{X2} \frac{dp_2^w}{dk_1} \left(1 + \tau_2^* \epsilon_{Y2}^* \frac{M_{Y2}^*}{p_2^w M_{X2}} \right) + \left(\tau_2^* \frac{\partial M_{Y2}^*}{\partial k_1} + r_2' k_1 + r_2 \right) \right] dk_1, \tag{46.2}$$

$$where \;\; \Delta_2 \equiv 1 - \epsilon_{X2} - \epsilon_{Y2}^* \frac{M_{Y2}^*}{p_2^w M_{X2}}.$$

Proposition 3: 1) Capital mobility from home to foreign country in period 1 has positively related to the second period's welfare for foreign country.

$$\frac{dV_2^*}{dk_1} > 0 \tag{47.1}$$

2) Impact of capital mobility from home to foreign country on the second period's welfare for home country is ambiguous. However, at $\tau_2 = 0$, following property holds;

$$\begin{cases} \left(\dfrac{dV_2}{dk_1}\right)_{\tau_2=0} < 0 & \text{if } |r_2' k_1| < M_{X2}\dfrac{dp_2^w}{dk_1} \\ \left(\dfrac{dV_2}{dk_1}\right)_{\tau_2=0} > 0 & \text{if } |r_2' k_1| > M_{X2}\dfrac{dp_2^w}{dk_1} \end{cases} \tag{47.2}$$

Intuitively, Proposition 3 (1) is obvious. Increase in capital movement in period 1 (k_1) rises the world relative price, which improves the terms of trade for foreign country who exports good X. In addition, increase in k_1 expands the returns on capital in period 2, increasing foreign welfare in period 2. Proposition 3 (2) is about impact of change in k_1 on home country welfare at the second period. It can either positive and negative impact. However, evaluating at $\tau_2 = 0$, that is when the impact of the change in k_1 on tariff revenue is ignored, if $|r_2' k_1| > M_{X2}\dfrac{dp_2^w}{dk_1}$, the second period welfare for home country is positively related to k_1 and if $|r_2' k_1| < M_{X2}\dfrac{dp_2^w}{dk_1}$, the opposite holds. Combining Proposition 3 and Eq. (33), we have the following lemma.

lemma 2: 1) There exists positive relation between the first period home country's tariff and the second period foreign country welfare, and negative relation between the first period foreign country tariff and its own second period welfare.

$$\frac{dV_2^*}{d\tau_1} > 0, \quad \frac{dV_2^*}{d\tau_1^*} < 0 \tag{48}$$

2) The relation between the first period tariffs and the second period welfare for home country is ambiguous. However, when evaluated at $\tau_2 = 0$, following relations hold;

$$\begin{cases} \left(\dfrac{dV_2}{d\tau_1}\right)_{\tau_2=0} < 0, \left(\dfrac{dV_2}{d\tau_1^*}\right)_{\tau_2=0} > 0 & \text{if } |r_2' k_1| < M_{X2}\dfrac{dp_2^w}{dk_1} \\ \left(\dfrac{dV_2}{d\tau_1}\right)_{\tau_2=0} > 0, \left(\dfrac{dV_2}{d\tau_1^*}\right)_{\tau_2=0} < 0 & \text{if } |r_2' k_1| > M_{X2}\dfrac{dp_2^w}{dk_1} \end{cases} \tag{49}$$

We investigate the direction and change in home and foreign country's welfare for the first and the second period. Decision on tariff rates at period 1 triggers the capital movement between countries. However, due to the imperfect capital market, the tariff combination in period 1 affects the second period's market equilibrium. Therefore, home and foreign country select its own first period tariff rate, considering welfare impact for next two periods.

2. Nash Bargaining Tariff Rates

Suppose two countries start to negotiate the tariff rates cooperatively. We simplify the model by assuming they have only two periods to adjust their tariff rates and the tariff rates they impose at the second period remain unchanged after that period. If the discount factors for each country are significantly big enough, the two countries will have Nash bargaining tariff rates with perfect capital mobility as the last period tariff rates($\tau_2 = \tau_L$, $\tau_2{}^* = \tau_L{}^*$).

We now consider the constrained Nash bargaining tariff rates where τ_1 and $\tau_1{}^*$ are subjected to be non-negative values. Given the initial and second period tariff combination, the maximization problem is to maximize the objective function by choosing the first period tariff rates, subject to the condition that no country becomes worse off and there is no negative tariff or import subsidy;

$$\begin{aligned} &\underset{\tau_1, \tau_1{}^*}{\mathrm{Max}} \left(W - \overline{W}\right)^{\psi} \left(W^* - \overline{W}^*\right)^{1-\psi} \\ &s.t. \quad W > \overline{W}, \quad W^* > \overline{W}^*, \quad \tau_1 \geq 0, \quad \tau_1{}^* \geq 0, \end{aligned} \tag{50}$$

where

$$W = V_1 + \delta V_2, \;\; W^* = V_1{}^* + \delta^* V_2{}^*, \;\; \overline{W} = \overline{V_1} + \delta \overline{V_2}, \;\; and \;\; \overline{W}^* = \overline{V_1}{}^* + \delta^* \overline{V_2}{}^*. \tag{51}$$

W and W^* are time discounted indirect utility function for the home and foreign country for two periods. Since V_t and $V_t{}^*$ are function of τ_1 and $\tau_1{}^*$, we can write

$$W = W(\tau_1, \tau_1{}^*; \tau_0, \tau_0{}^*, \tau_2, \tau_2{}^*) \tag{52.1}$$

$$W^* = W^*(\tau_1, \tau_1{}^*; \tau_0, \tau_0{}^*, \tau_2, \tau_2{}^*) \tag{52.2}$$

The first order conditions for this maximization problem are

$$\psi\frac{\partial W}{\partial\tau_1}\frac{1}{\Phi}+(1-\psi)\frac{\partial W^*}{\partial\tau_1}=0, \tag{53.1}$$

$$\psi\frac{\partial W}{\partial{\tau_1}^*}\frac{1}{\Phi}+(1-\psi)\frac{\partial W^*}{\partial{\tau_1}^*}=0. \tag{53.2}$$

