

Conflicts and delays in international trade agreements

Jung Hur*

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Abstract

This paper considers a model of an international trade agreement where countries differ in the extent of externalities. We show that a delay in the trade negotiation may occur and result in an inefficient world welfare. We also argue that a possibility of international compensation scheme in the trade agreement enables to reduce the actual delaying time in the negotiation stage.

Key words: international trade agreement, negative externality, a war of attrition, delay

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*Assistant Professor, Department of Economics, National University of Singapore, AS2 Level 6, 1 Arts Link, Singapore 117570; e-mail: ecshurj@nus.edu.sg; tel: +65-6516-4873; fax: +65-6775-2646.

1 Introduction

A delay in international trade negotiations is common. It took six years (1987-93) to reach a conclusion in the previous Uruguay Round trade negotiation after the GATT member countries decided to launch it at their meeting in Punta Del Este, Uruguay in 1986. When the WTO recently faced the pessimistic delay of multilateral negotiation in August 2006, it had already spent five years (2001-2006) since the WTO member countries prepared the Work Program declared at Doha, Qatar in 2001 and hoped to conclude the complex set of multilateral negotiations by the end of 2006 as scheduled in the sixth WTO ministerial conference held in Hong Kong in 2005. Even in cases of bilateral free trade talks it usually takes at least one or two years to finalize the negotiation. It is a bit surprising to know that, although delays in trade negotiations are quite often observed during real trade talks, most of international trade theories have assumed away a possibility of delay in a trade negotiation stage.

What causes the delay of trade negotiation among countries? Will the delay of trade negotiation be inevitable? If so, does it mean that the outcome of trade negotiation is inefficient? What determines the length of the delay? Not all but some answers to these questions will be addressed in this paper.

Possibility of delay has been studied in non-cooperative bargaining literature. In particular, the basic alternating-offer game suggested by Rubinstein (1982) has been extended to show the possibility of delay in the timing of the agreement. Those extended models show that the sources of delay are multiple issues (i.e. multiple pies), multiple players, incomplete information and uncertainty about the size of pie or the order of move. (For more survey, see Carraro et al (2005).) More importantly, the bargaining literature finds that, in cases that a delay exists, the efficiency of equilibrium is not necessarily guaranteed.

There have been some attempts in international trade literature in order to introduce more realistic trade negotiations using alternating-offer games. Furusawa (1999) adopt Rubinstein (1982) bargaining model with two players alternating in making an offer with an infinitesimal lag between offers. Furusawa and Wen (2002) consider a bargaining game with endogenous interim disagreement actions. (See Busch and Wen (1995) for their theoretical backgrounds.). However their focus was not on a delay of trade negotiation. To our knowledge, Bac and Raff (1997) is the only trade paper that shows

a possibility of a delayed trade concession. They adopt the idea of Bac and Raff (1996) and introduce incomplete information on prior beliefs between two negotiating governments.

Basically, our approach differs from the above trade literature: we adopt a war of attrition game (so-called "chicken game") for a model of trade negotiation. First, although we believe that bargaining models are most useful to study a trade negotiation in general, we want to capture a more realistic situation where negotiating countries are conflicting each other about what to cooperate over. In this conflicting situation, a conclusion of trade negotiation may be delayed in real trade talks because negotiating parties do not want to immediately "give up" their preferred set of agenda when they meet for the first time. A country may expect a gain by delaying the negotiation because it may have a chance to win against its negotiating partners. However, the delay may incur a cost to the country because it loses the benefit of an early cooperation. So we need to consider the costs and benefits of delay. After all, in this paper we view a trade negotiation as a game of "giving-up" their preferred type of agreements. Second, we think that a delay in trade negotiation is mutual in a following sense. A delayed trade negotiation occurs because both parties in the negotiation table expect that each other's negotiating partner would not give up their policies. The delay will be ceased only when both give up their preferred type of policies.

What makes countries conflict in a trade negotiation process? This paper suggests a model of asymmetrical structure of externality between countries. To illustrate the basic model, imagine two-country world where a free trade agreement is being negotiated between a polluter country and a pollutee country. The polluter creates air pollution from which the pollutee, a trading partner, suffers. The pollution, a source of external costs, reduces welfare levels of both countries. Two countries meet for a free trade talk. At the same time, they seek for a possible extension of the free trade agreement to include a higher standard of tax policy in the polluter so as to reduce the level of the global pollution. In this framework, the two countries face two different sizes of the world 'pie'; the world welfare level under the free trade agreement with the global tax policy and the one without it. The former may yield a larger pie than the latter. However, the individual welfare levels under the two types of trade agreements (with and without the global tax policy) might be different: The polluter may prefer the latter, while the pollutee prefers the former. They understand that both would lose if no agreement is

realized.

If there is a proper compensation scheme between the two nations, there might not be any conflicts in selecting the most beneficial type of agreement to themselves; they may choose the free trade agreement with the global tax policy and share the largest pie. In order to focus on our main idea of conflicts and delays in the trade agreement, first we will assume a lack of international transfer scheme in the negotiation agenda. Then we will contrast the results to those with an international compensation scheme and investigate what conditions are needed to have a delayed trade negotiation.

The above illustration of a ‘polluter-pollutee’ is an example of a cross-border externality between countries. In addition to such environmental issues as pollution, the existence of international externality in other areas has been studied by trade economists. Staiger (2003) notes that labor standards are associated with international externality as well. In his paper, he mentions two kinds of non-peculiar international externality in labor. The first one is political concern: ‘...weak labor standards and poor labor conditions in one country may create social unrest, thereby inducing political concerns in other countries’. The second one is humanitarian concern: ‘...a country’s choice of weak labor standards may induce humanitarian concerns in other countries, if those countries have a direct concern for the well-being of workers in this country’.

In fact, the international externality has been taken seriously by the WTO. A main issue within the WTO is whether to attach environment and labor standards to trade agreements among the Members of the WTO. Although still debatable about the issue of policy linkages, some theoretical works have made a progress to identify the efficiency and role of international cooperation over domestic policies. Bagwell and Staiger (2001) is supportive to the view that the WTO is well-suited to deal with the issue of environment and labor standards given that it enhances the security of market-access commitments. Ederington (2001, 2002) develops Bagwell and Staiger (2001)’s view to see whether or not the WTO can effectively enforce the free trade agreement when a concern of an externality exists among countries. Surprisingly, Ederington (2002) showed that the benefit of a policy linkage in enforcing an agreement may be lower than is commonly believed. Limao (2005) considers the case of cross-border externality and investigates conditions under which linking trade and domestic policy in self-enforcing agreement may be beneficial. Conconi and Perroni (2002) consider a multi-

lateral negotiation over tariff and tax and examine joint welfare levels under all possible policy coordinations among many countries.

Due to the symmetrical structure of the externalities assumed in the previous trade literature, the cooperative equilibrium is immediate and thus there is no room to study a possibility of a delay in a negotiation process. Although our paper is in line with this literature, we focus on a case where the extent of externalities are not symmetric between countries. Assuming the asymmetrical externalities (e.g. a ‘polluter-pollutee’ relationship), we show that a delay may occur in deciding a type of agreements in a negotiation stage and the delayed trade negotiation is associated with an inefficient outcome for the world welfare. Furthermore, we find that the presence of international compensation scheme in the trade agreement may play a role of shortening the length of delay in the negotiation stage.

The paper is organized as follows. Section 2 describes a static trade model in which two trading countries try to choose their optimal import tariff and production tax level under different trading structure; no agreement, partial agreement and full agreement. Section 3 presents a dynamic model where international cooperation occurs in two stages; negotiation and implementation. In this section, we will derive our main results of a possibility of delayed negotiation and its association with inefficient world welfare level. Section 4 concludes the paper.

2 The Model

We consider a two-good partial equilibrium model in which South (without *) and North (with *) trade. We define South as a country that suffers from domestic production externality and North as a country that is affected by the cross-border externality from South.

Both countries consume and produce three goods, x , y and z . A representative consumer in a country has a quasi-linear utility function which is separable among the three goods. z is a traded numeraire good and the marginal utility of its consumption is one. This enables us to focus on the partial equilibrium model for the two non-numeraire sectors, x and y , in which the demand functions are linear. We assume that when South and North trade, South imports good x from North and exports good y to North.

For the purpose of illustration, let us denote the demand functions by $p_i^d = 1 - d_i$ for South and $p_i^{d*} = 1 - d_i^*$ for North, where p_i^d (p_i^{d*}) is buyers’

price of good i in South (North) and d_i (d_i^*) is the quantity demanded for good i in South (North) for $i \in \{x, y\}$. Furthermore, let us denote the supply functions in South by $p_x^s = 2s_x$ and $p_y^s = s_y$ and in North $p_x^{s*} = s_x^*$ and $p_y^{s*} = 2s_y^*$, where p_i^s (p_i^{s*}) is suppliers' price of good i in South (North) and s_i (s_i^*) is the quantity supplied of good i in South (North) for $i \in \{x, y\}$.

South's production functions are $s_x = e^{\frac{1}{2}}$ and $s_y = (2l_y)^{\frac{1}{2}}$, where e is the input used in x production and l_y is the input in y production, assuming that the supply of the two inputs are infinitely elastic at a unitary input price. The two inputs differ in that the use of e yields domestic externality in South and creates the cross-border external costs to North as well. We interpret the use of the input e as environmentally unfriendly one such as burning trees, polluting waters, leaking chemicals etc., or as illegal use of labor forces such as slaves, child labors, workers in jails, etc. The use of such inputs may create transboundary pollutions geographically or may incur psychological costs to other countries. To illustrate these externalities, let us denote the domestic externality in South by $\Phi e^{\frac{1}{2}}$ with $\frac{1}{21} < \Phi < \frac{3}{4}$ and the cross-border externality in North by $\lambda \Phi e^{\frac{1}{2}}$ with $0 \leq \lambda \leq 1$. The boundary of Φ ensures the positiveness of variables in our model, and the boundary of λ implies that the cross-border externality is secondary and indirect. North's production functions are defined symmetrically, except that the input used in production x in North does not yield any externalities. We indicate the input by l_x^* . So, for North, $s_x^* = (2l_x^*)^{\frac{1}{2}}$ and $s_y^* = (l_y^*)^{\frac{1}{2}}$ with $\Phi^* = 0$.

One of our important assumption is the specification of externalities between the two countries as explained above. So here we clearly provide the assumption as follows.

Assumption 1 $\Phi > \Phi^* = 0$, $0 \leq \lambda \leq 1$, and $0 \leq \lambda^* \leq 1$.

Since the externality in North is zero, the level of cross-border externality (λ^*) from North to South does not matter for the analysis. However, if North also creates externality, then the level of λ^* will play an important role in determining the equilibrium of the model. What we assume here is an existence of a sufficiently large difference in externalities between the two negotiation countries both domestically and internationally. With Assumption 1, we have South as the country that creates externality and that affects negatively North's welfare level. Later in Assumption 2, we will be more specific about the level of Φ .

In order to focus on governments providing protection for import competing sectors and correcting for production externalities in the sectors, we allow governments to affect their domestic import price and the world price through an import tariff and a production tax.¹ More specifically, consumers' price in the importing sector of South is given by $p_x^d \equiv p_x^w + t$, where p_x^w is the world price and t is a specific import tariff. Producers in the sector receive $p_x^s \equiv p_x^d - \theta$, where θ is a unit production tax. In exporting sectors, we have $p_y^d = p_y^s \equiv p_y^w$. For North, consumers' price in the importing sector is $p_y^{d*} \equiv p_y^w + t^*$, where p_y^w is the world price and t^* is a specific import tariff. Producers in the sector receive the same price, $p_y^{s*} = p_y^{d*}$ because there is no production tax imposed in North. In exporting sector, we have $p_x^{d*} = p_x^{s*} \equiv p_x^w$.

The world equilibrium prices are determined by the equality between a country's import demand, M and the trading partner's export supply, E . That is, p_x^w and p_y^w are such that $M_x(p_x^w, t, \theta) = E_x^*(p_x^w)$ and $M_y^*(p_y^w, t^*) = E_y(p_y^w)$ respectively, where $M_x(p_x^w, t, \theta) \equiv d_x(p_x^d) - s_x(p_x^s)$ and $E_y(p_y^w) \equiv s_y(p_y^s) - d_y(p_y^d)$ for South and $M_y^*(p_y^w, t^*) \equiv d_y^*(p_y^{d*}) - s_y^*(p_y^{s*})$ and $E_x^*(p_x^w) \equiv s_x^*(p_x^{s*}) - d_x^*(p_x^{d*})$ for North. The world equilibrium prices are $p_x^w = p_x^{d*} = p_x^{s*} = \frac{4-3t+\theta}{7}$ and $p_y^w = p_y^d = p_y^s = \frac{4-3t^*}{7}$. Note that the world (export) prices are decreasing in tariffs and increasing in the production tax. This is because an increased tariff reduces the importers' demand and thus creates excess export supply in the world markets; and an increased production tax discourages the domestic supply and thus creates excess import demand in the world markets. As for the domestic (import) prices, we can obtain $p_x^d = \frac{4+4t+\theta}{7}$ and $p_x^s = \frac{4+4t-6\theta}{7}$ for South and $p_y^{s*} = p_y^{d*} = \frac{4+4t^*}{7}$ for North. First, the tariff increases domestic prices to consumers and producers. This is true under a standard economic model where the import tariff costs are shared by importers and exporters. Second, the production tax increases consumers' price but lowers producers' price. This is also true under a standard assumption that the tax is shared by both consumers and producers.

We define national welfare as the sum of consumer surplus, producer surplus, revenues from tariff and tax, and externality costs as follows.

¹The assumption that the negative production externality exists in the import competing sector is not essential to get our main results in the paper. One can extend our model to analyze the export policies by considering the negative domestic externality in exporting sectors. However the current model makes it easier for us to focus on a government coordinating over import policies with other governments in an agreement.

$$W_x(t, \theta) = \int_{p_x^d}^1 (d_x) dp_x^d + \int_0^{p_x^s} (s_x) dp_x^s + tM_x + (\theta - \Phi) s_x, \quad (1)$$

$$W_y(t^*) = \int_{p_y^d}^1 (d_y) dp_y^d + \int_0^{p_y^s} (s_y) dp_y^s, \quad (2)$$

$$W_x^*(t, \theta) = \int_{p_x^{d*}}^1 (d_x^*) dp_x^{d*} + \int_0^{p_x^{s*}} (s_x^*) dp_x^{s*} - \lambda \Phi s_x, \quad (3)$$

$$W_y^*(t^*) = \int_{p_y^{d*}}^1 (d_y^*) dp_y^{d*} + \int_0^{p_y^{s*}} (s_y^*) dp_y^{s*} + t^* M_y^*. \quad (4)$$

South and North maximize their national welfare level, $W = W_x(t, \theta) + W_y(t^*)$ and $W^* = W_x^*(t, \theta) + W_y^*(t^*)$, respectively under the three different regimes; No agreement, full agreement, and partial agreement. We will next analyze the optimal policies and corresponding welfare levels for each of the three regimes.