Eq. (53.1) and (53.2) allow us to have τ_1 and ${\tau_1}^*$, that satisfy two equations simultaneously. Total differentiation of W and W^* are[2)]

$$\begin{aligned} dW\cdot\frac{1}{v_b}= &\frac{1}{\Delta_1}p_1^w\frac{\partial M_{X1}}{\partial\tau_1}\{1+\tau_1(\epsilon_{X1}+\Delta_1)\}d\tau_1-\frac{1}{\Delta_1}\frac{\partial M_{Y1}}{\partial{\tau_1}^*}(1+\tau_1\epsilon_{X1})d{\tau_1}^* \\ &+\delta\left[\begin{array}{l}\frac{1}{\Delta_2}(1+\tau_2\epsilon_{X2})\left\{p_2^w\frac{\partial M_{X2}}{\partial k_1}-\frac{\partial {M_{Y2}}^*}{\partial k_1}+{r_2}'k_1+r_2\right\} \\ +\tau_2p_2^w\frac{\partial M_{X2}}{\partial k_1}-{r_2}'k_1\end{array}\right]\left(\frac{\partial k_1}{\partial\tau_1}d\tau_1+\frac{\partial k_1}{\partial{\tau_1}^*}d{\tau_1}^*\right) \end{aligned} \tag{54.1}$$

$$\begin{aligned} dW^*\cdot\frac{1}{v^*_{b^*}}=&-\frac{1}{\Delta_1}p_1^w\frac{\partial M_{X1}}{\partial\tau_1}\left\{1+{\tau_1}^*\epsilon^*_{Y1}\frac{{M_{Y1}}^*}{p_1^wM_{X1}}+\frac{\gamma_1}{M_{X1}}\left(p_1^w\frac{\partial {f_1}^*}{\partial k_1}+{\tau_1}^*\frac{\partial {M_{Y1}}^*}{\partial k_1}\right)\right\}d\tau_1 \\ &+\frac{1}{\Delta_1}\frac{\partial {M_{Y1}}^*}{\partial{\tau_1}^*}\left\{1+{\tau_1}^*(1-\epsilon_{X1})+\frac{\gamma_1}{M_{X1}}p_1^w\frac{\partial {f_1}^*}{\partial k_1}\right\}d{\tau_1}^* \\ &-\delta^*\left[\begin{array}{l}\frac{1}{\Delta_2}\left(1+{\tau_2}^*\epsilon_{Y2}{}^*\frac{{M_{Y2}}^*}{p_2^wM_{X2}}\right)\left(p_2^w\frac{\partial M_{X2}}{\partial k_1}-\frac{\partial {M_{Y2}}^*}{\partial k_1}+{r_2}'k_1+r_2\right) \\ -\left({\tau_2}^*p_2^w\frac{\partial {M_{Y2}}^*}{\partial k_1}+{r_2}'k_1+r_2\right)\end{array}\right]\left(\frac{\partial k_1}{\partial\tau_1}d\tau_1+\frac{\partial k_1}{\partial{\tau_1}^*}d{\tau_1}^*\right) \end{aligned} \tag{54.2}$$

Solving the first order conditions, the Nash bargaining tariff rates, $\widetilde{\tau_1}$ and $\widetilde{\tau_1}^*$, are

$$\widetilde{\tau_1}=-\frac{\Lambda-Z\left\{(\epsilon_{X1}-1)\dfrac{\frac{\partial k_1}{\partial\tau_1}}{p_1^w\frac{\partial M_{X1}}{\partial\tau_1}}+(\epsilon_{X1}-1+\Delta_1)\dfrac{\frac{\partial k_1}{\partial{\tau_1}^*}}{\frac{\partial {M_{Y1}}^*}{\partial{\tau_1}^*}}\right\}}{\psi v_b} \tag{55.1}$$

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2) We assume that $\dfrac{\partial v_1}{\partial b_1}=\dfrac{\partial v_2}{\partial b_2}=v_b$, $\dfrac{\partial {v_1}^*}{\partial {b_1}^*}=\dfrac{\partial {v_2}^*}{\partial {b_2}^*}=v^*_{b^*}$.

$$\tilde{\tau}_1^* = \frac{\Lambda - Z\left\{\epsilon_{X1}\dfrac{\dfrac{\partial k_1}{\partial \tau_1}}{p_1^w\dfrac{\partial M_{X1}}{\partial \tau_1}} + (\epsilon_{X1}+\Delta_1)\dfrac{\dfrac{\partial k_1}{\partial \tau_1^*}}{\dfrac{\partial M_{Y1}^*}{\partial \tau_1^*}}\right\}}{(1-\psi)\,v_{b^*}^*\Phi} \tag{55.2}$$

$$\text{where} \quad \Lambda \equiv \psi v_b - (1-\psi)v_{b^*}^*\Phi\left(1+p_1^w\frac{\gamma_1}{M_{X1}}\frac{\partial f_1^*}{\partial k_1}\right), \tag{55.3}$$

$$\text{and } \; Z \equiv \psi\delta\frac{dV_2}{dk_1} + (1-\psi)\,\delta^*\frac{dV_2^*}{dk_1}\Phi. \tag{55.4}$$

The Nash bargaining tariff rates for the home and foreign country in (55.1) and (55.2) are the contract curve that is driven from two-period, time-discounted welfare functions for home and foreign country. The value of τ_1, τ_1^* can be positive, zero or negative, depending on the parameter value of ψ.