Non-cooperative equilibrium

Each country chooses policies to maximize the objective function by taking the other trading country's policies as given. The optimal policies are given by the following solutions for South and North respectively:

$$t^O = \frac{1}{10}\Phi + \frac{1}{20}; \theta^O = \Phi; t^{*O} = \frac{1}{20}, \quad (5)$$

where superscript O means "non-cooperative equilibrium". The optimal tariffs are positive, which reflects a country's ability of seeking market power through a tariff policy in the world trading markets. (In a more general model, the optimal tariff is the product of the world price and the inverse of the world price elasticity of foreign export supply.) The optimal tax is a Pigouvian tax, which is the equivalent level to the marginal costs of the externality in South. However it does not cover the cross-border externality in North.

Note that in (5) $t^O > t^{*O}$ since Φ is strictly positive. The difference (i.e., $|t^O - t^{*O}|$) is even increasing as Φ rises. This can be interpreted as follows: South's optimal tax is higher when the domestic externality costs are larger. As the higher tax is imposed, the world price increases because the tax reduces domestic production and thus increases import demand. Facing the rise of the import demand, the government increases its trade barriers.

Using the specific solutions for the optimal tariffs and tax, we can obtain the following welfare functions for South and North:

$$W^O = \left(\frac{1}{5}\Phi^2 - \frac{3}{10}\Phi + \frac{7}{40} \right) + \left(\frac{101}{400} \right), \quad (6)$$

$$W^{*O} = \left(\frac{1}{100}\Phi^2 + \frac{1}{100}\Phi + \frac{2}{5}\Phi^2\lambda - \frac{3}{10}\Phi\lambda + \frac{101}{400} \right) + \left(\frac{7}{40} \right), \quad (7)$$

where the first parentheses of W^O and W^{*O} represent W_x^O and W_x^{*O} , and the second parentheses are W_y^O and W_y^{*O} respectively.

Full agreement: tariffs and tax

Full agreement is when both countries choose import tariffs and the production tax to maximize the joint objective functions, $W + W^*$. The cooperative equilibrium tariffs and production tax are given by the following solutions for South and North respectively:

$$t^F = 0; \theta^F = \Phi + \Phi\lambda; t^{*F} = 0, \quad (8)$$

where superscript F means "full agreement". The equilibrium tariffs are zero and the tax covers both domestic externality and the cross-border externality. Non-cooperative equilibrium is inefficient since the Nash tariffs are too high and the Nash tax is too low from the global welfare perspective. The global welfare will be improved under the full agreement since the two sources of inefficiency are removed.

Using the cooperative tariffs and tax under the full agreement, we can obtain the following welfare functions for South and North:

$$W^F = \left(\frac{19}{98}\Phi^2 - \frac{1}{49}\Phi\lambda - \frac{15}{49}\Phi - \frac{2}{49}\Phi^2\lambda - \frac{23}{98}\Phi^2\lambda^2 + \frac{17}{98} \right) + \left(\frac{25}{98} \right), \quad (9)$$

$$W^{*F} = \left(\frac{1}{49}\Phi - \frac{13}{49}\Phi\lambda + \frac{1}{49}\Phi^2 + \frac{23}{49}\Phi^2\lambda + \frac{22}{49}\Phi^2\lambda^2 + \frac{25}{98} \right) + \left(\frac{17}{98} \right), \quad (10)$$

where the first parentheses of W^F and W^{*F} represent W_x^F and W_x^{*F} , and the second parentheses are W_y^F and W_y^{*F} respectively. It can be easily verified that $W^F + W^{*F} > W^O + W^{*O}$.

Is the cooperative equilibrium always better than the non-cooperative equilibrium, viewed from an individual country's perspective? For North,

the cooperative equilibrium is better since the global optimal tax will remove the cross-border externality and the reciprocal free trade system also removes the terms-of-trade externalities between South and North. However for South, this may not be the case. Mayer (1981) and Kennan and Riezman (1988) point out that if countries are sufficiently asymmetric in size, a large country gains from trade wars. Analogously, in our model where countries are sufficiently asymmetric in externalities, a country with a large externality, which is South, may gain more from trade wars (i.e. non-cooperative equilibrium) in a similar fashion.

To see more formally, let us define the critical value of $\bar{\Phi}(\lambda)$ as a solution of $W^O(\bar{\Phi}, \lambda) = W^F(\bar{\Phi}, \lambda)$ for any given value of $\lambda \in [0, 1]$. If $0 < \bar{\Phi}(\lambda) < \Phi$, then $W^O(\Phi, \lambda) > W^F(\Phi, \lambda)$ and if $0 < \Phi < \bar{\Phi}(\lambda)$, then $W^O(\Phi, \lambda) < W^F(\Phi, \lambda)$. In both cases, we have $W^{*O} < W^{*F}$ for North. Does the critical value $\bar{\Phi}$ exist? What is the relationship between the given value of λ and the critical value of $\bar{\Phi}$? The answer to the first question is yes and to the second question is a negative relationship. A detailed explanations are delegated to Appendix 1.

In order for South and North to have a room for the full agreement, we will need the following assumption for the range of externalities:

Assumption 2 We consider $\Phi \in [\underline{\Phi}, \bar{\Phi}(\lambda))$, where $\underline{\Phi}$ is a lower bound (i.e. $\frac{1}{21}$) and $\bar{\Phi}(\lambda)$ is defined as a solution of $W^O(\bar{\Phi}, \lambda) = W^F(\bar{\Phi}, \lambda)$ for a given value of $\lambda \in [0, 1]$. (See Appendix 1 for the properties of $\bar{\Phi}(\lambda)$.)

Under the above assumption, we have $W^O(\Phi, \lambda) < W^F(\Phi, \lambda)$ and $W^{*O} < W^{*F}$. However, South may want an alternative agreement without its commitment to the globally optimal tax because the globally optimal tax may not be nationally optimal one given the zero tariffs between them. If there is a room for South to increase its welfare beyond the welfare level from the full cooperation, the government of South might follow the alternative way. Next we will explore this possibility of free trade agreement excluding the tax commitment.

Partial agreement: tariffs only

As an alternative to the full agreement with tariff and tax, both countries may agree to choose a common cooperative tariff only. That is, they maximize their respective national welfare functions with a restriction of common international policy, $t = t^*$ only. In this sense, we name this case as *partial agreement* since the domestic policy is excluded in the agreement.

The equilibrium tariff and tax are given by the following solutions for South and North respectively: Given that the tariffs are non-negative,

$$t^P = 0; \theta^P = \frac{21}{23}\Phi - \frac{1}{23}; t^{*P} = 0, \quad (11)$$

where superscript P means a "partial agreement: tariff only". Note that since $\Phi \geq \frac{1}{21}$, the production tax are non-negative.

Note that the tariffs are zero as in full agreement case. The reciprocal free trade system eliminates the terms-of-trade externality and the global welfare will be improved upon, compared to the non-cooperative equilibrium case. Interestingly the tax rate is less than the non-cooperative equilibrium, i.e. $\theta^P < \theta^O$. This can be understood as follows. The tax discourages the domestic production and thus creates an excess import demand in the world market. The excess demand increases the world price, which in turn increases the foreign export supply. The higher export supply would make the domestic country more protective in trade. Since the government in South is subject to the zero tariff, the additional protection motive in trade leads the government to choose a lower tax than the Nash tax level. By choosing a lower tax South can increase the domestic production against the foreign exported products, and thus effectively improve the protection level. This result is similar to what Copeland (1990) finds about the strategic use of negotiable and nonnegotiable trade barriers.