Denote ψ_α as the threshold value of ψ that forces home country to choose a tariff rate of $\tau_1=0$. The corresponding tariff rate chosen by the foreign country is defined as $\overline{\tau_1}^*$. From Eq. (55.2), $\overline{\tau_1}^*$ can be written as

$$\overline{\tau_1}^* = \frac{-Z\cdot\left(\dfrac{\dfrac{\partial k_1}{\partial \tau_1}}{p_1^w\dfrac{\partial M_{X1}}{\partial \tau_1}} + \dfrac{\dfrac{\partial k_1}{\partial \tau_1^*}}{\dfrac{\partial M_{Y1}^*}{\partial \tau_1^*}}\right)}{(1-\psi)\,v_{b^*}^*\Phi} \tag{56.1}$$

Similarly, suppose the case in which foreign country has no tariff as a result of tariff negotiation and let the corresponding value of ψ and τ_1 as ψ_β and $\overline{\tau_1}$. The home country tariff rate along with ψ_β and $\tau_1^*=0$ is

$$\overline{\tau_1} = \frac{-Z\cdot\left(\dfrac{\dfrac{\partial k_1}{\partial \tau_1}}{p_1^w\dfrac{\partial M_{X1}}{\partial \tau_1}} + \dfrac{\dfrac{\partial k_1}{\partial \tau_1^*}}{\dfrac{\partial M_{Y1}^*}{\partial \tau_1^*}}\right)}{\psi v_b}. \tag{56.2}$$

From (56.1) and (56.2), $\overline{\tau_1}^*$ and $\overline{\tau_1}$ have the same sign. Since $\frac{\partial W}{\partial \psi} > 0$ and $\frac{\partial W^*}{\partial \psi} < 0$, if $\overline{\tau_1}$ is positive then $\overline{\tau_1}^*$ has to be positive, and if $\overline{\tau_1}$ is negative then $\overline{\tau_1}^*$ has to be negative. That is, the efficiency locus that tracks down the Nash bargaining tariff combination (τ_1, τ_1^*) is negatively sloped. In this paper, we drop the case where both τ_1 and τ_1^* are negative. Then the efficiency locus in Eq. (56.1) and (56.2) can be depicted as a line that goes through the first quadrant of $\tau_1 - \tau_1^*$ plane. Also the fact that the negatively sloped efficiency locus along with (55.1) and (55.2) implies that $\psi_\alpha < \psi_\beta$ when $\overline{\tau_1}$ and $\overline{\tau_1}^*$ are both positive, $\psi_\alpha = \psi_\beta$ when $\overline{\tau_1} = \overline{\tau_1}^* = 0$.

Now we turn our attention to the Nash bargaining tariff combination for the first period, given the initial and the second period (long run) tariff combination. We consider that the second period tariff combination is the same as the Nash bargaining tariff combination under the perfect capital market. According to lemma 1, when $V(0,0) \geq \overline{V}$, $V^*(0,0) \geq \overline{V}^*$, there are three possible Nash bargaining solutions we can consider;

Case A. both countries has zero tariffs, if $\psi = \hat{\psi}$

Case B. home country imposes positive tariff, while foreign has free trade, if $\psi > \hat{\psi}$

Case C. home country has no tariff, while foreign country imposes positive tariff, if $\psi < \hat{\psi}$

Depending on the value of ψ, at least one country has free trade. In the model, the Nash bargaining outcome under the perfect capital market will be the tariff combination both countries impose since we assume that the second period is the last period of tariff adjustment and trade between the countries last infinitely thereafter with the second period tariff combination.

We investigate what will be the first period tariff combination and how tariffs adjust during the first and second period. We focus on the case where both countries has zero tariffs (Case A) and the case where only home country imposes positive tariff (Case B). The last case, Case C, is simply opposite to Case C so that we skip to prove it.

Figure 2~11 shows possible tariff adjustment process. In the diagram, W and W^* are the iso-welfare curve of home and foreign country, respectively. And point $(\tau_N, \tau_N{}^*)$ is the initial value of the tariff rates, which is the Nash equilibrium with the countries choosing their tariff rates in a non-cooperative way.[3] The diagram also shows the contract curve between the countries, which is the locus of the tangency points between the home country's iso-welfare curve and foreign country's iso-welfare curve.

It is well-known that the solution to the bargaining problem in Eq. (50) is represented by a point on the contract curve. To interpret the solution, we treat ψ as a parameter. A change in ψ will lead to a shift in the equilibrium point. In particular, since ψ is a measure of home country's bargaining power, an increase in ψ will imply that the equilibrium point will shift along the contract curve toward point which corresponds to a larger value in τ_1 and smaller value in $\tau_1{}^*$(i.e., with home country's welfare rising but foreign country's welfare decreasing).

Case A. $\psi=\hat{\psi}$

There exists $\hat{\psi}\in(0,1)$ that makes both countries reach complete free trade in the long run. Therefore, assuming that the negotiation power factor home country is $\psi=\hat{\psi}$, the long-run welfare maximizing tariff rates are free trade for both countries, i.e., $\tau_2=\tau_2{}^*=0$ in this model. Given this second period tariff combination, there are several possible efficiency loci that we can consider in tracing down the first period Nash bargaining tariff combination. Figure 2 to 6 show different possible case, all with free trade by both countries in the long-run.

Case A-1: $\psi=\hat{\psi}$, $\psi_\beta>1>0>\psi_\alpha$

Line A in Figure 2 is an example in which $\psi_\beta>1>0>\psi_\alpha$. The first period tariff combination occurs at a point a if $\hat{\psi}=0$ at which all negotiation gains go to the foreign country and occurs at point a' if $\hat{\psi}=1$, where the home country takes all gains from tariff negotiation. For ψ that is between 0 and 1, the first period Nash bargaining outcome happens along the line segment aa'. In this case, Figure 2 shows that the first period Nash

3) It is worthwhile to note that the iso-welfare curve do not necessarily have the zero slope for W and infinite slope for $\overline{W^*}$ because the Nash equilibrium is obtained by having each country maximizing its long-run utility function, not function W and $\overline{W^*}$.

bargaining tariff rates are positive for both the home and foreign country. That is, rather than moving to free trade immediately, the two countries take gradual steps in tariff adjustment.

Case A-2: $\psi = \hat{\psi}$, $\psi_\beta > 1 > \psi_\alpha > 0$

Secondly, we can consider a case where $\psi_\beta > 1 > \psi_\alpha > 0$. Line B in Figure 3 is an efficiency locus for this case. The first period tariff rates occur along the line segment *(b,b′]* if $\hat{\psi} \in (\psi_\alpha, 1]$. On the other hands, only the foreign country imposes positive tariff on importing goods, while the home country has free trade at the first period if $\hat{\psi} \in [0, \psi_\alpha]$. It is a point on the line segment $\overline{b\overline{\tau}_1^*}$. Either $\hat{\psi} \in (\psi_\alpha, 1]$ or $\hat{\psi} \in [0, \psi_\alpha]$, immediate tariff adjustment toward its long run tariff combination is never observed.

Case A-3: $\psi = \hat{\psi}$, $1 > \psi_\beta > 0 > \psi_\alpha$

Line C in Figure 4 is the opposite case of line B, which happens in case $1 > \psi_\beta > 0 > \psi_\alpha$. As opposed to the previous case, home country always imposes positive tariff for all value $\hat{\psi} \in [0, 1]$, while foreign country imposes positive tariff if $\hat{\psi} \in [0, \psi_\beta]$ and free trade if $\hat{\psi} \in [\psi_\beta, 1]$. Nash bargaining solution at the first period will happen along $[c', \overline{\tau}_1]$ for $\hat{\psi} \in [\psi_\beta, 1]$ and $[c, c']$ for $\hat{\psi} \in [0, \psi_\beta]$.

Case A-4: $\psi = \hat{\psi}$, $1 > \psi_\beta > \psi_\alpha > 0$

Lastly, line D in Figure 5 displays the case when $1 > \psi_\beta > \psi_\alpha > 0$. It is like a combination of case A-2 and A-3. Depending on the value of, the first period tariff rate may turn out to be positive or free trade for home and foreign country; the Nash bargaining solution occurs along $[d, \overline{\tau}_1{}^*]$ if $\hat{\psi} \in [0, \psi_\alpha]$, along (d, d') if $\hat{\psi} \in (\psi_\alpha, \psi_\beta)$, along $[d', \overline{\tau}_1]$ if $\hat{\psi} \in [\psi_\beta, 1]$.

Case A-5: $\psi_\alpha \geq \psi_\beta$

In this case, as Figure 6 shows, the contract curve is below(for $\psi_\alpha > \psi_\beta$) or cuts(for $\psi_\alpha = \psi_\beta$) the origin. Given the constraint that $\tau_1 \geq 0$ and $\tau_1{}^* \geq 0$, possible solution for the bargaining problem can be represented by part of the vertical axis, $\overline{\tau_1}^* 0$, plus the part of the horizontal axis, $0\overline{\tau_1}$. Therefore at least one country imposes free trade at the first period and both country move to free trade at the first period is possible to happen.

Case B $\psi = \tilde{\psi} > \hat{\psi}$

Given $W(0,0) \geq \overline{W}$ and $W^*(0,0) \geq \overline{W}^*$, if a given parameter ψ is bigger than $\hat{\psi}$, the long run welfare maximization tariff for the home country is positive and that for the foreign country is free trade. Denote the positive long run tariff rate that home country imposes on importing goods at time 2 as $\bar{\tau}$ so that $\tau_2 = \bar{\tau}$ and $\tau_2^* = 0$. Possible tariff adjustment paths are analyzed in Fig. 7~Fig. 11.

Case B-1: $\psi = \tilde{\psi} > \hat{\psi}$, $\psi_\beta > 1 > 0 > \psi_\alpha$

Contract curve in Figure 7 shows the case where the efficiency locus goes through point a and a', which happens if $\psi_\alpha < 0$ and $\psi_\beta > 1$. For any $\tilde{\psi} > \hat{\psi}$, Nash bargaining tariff combination contains positive tariffs for both home and foreign country at the first period and it moves to the long run welfare maximizing tariff combination $(\bar{\tau}, 0)$ at the following period.

Case B-2: $\psi = \tilde{\psi} > \hat{\psi}$, $\psi_\beta > 1 > \psi_\alpha > 0$

If $\psi_\beta > 1 > \psi_\alpha > 0$, the possible tariff negotiation results are either positive tariffs for both countries or only the foreign country imposes a positive tariff while the home country has free trade at the first period. If $\tilde{\psi} \in [0, \psi_\alpha]$, the home country is forced to have free trade and the foreign country still have a positive tariff. If $\tilde{\psi} \in [\psi_\alpha, 1]$, both the home and foreign country have positive tariff at the first period and then move to the long run welfare maximizing tariff combination of $(\bar{\tau}, 0)$ at the following period. This case is depicted in Figure 8.

Case B-3 : $\psi = \tilde{\psi} > \hat{\psi}$, $1 > \psi_\beta > 0 > \psi_\alpha$

If $1 > \psi_\beta > 0 > \psi_\alpha$, possible Nash bargaining tariff outcomes include cases in that two countries have positive tariffs or only the home country has positive tariffs and the foreign country has free trade at the first period. Relying on the value of $\tilde{\psi}$, tariff adjustment may follow the paths indicated in Figure 9(A). However, if the efficiency locus goes through $\overline{cc'}$ in Figure 9(B), moving from the initial tariff to the long run welfare maximizing tariff rate immediately, or only the home country has a positive tariff rate at the first period that is lower than the long run welfare tariff rate, $\bar{\tau}$, then having $\bar{\tau}$ at the second period is also a possible negotiation outcome between two countries. It is rather radical change in tariff adjustment; however, given the model described in this paper, we find no reason for such a case not to happen.

Case B-4 : $\psi = \tilde{\psi} > \hat{\psi}$, $1 > \psi_\beta > \psi_\alpha > 0$

In this case, the efficiency locus cuts through d and d'. Line D in Figure 10 is the efficiency locus where there exists $\psi_\alpha \in (0, 1)$ and $\psi_\beta \in (0, 1)$. Three possible paths in Figure 10(A) contain (i) both countries imposes positive tariff if $\tilde{\psi} \in (\psi_\alpha, \psi_\beta)$ (ii) home country imposes a positive tariff while foreign country has free trade if $\tilde{\psi} \in [\psi_\beta, 1]$ or (iii) only foreign country has a positive tariff and home country has free trade if 1 $\tilde{\psi} \in [0, \psi_\alpha]$ at the first period and then moves to long run welfare maximizing tariff combination $(\bar{\tau}, 0)$ at the second period. A special case we can consider is illustrated in Figure 10(B), where foreign country moves to its own long run welfare tariff rate immediately and home country reduces its tariff rate even lower than $\bar{\tau}$. Like the previous case, such a reverse of tariff movement for the home country can be regarded as a special case of adjustment process. Also, in case of $\hat{\tau}_1 = \overline{\tau_1}$, we can say that the negotiation lead to an immediate tariff adjustment to its long run welfare tariff combination.