Using the policies chosen under the partial agreement, we can obtain the following welfare functions for South and North:

$$W^P = \left(\frac{9}{46}\Phi^2 - \frac{7}{23}\Phi + \frac{4}{23} \right) + \left(\frac{25}{98} \right), \quad (12)$$

$$W^{*P} = \left(\frac{9}{529}\Phi^2 + \frac{9}{529}\Phi + \frac{9}{23}\Phi^2\lambda - \frac{7}{23}\Phi\lambda + \frac{269}{1058} \right) + \left(\frac{17}{98} \right), \quad (13)$$

where the first parentheses of W^P and W^{*P} represent W_x^P and W_x^{*P} , and the second parentheses are W_y^P and W_y^{*P} respectively. It can be easily verified that $W^P + W^{*P} > W^O + W^{*O}$. Furthermore, the global welfare under the full agreement is higher than the partial agreement. That is, $W^F + W^{*F} > W^P + W^{*P}$.

Is the full agreement equilibrium always better than the partial agreement equilibrium, viewed from an individual country's perspective? South's

welfare is higher under the partial agreement equilibrium, while North's welfare is higher under the full agreement equilibrium. This is because South can seek a slightly better market power in the world trading relation by imposing a lower tax. Hence in sum, we have $W^P > W^F > W^O$ and $W^{*F} > W^{*P} > W^{*O}$.

In a model where the degree of asymmetry of externalities are negligibly small (i.e. when Φ is close to 0), an individual country's welfare could be still higher under the full agreement equilibrium. However, as modeled in our paper, the asymmetry of externality gives each country a different preference over the types of agreements. Here we summarize our first proposition about the welfare comparison over the three different types of equilibrium in a static model.

Proposition 1 *Assume $\Phi \in [\underline{\Phi}, \bar{\Phi}(\lambda))$. Then, (i) the global welfare levels are ranked as $W^F + W^{*F} > W^P + W^{*P} > W^O + W^{*O}$; and (ii) the individual welfare levels are ranked as $W^P > W^F > W^O$ for South and $W^{*F} > W^{*P} > W^{*O}$ for North.*

According to the above proposition, if there is a proper compensation scheme between North and South, they would form the full agreement and obtain $W^F + W^{*F}$, the largest global pie for them. The remaining problem is how to share the pie between South and North. The lesson from the bargaining literature we addressed briefly in Introduction tells us that the current model can not generate any delay in deciding how to share the pie. The equilibrium will occur immediately and the resulting world welfare level will be efficient.

Case 1: Presence of International Compensation

Suppose that there is a properly working international compensation scheme between them. Under this system, suppose that South will get α share out of the total world welfare, which is $\alpha(W^F + W^{*F})$. This should be at least greater than W^F which is the share of welfare under the full agreement without the compensation. However, North would not give the share greater than W^P , which is the level of welfare of South under the partial agreement. So we have the following range for α :

$$\frac{W^F}{W^F + W^{*F}} < \alpha < \frac{W^P}{W^F + W^{*F}}.$$

However, what if South has an alternative option to the full agreement with the compensation? The alternative could be to delay the conclusion of an agreement with a hope to receive its preferred type of agreement, which is partial agreement.

If South expects its share of welfare level from the delayed trade negotiation, say, C to be somewhere in the range of α , South might choose to delay the negotiation, instead of an immediate agreement with North. That is, South strategically delays the negotiation if the following α is compensated by North:

$$\frac{W^F}{W^F + W^{*F}} < \alpha < C < \frac{W^P}{W^F + W^{*F}}.$$

To find out the value of C and see how South strategically delay the cooperation, we will focus on the case without international compensation scheme.

Case 2: Absence of International Compensation

Suppose that there is no possible compensation scheme between North and South. Then according to Proposition 1, South prefers only free trade agreement without tax while North prefers the full agreement over tariffs and tax. This yields an interesting interaction between South and North. To see how they can determine the type of agreements, let us have the following payoff matrix for them.

		North	
		Full agreement	Partial Agreement
South	Full agreement	W^F, W^{*F}	W^O, W^{*O}
	Partial Agreement	W^O, W^{*O}	W^P, W^{*P}

[Table 1: Payoff matrix for South and North]

Suppose that each of the two governments, South and North, faces a payoff matrix as above Table 1. The strategies given to the governments are either full agreement or partial agreement. If each of the two governments chooses simultaneously a type of agreements given the other government's choice, then two Nash equilibria may arise: First, a mutual choice of the full agreement is a Nash equilibrium since South would choose the full agreement if North chooses it, and given the South's choice North would not want

to change the choice. The choice of the partial agreement is also a Nash equilibrium since North would choose the partial agreement if South chooses it, and given the North's choice South would not want to change the choice. The existence of the two Nash equilibria illustrates an international conflict between South and North in their preference for the type of an agreement: An agreement is better than no-agreement. However, the full agreement is better for North while a partial agreement is better for South.²

To determine a type of an agreement and to determine the value of C , we will introduce a dynamic model in the next section where the two countries are engaged in a trade cooperation with two stages-Negotiation and Implementation.

3 The Dynamic Model

In this section, we explore a two-stage game for a possible cooperation between South and North. The two-stage game is described as follows.

Stage 1: Negotiation Stage

At time τ_N , South and North simultaneously choose a strategy from $\{Q, NQ\}$, where Q means "I give up my preferred agreement", and NQ means that the country becomes silent and passes time, implying that "I do not give up my preferred agreement". If South announces Q and North announces NQ , North wins and Stage 2 begins right away without further delay. If South announces NQ and North announces Q , South wins and Stage 2 begins right away without further delay. If both choose Q at the same time, a type of agreements will be chosen by a fair lottery. If South and North announce NQ simultaneously, time τ_N ends and no countries win. At time $\tau_N + \Delta_N$, they repeat the game again.

Stage 2: Implementation Stage

At Stage 2, South and North engage in an infinitely repeated cooperative game with a trigger strategy as follow. (There is no delay between stage 1 and 2.) South and North agree on the type of agreements based on the result from the negotiation stage. If a country deviates from the agreement at time

²This situation is similar to so-called "Battle of Sex" game, where both parties are better off by agreeing each other for a choice. However here their payoffs from the choice are different.

τ_I , the other country retaliates at time $\tau_I + \Delta_I$ by imposing its Nash policies and not cooperating with the deviating country forever.

We will solve this two-stage game by backward induction, which enable us to solve for a subgame perfect equilibrium in which an agreement will be selected from the two possible ones - partial and full agreements.

3.1 Implementation Stage

South and North have finished their "War of Attrition" game and have decided a type of an agreement. It could be a full agreement or a partial agreement. We will explore how South and North can sustain a chosen type of agreement in the implementation stage.

Full agreement: tariffs and tax

Suppose that both South and North agree the full agreement equilibrium tariffs and tax level. In the long run, however, each country has an incentive to deviate the agreement at any given time τ_I since the deviation from the cooperative policies can increase the welfare level of the deviating country. So, for the full agreement equilibrium to be self-enforced, the punishment should be severe enough to offset the gains from the deviation.³ The incentive constraints for South and North are expressed by:

$$G^F \leq \frac{\delta^F}{1 - \delta^F} L^F \text{ and } G^{*F} \leq \frac{\delta^{*F}}{1 - \delta^{*F}} L^{*F}. \quad (14)$$

$G^F \equiv W^D(t^O, \theta^O; t^{*F}) - W^F(t^F, \theta^F; t^{*F})$ is South's welfare gain at time τ_I when South deviates the full agreement tariff t^F and tax θ^F by setting the Nash policies t^O and θ^O given that North abides by the full agreement tariff t^{*F} . $L^F = W^F(t^F, \theta^F; t^{*F}) - W^O(t^O, \theta^O; t^{*O})$ is South's welfare loss after time Δ_I passes when North retaliates South by setting its Nash policy t^{*O} . As usual, a country's patience level is determined by discount factor δ^F , which is defined as $\delta^F \equiv \exp^{-r^F \Delta_I}$. Here the variable r^F is the rate at which South discounts the future value. So when the discount rate (r^F) becomes smaller, the country becomes more patience.