Case B-5 : $\psi = \tilde{\psi} > \hat{\psi}$, $\psi_\alpha \geq \psi_\beta$

If $\psi_\alpha \geq \psi_\beta$, the efficiency locus passes through or below the origin as shown in Figure 11. Both countries never impose positive tariff on their importing goods at the first period. In order to adjust mutual tariff combination, at least one country(or both) has free trade and then it gets to the long run tariff combination at the following period. We again denote ψ_γ as the value of ψ that makes complete free trade for both countries as the first period Nash bargaining tariff combination. Figure 11(A) shows example paths of tariff adjustment and two countries may agree on immediate adjustment, which occurs of $\hat{\tau}_1 = \bar{\tau}$. Figure 11(B) illustrates the case when overcutting of home country tariff arises.

V. Conclusion

In this paper, our focus is to see the impact of imperfect international capital mobility on tariff adjustment process between two large countries. Assuming complete specialization of each country, the results show that the existence of an imperfect international capital market may trigger a gradual tariff adjustment. That is, when it takes time and causes idle capital in reallocating capital between countries, tariff negotiations between two countries may end up with a different tariff combination, rather than reaching a long run welfare maximizing tariff combination immediately at the first period. The results also include cases where immediate adjustment is the Nash bargaining negotiation result.

Given the long run tariff rates that maximizes the home and foreign country welfare mutually, the existence of an imperfect capital mobility works as a cost of adjustment. Loosely speaking, if such a cost of reallocating capital exceeds the gains from expedited tariff adjustments, immediate tariff adjustments would not be the best for both countries. Whether countries have immediate or gradual tariff adjustments depend on the welfare functions and the initial conditions each country is endowed.

The model also shows that the short run tariff rate of a country may be even lower than its long run tariff rate, i.e., the first period tariff rate is lower than the long run welfare maximizing tariff rate that is imposed at the second period. It may be a rather counter-intuitive result. However, given the model described in this paper, especially given the general functional forms of utility function, there is no reason to exclude those cases. However, in case that two countries move to complete free trade in the long run, such overcutting of tariff rates would not be observed.

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APPENDIX
Deriving Import Demand Function for the Second Period

For home country, from Eq. (40.1), the first order conditions are

$$\frac{\partial u_2}{\partial C_{X2}} - \lambda p_2^w (1+\tau_2) = 0 \tag{A.1}$$

$$\frac{\partial u_2}{\partial C_{Y2}} - \lambda = 0 \tag{A.2}$$

$$f_2(k_1) + b_2 - p_2^w (1+\tau_2) C_{X2} - C_{Y2} = 0 \tag{A.3}$$

Plugging $b_2 \equiv \tau_2 p_2^w C_{X2} - r_2(k_1)k_1$ into Eq. (A.3), we have

$$\frac{\partial u_2}{\partial C_{X2}} - \frac{\partial u_2}{\partial C_{Y2}} p_2^w (1+\tau_2) = 0 \tag{A.4}$$

$$f_2(k_1) - r_2(k_1) k_1 - p_2^w C_{X2} - C_{Y2} = 0 \tag{A.5}$$

Denoting $u_{X_2} = \dfrac{\partial u_2}{\partial C_{X2}}$, $u_{Y_2} = \dfrac{\partial u_2}{\partial C_{Y2}}$, $u_{X_2X_2} = \dfrac{\partial}{\partial C_{X2}}\left(\dfrac{\partial u_2}{\partial C_{X2}}\right)$, and $u_{X_2Y_2} = \dfrac{\partial}{\partial C_{Y2}}\left(\dfrac{\partial u_2}{\partial C_{X2}}\right)$ and totally differentiating Eq. (A.4) and (A.5), we have a system of equation as following;

$$\begin{bmatrix} u_{X_2X_2} - p_2^w(1+\tau_2)u_{Y_2X_2} & u_{Y_2X_2} - p_2^w(1+\tau_2)u_{Y_2Y_2} \\ p_2^w & 1 \end{bmatrix} \begin{bmatrix} dC_{X2} \\ dC_{Y2} \end{bmatrix} = \begin{bmatrix} u_{Y_2}(1+\tau_2)dp_2^w \\ -C_{X2}\, dp_2^w - r_2{}'\, k_1\, dk_1 \end{bmatrix}$$

Rewriting this,

$$\begin{bmatrix} dC_{X2} \\ dC_{Y2} \end{bmatrix} = \frac{1}{H} \begin{bmatrix} 1 & -\left(u_{Y_2X_2} - p_2^w(1+\tau_2)u_{Y_2Y_2}\right) \\ -p_2^w & u_{X_2X_2} - p_2^w(1+\tau_2)u_{Y_2X_2} \end{bmatrix} \begin{bmatrix} u_{Y_2}(1+\tau_2)dp_2^w \\ -C_{X2}\, dp_2^w - r_2{}'\, k_1\, dk_1 \end{bmatrix} \tag{A.7}$$

$$\text{단,}\quad H \equiv \left(u_{XX}^2 - p_2^w(1+\tau_2)u_{YX}^2\right) - p_2^w \cdot \left(u_{YX}^2 - p_2^w(1+\tau_2)u_{YY}^2\right) < 0$$