³The punishment can be done through a cross-retaliation in a sense that North can retaliate with tariff policy if South deviates with tax policy. Otherwise, the full agreement can not be self-enforced.

Similarly, $G^{*F} = W^{*D}(t^{*O}; t^F, \theta^F) - W^{*F}(t^{*F}; t^F, \theta^F)$ is North's welfare gain at time τ_I when North deviates the full agreement tariff t^{*F} by setting the Nash policy t^{*F} given that South keeps the full agreement tariffs t^F and tax θ^F . $L^{*F} = W^{*F}(t^{*F}; t^F, \theta^F) - W^{*O}(t^{*O}; t^O, \theta^O)$ is North's welfare loss after time Δ_I passes when South retaliates North by setting its Nash policies t^O and θ^O . We also define $\delta^{*F} \equiv \exp^{-r^{*F}\Delta_I}$ where the variable r^{*F} is the discount rate of North for the future value.

These two constraints yield the following conditions for the discount factors, δ^F and δ^{*F} .

$$\delta^F \geq \bar{\delta}^F \equiv \frac{120\Phi + 400\Phi\lambda + 120\Phi^2 + 800\Phi^2\lambda + 4600\Phi^2\lambda^2 + 30}{51} \quad (15)$$

$$\delta^{*F} \geq \bar{\delta}^{*F} \equiv \frac{30}{204\Phi + 680\Phi\lambda + 204\Phi^2 + 1360\Phi^2\lambda + 8800\Phi^2\lambda^2 + 51} \quad (16)$$

It is straightforward to check $\bar{\delta}^F \in (\frac{10}{17}, 1]$ and $\bar{\delta}^{*F} \in (\frac{8}{1745}, \frac{10}{17})$. So $\bar{\delta}^F > \bar{\delta}^{*F}$ and thus $\bar{r}^F \Delta_I < \bar{r}^{*F} \Delta_I$ for all range of Φ and λ . This implies that for a given time Δ_I the required discount rate for South should be smaller than that of North. So, South needs to be more patient than North in order to sustain the full agreement.

Lemma 1 (Implementation Stage - Full Agreement) *Suppose that the full agreement equilibrium policies (t^F, θ^F, t^{*F}) are agreed in the negotiation stage. For this agreement to be self-enforced between South and North in the long run, South needs to be more patient than North, and the discount rate of South needs to be smaller than North's. That is, $\bar{\delta}^F > \bar{\delta}^{*F}$ and $\bar{r}^F < \bar{r}^{*F}$ for all range of Φ , λ and Δ_I .*

Intuitively, under the full agreement South would have a higher incentive to deviate from the full agreement than North would because the gain from deviation is relatively larger than the loss from it. Hence, in order to make the full agreement sustainable in the long run, the future value of the full agreement to South must be high enough to cancel the one-time gain from deviation. This can be done by requiring a smaller discount rate of South than that of North.

Partial agreement: tariffs only

Suppose that both South and North agree the partial agreement equilibrium. For the partial agreement equilibrium to be self-enforced, the following incentive constraints for South and North must be satisfied.

$$G^P \leq \frac{\delta^P}{1 - \delta^P} L^P \text{ and } G^{*P} \leq \frac{\delta^{*P}}{1 - \delta^{*P}} L^{*P}. \quad (17)$$

$G^P \equiv W^D(t^O, \theta^O; t^{*P}) - W^P(t^P, \theta^P; t^{*P})$ is South's welfare gain at time τ_I when South deviates the partial agreement tariff t^P and tax θ^P by setting the Nash policies t^O and θ^O given that North abides by the partial agreement tariff t^{*P} . Note that South will set its welfare-maximizing tax rate θ^O when it deviates from the cooperation. $L^P = W^P(t^P, \theta^P; t^{*P}) - W^O(t^O, \theta^O; t^{*O})$ is South's welfare loss after time Δ_I passes when North retaliates South by setting its Nash policy t^{*O} . The welfare will be discounted by the discount factor δ^P . Similarly, $G^{*P} = W^{*D}(t^{*O}; t^P, \theta^P) - W^{*P}(t^{*P}; t^P, \theta^P)$ is North's welfare gain at time τ_I when North deviates the partial agreement tariff t^{*P} by setting the Nash policy t^{*O} given South's tariff t^P and tax θ^P . $L^{*P} = W^{*P}(t^{*P}; t^P, \theta^P) - W^{*O}(t^{*O}; t^O, \theta^O)$ is North's welfare loss after time Δ_I passes when South retaliates North by setting its Nash policies t^O and θ^O . The welfare will be discounted by the discount factor δ^{*P} .

These two constraints yield the following conditions for the discount factors, δ^P and δ^{*P} .

$$\delta^P \geq \bar{\delta}^P \equiv \frac{1960\Phi + 1960\Phi^2 + 490}{1173} \quad (18)$$

$$\delta^{*P} \geq \bar{\delta}^{*P} \equiv \frac{15870}{18179 - 45080\Phi\lambda + 72716\Phi + 72716\Phi^2 - 90160\Phi^2\lambda} \quad (19)$$

It is easy to check $\bar{\delta}^P \in (\frac{490}{1173}, 1]$ and it is increasing in the value of Φ . However, the range of $\bar{\delta}^{*P}$ is not obtained straightforwardly and the relative size between $\bar{\delta}^P$ and $\bar{\delta}^{*P}$ depends on a value of Φ and λ . To resolve this complexity let us equate $\bar{\delta}^P$ and $\bar{\delta}^{*P}$ and find out the critical value of $\widehat{\Phi}(\lambda)$ which makes $\bar{\delta}^P$ and $\bar{\delta}^{*P}$ equal for a given value of λ .⁴

Now we consider both $\bar{\Phi}(\lambda)$ and $\widehat{\Phi}(\lambda)$ to see how the partial agreement can be sustainable. In Figure 3 in Appendix 3, consider $\lambda^L \in [0, \bar{\lambda}]$. Then

⁴An illustration of the critical value of $\widehat{\Phi}(\lambda)$ for a given λ is delegated to Appendix 2. Note that the valid range for Φ is restricted by the value of $\bar{\Phi}(\lambda)$ defined in Appendix 1.

we have two cases as follows. First, if $\underline{\Phi} < \Phi < \widehat{\Phi}(\lambda^L)$, then $\bar{\delta}^P > \bar{\delta}^{*P}$, meaning that the discount factor of South is larger than that of North. This in turn implies that the discount rate of South must be smaller than North's, $\bar{r}^P < \bar{r}^{*P}$. Second, if $\widehat{\Phi}(\lambda^L) < \Phi < \bar{\Phi}(\lambda^L)$, then $\bar{\delta}^P < \bar{\delta}^{*P}$ and $\bar{r}^P > \bar{r}^{*P}$. Next consider $\lambda^H \in [\bar{\lambda}, 1]$ in the same figure. Then we have only one case: Since $\underline{\Phi} < \Phi < \bar{\Phi}(\lambda^H)$, we have $\bar{\delta}^P > \bar{\delta}^{*P}$ and $\bar{r}^P < \bar{r}^{*P}$. These results are summarized in order as follows.