Therefore, we can get

$$\frac{dC_{X2}}{dp_2^w}=\frac{1}{H}\left\{u_{Y_2}(1+\tau_2)+\left(u_{Y_2X_2}-p_2^w(1+\tau_2)u_{Y_2Y_2}\right)C_{X2}\right\}<0 \tag{A.8}$$

$$\frac{dC_{Y2}}{dp_2^w}=-\frac{1}{H}\left\{p_2^w\,u_{Y_2}(1+\tau_2)+\left(u_{X_2X_2}-p_2^w(1+\tau_2)u_{Y_2X_2}\right)C_{X2}\right\} \tag{A.9}$$

$$\frac{dC_{X2}}{dk_1}=\frac{1}{H}\left(u_{Y_2X_2}-p_2^w(1+\tau_2)u_{Y_2Y_2}\right)r_2{}'k_1>0 \tag{A.10}$$

$$\frac{dC_{Y2}}{dk_1}=-\frac{1}{H}\left(u_{X_2X_2}-p_2^w(1+\tau_2)u_{Y_2X_2}\right)r_2{}'k_1>0 \tag{A.11}$$

For foreign country, from Eq. (40.2), the first order conditions are;

$$\frac{\partial u_2{}^*}{\partial C_{X2}{}^*}-\lambda^*p_2^w=0 \tag{A.12}$$

$$\frac{\partial u_2{}^*}{\partial C_{Y2}{}^*}-\lambda^*(1+\tau_2{}^*)=0 \tag{A.13}$$

$$p_2^w f_2{}^*(k_L)+b_2-p_2^w C_{X2}{}^*-(1+\tau_2{}^*)C_{Y2}{}^*=0 \tag{A.14}$$

Since $b_2{}^*=\tau_2{}^*C_{Y2}{}^*+r_2(k_1)k_1$, Eq. (A.12)~(A.14) can be reorganized as;

$$\frac{\partial u_2{}^*}{\partial C_{X2}{}^*}-\frac{p_2^w}{1+\tau_2{}^*}\frac{\partial u_2{}^*}{\partial C_{Y2}{}^*}=0 \tag{A.15}$$

$$p_2^w f_2{}^*(k_L)+r_2(k_1)k_1-p_2^w C_{X2}{}^*-C_{Y2}{}^*=0 \tag{A.16}$$

Similarly, denoting $u^*_{X_2^*}=\dfrac{\partial u_2{}^*}{\partial C_{X2}{}^*}$, $u^*_{Y_2^*}=\dfrac{\partial u_2{}^*}{\partial C_{Y2}{}^*}$, $u^*_{X_2^*X_2^*}=\dfrac{\partial}{\partial C_{X2}{}^*}\left(\dfrac{\partial u_2{}^*}{\partial C_{X2}{}^*}\right)$, $u^*_{X_2^*Y_2^*}=\dfrac{\partial}{\partial C_{Y2}{}^*}\left(\dfrac{\partial u_2{}^*}{\partial C_{X2}{}^*}\right)$ and $p_2{}^*=\dfrac{p_2^w}{1+\tau_2{}^*}$, we have,

$$\begin{bmatrix} u^*_{X_2^*X_2^*}-p_2{}^*u^*_{Y_2^*X_2^*} & u^*_{X_2^*Y_2^*}-p_2{}^*u^*_{Y_2^*Y_2^*} \\ p_2^w & 1 \end{bmatrix}\begin{bmatrix} dC_{X2}{}^* \\ dC_{Y2}{}^* \end{bmatrix}=\begin{bmatrix} \dfrac{u^*_{Y_2^*}}{1+\tau_2{}^*}dp_2^w \\ \left(f_2{}^*-C_{X2}{}^*\right)dp_2^w+\left(r_2{}'k_1+r_2\right)dk_1 \end{bmatrix} \tag{A.17}$$

which can be rewritten as,

$$\begin{bmatrix} dC_{X2}{}^* \\ dC_{Y2}{}^* \end{bmatrix} = \frac{1}{H^*} \begin{bmatrix} 1\ , & -\left(u^*_{X_2^* Y_2^*} - p_2^* u^*_{Y_2^* Y_2^*}\right) \\ -p_2^w, & \left(u^*_{X_2^* X_2^*} - p_2^* u^*_{Y_2^* X_2^*}\right) \end{bmatrix} \begin{bmatrix} \dfrac{u^*_{Y_2^*}}{1+\tau_2{}^*} dp_2^w \\ \left(f_2{}^* - C_{X2}{}^*\right) dp_2^w + \left(r_2{}' k_1 + r_2\right) dk_1 \end{bmatrix} \tag{A.18}$$

$$단,\quad H^* \equiv \left(u^*_{X_2^* X_2^*} - p_2{}^* u^*_{Y_2^* X_2^*}\right) - p_2^w \cdot \left(u^*_{X_2^* Y_2^*} - p_2{}^* u^*_{Y_2^* Y_2^*}\right) < 0$$

Therefore, we can derive,

$$\frac{dC_{X2}{}^*}{dp_2^w} = \frac{1}{H^*} \left\{ \frac{u^*_{Y_2^*}}{1+\tau_2{}^*} - \left(u^*_{X_2^* Y_2^*} - p_2^* u^*_{Y_2^* Y_2^*}\right)\left(f_2{}^* - C_{X2}{}^*\right) \right\} \tag{A.19}$$

$$\frac{dC_{Y2}{}^*}{dp_2^w} = -\frac{1}{H^*} \left\{ p_2^w \frac{u^*_{Y_2^*}}{1+\tau_2{}^*} - \left(u^*_{X_2^* X_2^*} - p_2^* u^*_{Y_2^* X_2^*}\right)\left(f_2{}^* - C_{X2}{}^*\right) \right\} > 0 \tag{A.20}$$

$$\frac{dC_{X2}{}^*}{dk_1} = -\frac{1}{H^*} \left(u^*_{X_2^* Y_2^*} - p_2^* u^*_{Y_2^* Y_2^*}\right)\left(r_2{}' k_1 + r_2\right) > 0 \tag{A.21}$$

$$\frac{dC_{Y2}{}^*}{dk_1} = \frac{1}{H^*} \left(u^*_{X_2^* X_2^*} - p_2^* u^*_{Y_2^* X_2^*}\right)\left(r_2{}' k_1 + r_2\right) > 0 \tag{A.22}$$