Lemma 2 (Implementation stage - Partial agreement) *Assume $\Phi \in [\underline{\Phi}, \bar{\Phi}(\lambda)]$ for a given value of $\lambda \in [0, 1]$ and define $\bar{\lambda}$ as the value of λ when $\bar{\Phi}(\lambda) = \widehat{\Phi}(\lambda)$ where $\widehat{\Phi}(\lambda)$ is the value of Φ when $\bar{\delta}^P = \bar{\delta}^{*P}$. Now suppose that the partial agreement equilibrium policies (t^P, θ^P, t^{*P}) are agreed in the negotiation stage. For this agreement to be self-enforced between South and North in the long run (See Figure 3 in Appendix 3),*

- (i) *if $\Phi \in [\underline{\Phi}, \widehat{\Phi}(\lambda^L)]$ with $\lambda^L \in [0, \bar{\lambda}]$, then $\bar{\delta}^P > \bar{\delta}^{*P}$ and $\bar{r}^P < \bar{r}^{*P}$ is required. That is, if South's domestic externality and the cross-border externality are small, South needs to be more patient than North, and the discount rate of South needs to be smaller than North's.*
- (ii) *if $\Phi \in [\widehat{\Phi}(\lambda^L), \bar{\Phi}(\lambda^L)]$ with $\lambda^L \in [0, \bar{\lambda}]$, then $\bar{\delta}^P < \bar{\delta}^{*P}$ and $\bar{r}^P > \bar{r}^{*P}$ is required. That is, if South's domestic externality is large but the cross-border externality are small, North needs to be more patient than South, and the discount rate of North needs to be smaller than South's.*
- (iii) *if $\Phi \in [\underline{\Phi}, \bar{\Phi}(\lambda^H)]$ with $\lambda^H \in [\bar{\lambda}, 1]$, then $\bar{\delta}^P > \bar{\delta}^{*P}$ and $\bar{r}^P < \bar{r}^{*P}$ is required. That is, if South's domestic externality is small but the cross-border externality are large, South needs to be more patient than North, and the discount rate of South needs to be smaller than North's.*

Under the partial agreement system, South expects that North would have a higher incentive to deviate from the partial agreement than South would. Hence, in order to support the partial agreement in the long run, the future value of the partial agreement to North should be high enough to offset the loss from the deviation. This can be achieved by requiring a smaller discount rate of North than that of South. This is the case of (ii) where the domestic externality is in a large range.

However, as the domestic externality in South becomes smaller (cases of (i) and (iii)), the incentive for South to support the partial agreement becomes smaller as well.⁵ This can be explained as follows. As the domestic externality becomes smaller, the optimal tax rate under the partial agreement, θ^P , becomes smaller. Then the gap between θ^O and θ^P becomes smaller as well. This implies that South loses the potential way of protecting its import market through a lower tax under the partial agreement. Remind that in section 2, we shortly discussed that a lower optimal tax θ^P can indirectly protect the importing sector. So, the welfare level under the full agreement may become relatively more attractive to South than the level under the partial agreement. (That is, the gap between W^P and W^F is reduced.) Hence, in order to support the partial agreement, South must evaluate the future value of the partial agreement relatively higher, which requires that discount rate of South be smaller, as the domestic externality in South becomes smaller.

Which type of cooperation will be adopted depends on the decision in the negotiation stage where South and North engage in the "War of Attrition" game. Now we will solve stage 1.

3.2 Negotiation Stage

Here South and North engage in the "War of Attrition" game described as follows. (See Hendricks et al (1988) and Fudenberg and Tirole (1993) for more details and necessary assumptions for a stationary equilibrium.)

The negotiation stage starts at time $\tau_N = 0$. A pure strategy for a country is a choice of a time $\tau_N \geq 0$ to announce Q . The choice of Q at time τ_N is that the country announces that "I give up my preferred agreement". If the country passes the time silently, it implies the choice of NQ at time τ_N , meaning that "I do not give up my preferred agreement". So, any positive time length $\tau_N > 0$ with silence from both countries implies that they are willing to incur the costs of non-cooperative equilibrium welfare for every unit of the time, while, by delaying its choice, it shows its hope to get its preferred type of agreement. We assume that if both choose Q at the same time, a type of agreements will be chosen by a fair lottery.

Suppose that South and North are or have been silent at $\tau_N \geq 0$ and

⁵As for the case (iii), we can verify from Appendix 1 that as λ increases, the upper bound $\bar{\Phi}$ becomes smaller. So the range of Φ that satisfying Assumption 2 becomes smaller. So the case (iii) is similar to the case (i).

that South keeps being silent (i.e. NQ) for an instant time $\Delta_N > 0$. Now consider what the marginal cost and benefit for South to be silent for the time are. If North also keeps being silent, South incurs the cost of delay, which is the difference between W^F and W^O . This is because South could have been better off by the choice of Q , which yields W^F . If North breaks the silence and announces Q , South enjoys the welfare gains from the delay and the gain lasts as far as the agreement can be self-enforced. The present value of the welfare gain is the discounted value of difference between W^P and W^F . This is because South could have been worse off by the choice of Q , which yields W^F . When the discount rate is r , the discounted welfare gain is $\frac{W^P - W^F}{r}$. However, this gain can be realized on the condition that North chooses Q at the time Δ_N . So, two things are noteworthy. First, the discount rate for South should be \bar{r}^P from Lemma 2. Otherwise, the partial agreement negotiated in the first stage can not be sustained in the implementation stage. Second, the conditional probability should be calculated. Suppose that $H^*(\tau)$ ($H(\tau)$) is a cumulative distribution function describing a mixed strategy for North (South). That is, $H^*(\tau)$ is the probability that North chooses Q at or before $\tau \geq 0$. Then the probability that North chooses Q at the time Δ_N conditional on having not chosen Q at or before τ_N is $\frac{H^*(\tau_N + \Delta_N) - H^*(\tau_N)}{1 - H^*(\tau_N)}$.

As shown in the literature of a war of attrition, any equilibrium in which delay may occur involves South and North choosing mixed strategies such that each is indifferent between Q at time $\tau_N \geq 0$ and NQ for an another instantaneous time $\Delta_N > 0$. The marginal benefit of delay for the instantaneous time is equal to the marginal cost when the following condition holds

$$\left(\frac{H^*(\tau_N + \Delta_N) - H^*(\tau_N)}{1 - H^*(\tau_N)} \right) \left(\frac{W^P - W^F}{\bar{r}^P} \right) = (W^F - W^O) \Delta_N$$

Likewise, we can obtain the similar condition for North as follows, with the discount rate for north being \bar{r}^{*F} from Lemma 1.

$$\left(\frac{H(\tau_N + \Delta_N) - H(\tau_N)}{1 - H(\tau_N)} \right) \left(\frac{W^{*F} - W^{*P}}{\bar{r}^{*F}} \right) = (W^{*P} - W^{*O}) \Delta_N$$

From these two conditions, we can show that $H^*(\tau)$ and $H(\tau_N)$ become an exponential distribution function as Δ_N approaches to zero.

$$\begin{aligned}\lim_{\Delta_N \rightarrow 0} \left(\frac{H^*(\tau_N + \Delta_N) - H^*(\tau_N)}{(1 - H^*(\tau_N)) \Delta_N} \right) &= \frac{h^*(\tau_N)}{1 - H^*(\tau_N)} = \frac{\bar{r}^P (W^F - W^O)}{W^P - W^F}, \\ \lim_{\Delta_N \rightarrow 0} \left(\frac{H(\tau_N + \Delta_N) - H(\tau_N)}{(1 - H(\tau_N)) \Delta_N} \right) &= \frac{h(\tau_N)}{1 - H(\tau_N)} = \frac{\bar{r}^{*F} (W^{*P} - W^{*O})}{W^{*F} - W^{*P}}.\end{aligned}$$

where $h(\tau_N)$ and $h^*(\tau_N)$ are probability density functions. These yield the following exponential distribution functions.

$$\begin{aligned}1 - H^*(\tau_N) &= (1 - H^*(0)) \exp\left(-\frac{\tau_N}{V}\right) \\ 1 - H(\tau_N) &= (1 - H(0)) \exp\left(-\frac{\tau_N}{V^*}\right)\end{aligned}$$

where $\frac{1}{V} = \frac{\bar{r}^P (W^F - W^O)}{W^P - W^F}$ and $\frac{1}{V^*} = \frac{\bar{r}^{*F} (W^{*P} - W^{*O})}{W^{*F} - W^{*P}}$. Interestingly, as for the initial conditions of the cumulative distribution functions, we have the following lemma 3.

Lemma 3 $H(0) = 0$ and $H^*(0) = 0$. (See Appendix 4 for proof.)

According to Lemma 3, a delay will occur when both parties choose not Q at time $\tau_N = 0$. So, the expected times until Q is chosen by two countries can be calculated as follows: Using the property of the joint probability of exponential probability function, we have;

$$\begin{aligned}U &= \frac{VV^*}{V + V^*} \\ \text{where } V &= \frac{W^P - W^F}{\bar{r}^P (W^F - W^O)} \text{ and } V^* = \frac{W^{*F} - W^{*P}}{\bar{r}^{*F} (W^{*P} - W^{*O})}\end{aligned}$$

Here, U is the expected delaying time until both countries choose Q , which yields $U = \frac{VV^*}{V+V^*}$. The value of V is the expected time that South would choose Q and that of V^* is the expected time that North would choose Q . We expect that, after the expected time length U passes, the resulting type of agreements is determined by a fair lottery. This implies that the resulting world welfare may be inefficient for the following two reasons: First, it is inefficient because a partial agreement can be possibly chosen by the lottery. Second, it is also inefficient even if a full agreement is chosen because the full agreement is delayed with the strictly positive time, U .

We summarize the result as follows.

Proposition 2 *Suppose that both countries engage in a negotiation in a manner of ‘a war of attrition’ (as in the present model) to decide the type of agreements. Then a delay may be inevitable and inefficient.*

The expected lengths of delaying time in negotiation stage are determined by the discount rates, \bar{r}^{*F} or \bar{r}^{*P} and the relative size of welfare levels among the full, partial and no agreements. However, those are the functions of domestic and cross-border externalities, Φ and λ . Note that we assumed $\Phi > \Phi^* = 0$. So, the source of delay in the current model is the asymmetry of externalities between the two negotiating countries. In other words, suppose that there is no domestic externality in South either, i.e., $\Phi = 0$. Then we will have $W^F = W^P$ for South and $W^{*F} = W^{*P}$ for North. Hence, $V = V^* = U = 0$. Clearly the possibility of delay disappears. Generally speaking, when there is a symmetric structure of externalities between negotiating countries, no possible delay occurs.

Corollary *If $\Phi = \Phi^*$ and $\lambda = \lambda^*$, there would be no delay in the negotiation stage.*

So far, we assumed that there is no international compensation scheme from North to South. What if both parties have an option for compensation as a part of the agreement? The answer depends on how much North is willing to compensate the loss of South under the Full agreement. To find out a necessary condition for South to participate in the Full agreement with the compensation scheme, we will compare the case with and without the compensation scheme.

Suppose that there is no such scheme and they engage in the negotiation game as described in the paper. Then South expects the welfare level as $C = \left(\frac{W^P + W^F}{2}\right) J$ with J as a joint probability of both choosing Q at time $\tau_N > 0$. Note that $J = \exp(-\frac{\tau_N}{U})$.

Instead, suppose there is such a compensation scheme and both agree with the Full agreement. From Case 1 in Section 2 and using the value of C , South would not accept the proposal of North with the compensation scheme under the Full agreement if $W^F < \alpha (W^F + W^{*F}) < \left(\frac{W^P + W^F}{2}\right) J$, and accept it if $\left(\frac{W^P + W^F}{2}\right) J < \alpha (W^F + W^{*F}) < W^P$.

Therefore, we may still have a delayed trade negotiation even in the presence of international compensation scheme if

$$\frac{W^F}{W^F + W^{*F}} < \alpha < \left(\frac{W^P + W^F}{W^F + W^{*F}} \right) \frac{J}{2} < \frac{W^P}{W^F + W^{*F}}$$

Here, $\left(\frac{W^P + W^F}{W^F + W^{*F}} \right) \frac{J}{2}$ is greater than $\frac{W^F}{W^F + W^{*F}}$ if J is close to one. Since $J = \exp(-\frac{\tau_N}{U})$, it approaches to one when τ_N approaches to zero. As the actual delaying time gets shorter, the required share of the world welfare that South wants to have becomes larger. Provided that the value of α falls in the range found as above, the global welfare level will be $\left(\frac{W^P + W^F}{2} + \frac{W^{*P} + W^{*F}}{2} \right) J$ with J close to one. Note that this is smaller than $W^F + W^{*F}$ from our result in Proposition 1. This implies that the world welfare with the delayed negotiation is still inefficient. We summarize this finding in the following proposition.

Proposition 3 *Even if there is an international compensation scheme considered in the negotiation stage, the trade negotiation can be delayed. The outcome is still inefficient. However, the presence of international transfer in the trade agreement enables to reduce the actual delaying time in the negotiation stage.*

4 Conclusion

It is common to observe delayed trade agreements these days, but rare to see research on a source of the delay in the literature of international trade. To address this issue of delayed trade negotiation, this paper adopted a war of attrition game and showed that it is possible to generate delayed trade agreements when negotiation countries differ in the size of externality. More importantly, we argued that the delayed trade agreements may be associated with efficiency loss of world welfare.

The main results in the paper rely on an assumption of an asymmetric externality between countries: In the model, South is the only country that creates the externality and there exists a cross-border externality only towards North. This can be readily generalized by having both countries creating externalities and affecting their welfare levels through the cross-border externality each other. In this generalized model, our main results hold as long as one's externality is sufficiently larger than the other's.

In fact, the assumption of asymmetric structure of externalities is introduced in the paper in order to address the diversity among countries participating in a real trade negotiation round table. Srinivasan (2002) argued that the failure of the third WTO ministerial conference at Seattle, USA in 1999 was due to a wide difference between developing and developed countries in the choice of issues to be included in the negotiation agenda, such as intellectual property, labour standards, environments, etc. After all, the assumption of asymmetrical externality may be not too far from the reality of trade agreements in the world. Moreover, we hope that our paper provide a model that shows a possible consequence of conflicts between negotiating parties with different interests in an international trade cooperation.