On the other hand, to get the sign of the parenthesis in Eq. (43), we use Eq. (A.22). Since $C_{Y2}{}^* = M_{Y2}{}^*$,

$$\begin{aligned} -\frac{dM_{Y2}{}^*}{dk_1} + \left(r_2{}' k_1 + r_2\right) &= -\frac{1}{H^*} \left(u^*_{X_2^* X_2^*} - p_2^* u^*_{Y_2^* X_2^*}\right)\left(r_2{}' k_1 + r_2\right) + \left(r_2{}' k_1 + r_2\right) \\ &= -\frac{1}{H^*} \left(r_2{}' k_1 + r_2\right) p_2^w \left(u^*_{X_2^* Y_2^*} - p_2^w u^*_{Y_2^* Y_2^*}\right) > 0 \end{aligned} \tag{A.22}$$

Therefore, Eq. (43) has always positive value.

Figure 1

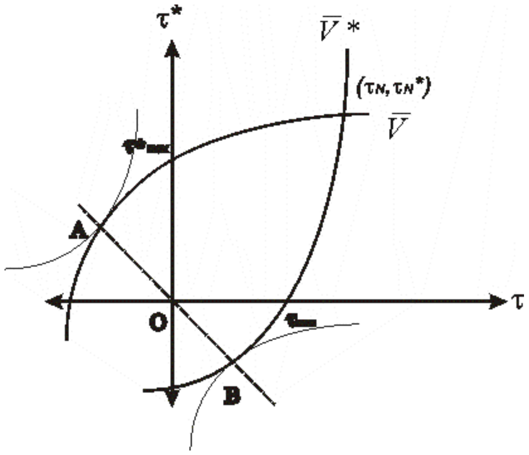


Figure 2

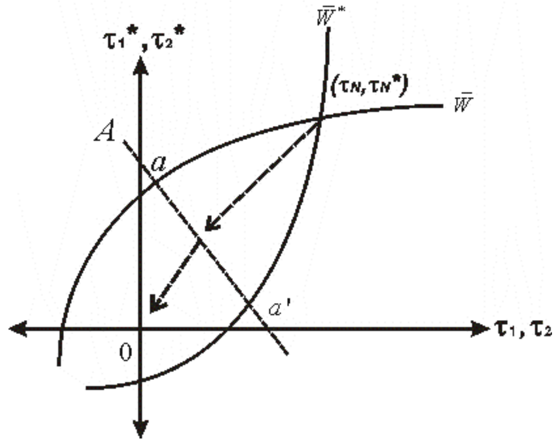


Figure 3

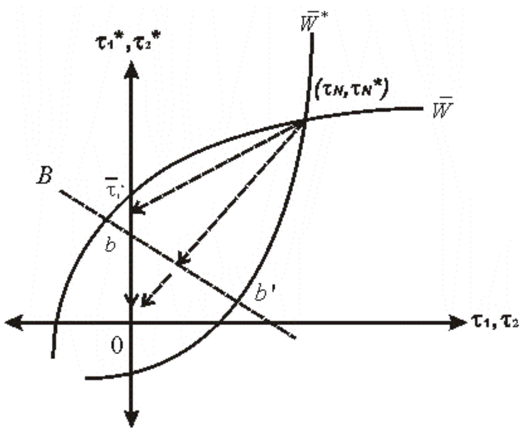


Figure 4

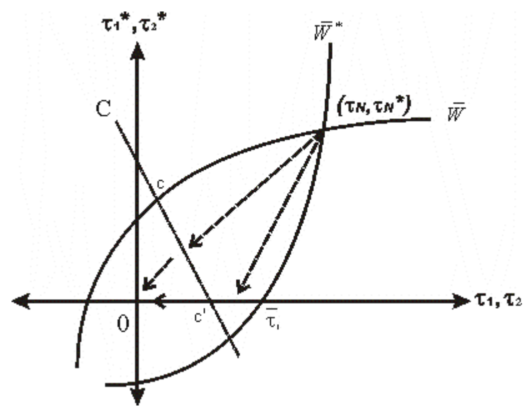


Figure 5

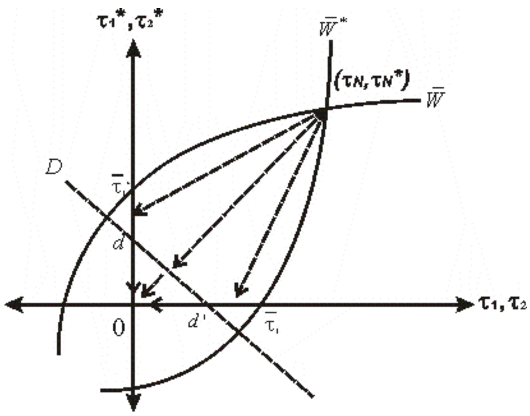


Figure 6

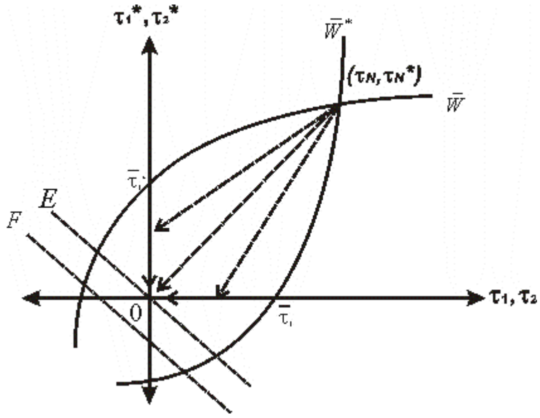


Figure 7

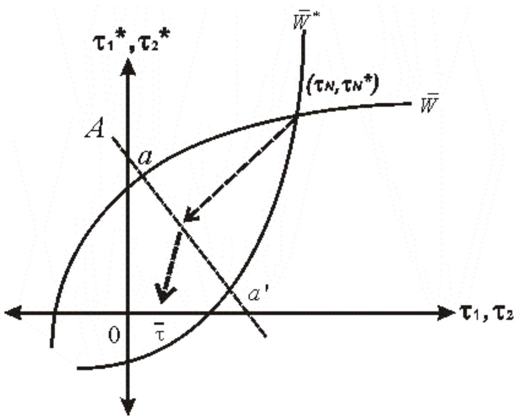


Figure 8

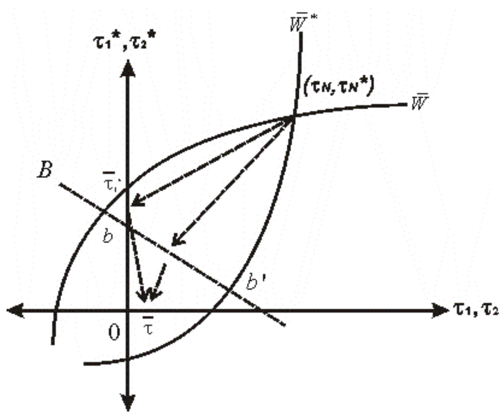


Figure 9

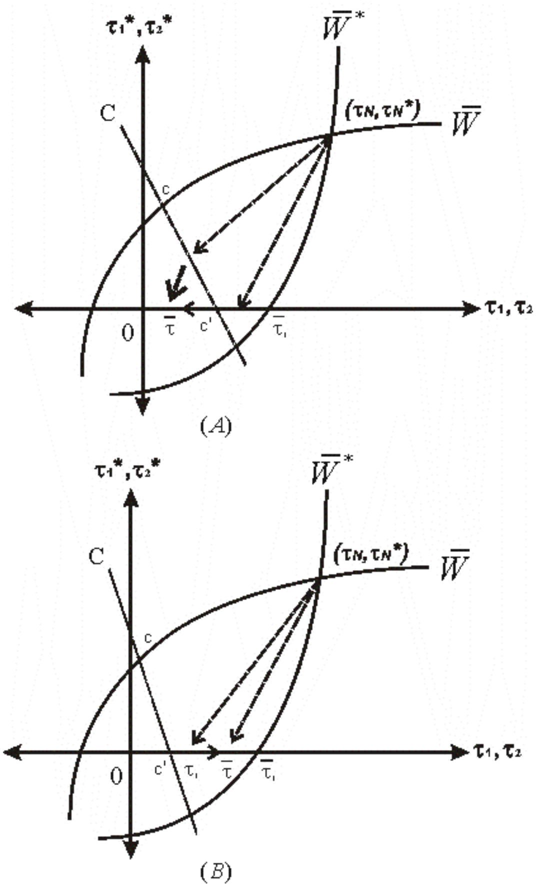


Figure 10

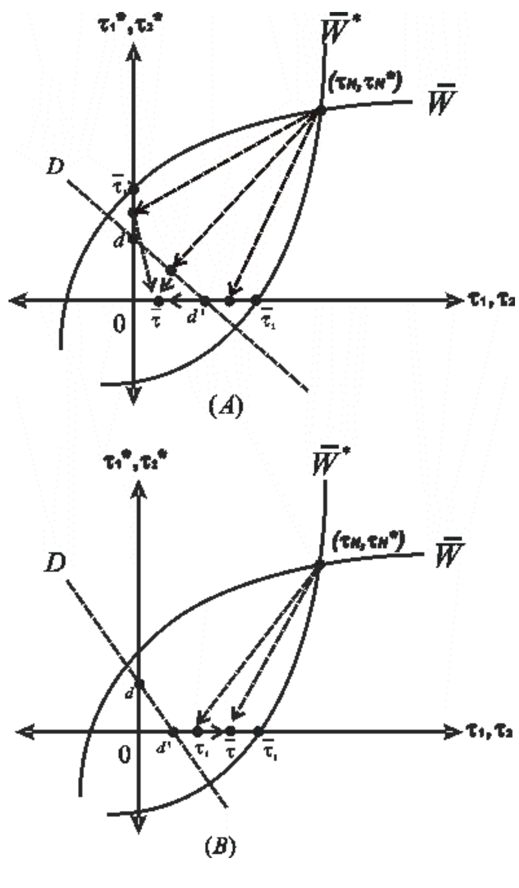
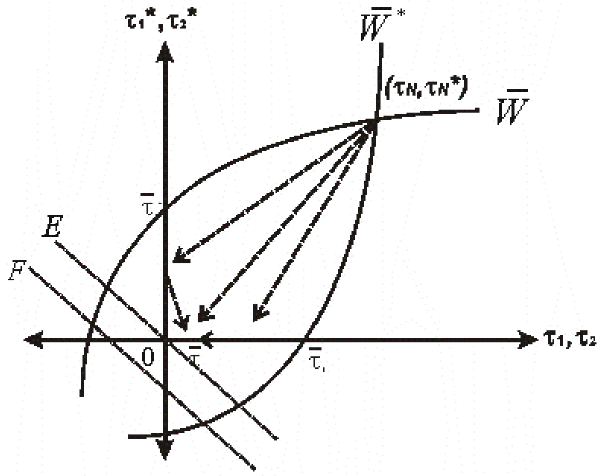
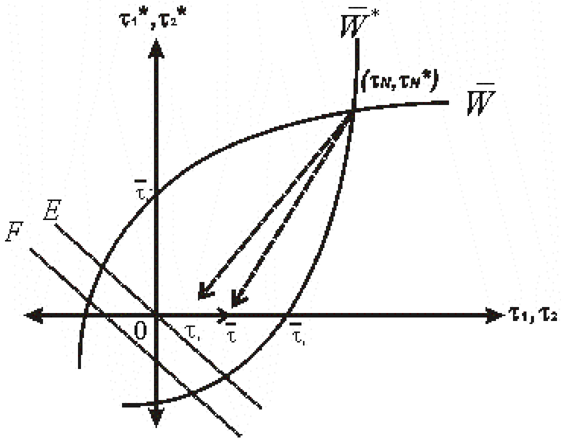


Figure 11



(A)



(B)