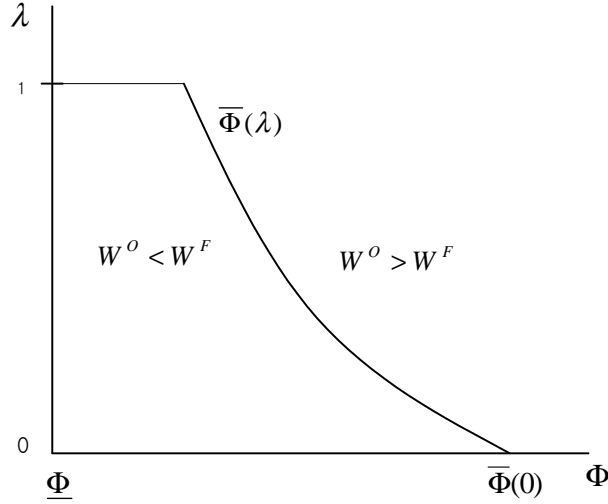
APPENDIX

Appendix 1: About $\bar{\Phi}(\lambda)$

(1) First, we have $p_x^{wO} > p_y^{wO}$ since $p_x^{wO}(t^O, \theta^O) = \frac{1}{10}\Phi + \frac{11}{20}$ and $p_y^{wO}(t^{*O}) = \frac{11}{20}$. Likewise, we have $p_x^{wF} > p_y^{wF}$ since $p_x^{wF}(t^F, \theta^F) = \frac{4+\Phi+\Phi\lambda}{7}$ and $p_y^{wF}(t^{*F}) = \frac{4}{7}$. Hence, $p_x^{wO}/p_y^{wO} > 1$ and $p_x^{wF}/p_y^{wF} > 1$ as long as there exists production externality in South (i.e. $\Phi > 0$). Furthermore, we can verify that $t^O - t^F > t^{*O} - t^{*F} > 0$ and $\theta^F - \theta^O > 0$. So when the trading system moves from non-cooperative to full agreement equilibrium, the increasing rate of p_x^w is greater than that of p_y^w because $\partial p_x^w / \partial t < 0$, $\partial p_y^w / \partial t^* < 0$, $\partial p_x^w / \partial \theta > 0$ and $\partial p_y^w / \partial \theta = 0$. Alternatively, check that $p_x^{wF}/p_y^{wF} > p_x^{wO}/p_y^{wO} > 1$ using the solutions for tariffs and tax. That is, $(p_x^{wF}/p_y^{wF}) - (p_x^{wO}/p_y^{wO}) = \frac{3}{44}\Phi + \frac{1}{4}\Phi\lambda > 0$. In words, the terms-of-trade of South becomes worse: The private surplus gains in the export sector y are not large enough to offset the losses in the import sector x . Second, however, an additional tax revenues due to the additional tax rate ($\Phi\lambda$) under the full agreement equilibrium are added to the government's objective function. Hence, the two opposing effects will determine the critical value.

(2) Suppose that $\bar{\Phi}'$ is the critical value when $\lambda = \lambda'$. Then we have $W^O(\bar{\Phi}', \lambda') = W^F(\bar{\Phi}', \lambda')$. As λ increases to λ'' , $(p_x^{wF}/p_y^{wF}) - (p_x^{wO}/p_y^{wO})$ becomes even larger since $(p_x^{wF}/p_y^{wF}) - (p_x^{wO}/p_y^{wO}) = \frac{3}{44}\Phi + \frac{1}{4}\Phi\lambda$. That is, a higher cross-border externality in North further deteriorates the terms-of-trade of South since South would have to increase its global optimal tax (i.e. $\partial \theta^F / \partial \lambda > 0$), which in turn reduces domestic production and thus increases

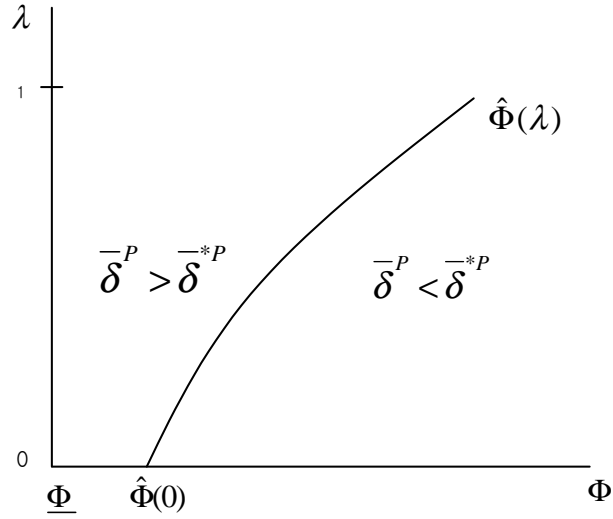
import demand in the world market. Furthermore, the tax revenue in South will be reduced due to the reduced domestic production. Hence $W^O(\bar{\Phi}', \lambda'') > W^F(\bar{\Phi}', \lambda'')$. Then a new critical value, $\bar{\Phi}''$ should be lower than $\bar{\Phi}'$ when $\lambda'' > \lambda'$. The negative relationship between $\bar{\Phi}$ and λ is illustrated in the following figure.



[Figure 1: the relationship between $\bar{\Phi}$ and λ from $W^O(\bar{\Phi}, \lambda) = W^F(\bar{\Phi}, \lambda)$]

Appendix 2: About $\hat{\Phi}(\lambda)$

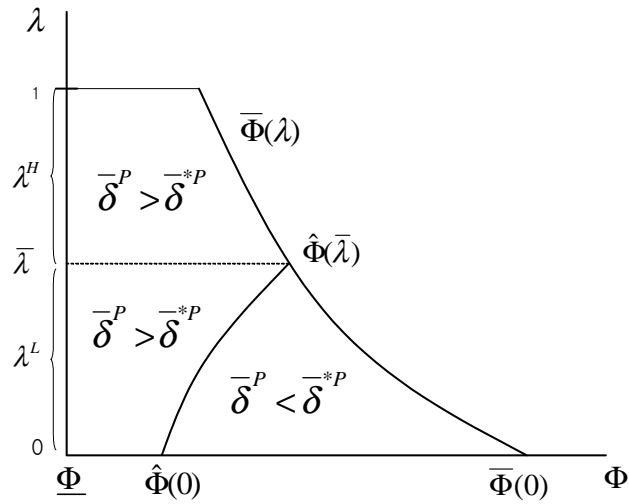
Let us define $\hat{\Phi}(\lambda)$ the critical value of Φ which makes $\bar{\delta}^P(\Phi, \lambda) = \bar{\delta}^{*P}(\Phi, \lambda)$ for a given value of λ . We know that $\bar{\delta}^P = \bar{\delta}^{*P}$ implies $\frac{G^P}{G^P+L^P} = \frac{G^{*P}}{G^{*P}+L^{*P}}$, which is $\frac{W^D-W^P}{W^D-W^O} = \frac{W^{*D}-W^{*P}}{W^{*D}-W^{*O}}$. Here only the right hand side is the function of λ . When $\lambda' > \lambda$, we can easily verify $\bar{\delta}^P(\Phi, \lambda') > \bar{\delta}^{*P}(\Phi, \lambda')$ from (7) and (13). Intuitively, a rise of the cross-border externality will decrease the welfare of North. So the loss from deviation becomes larger, which in turn yields a more room for cooperation to North. That is, the value of $\bar{\delta}^{*P}$ will decrease. Now, in order to make the two required discount factors equal, the critical value of Φ should increase. The higher domestic externality would decrease the welfare of South. So for the same reason, the value of $\bar{\delta}^P$ will decrease. So, we have $\bar{\delta}^P(\Phi', \lambda') = \bar{\delta}^{*P}(\Phi', \lambda')$. The positive relationship between $\hat{\Phi}$ and λ is illustrated in the following figure.



[Figure 2: the relationship between $\hat{\Phi}$ and λ from $\bar{\delta}^P = \bar{\delta}^{*P}$]

Appendix 3: Lemma 2

Let us combine the figure 1 and 2. With $\bar{\Phi}(0) > \hat{\Phi}(0)$ (which is easily calculated from the model), we have the following area of Φ for Lemma 2.



[Figure 3: the relationship between $\bar{\Phi}$ and $\hat{\Phi}$]

Appendix 4: Proof of Lemma 3

Suppose that $H(0)$ and $H^*(0)$ are both positive. Then both countries have

a strictly positive expected gains by choosing Q at time $\tau_N = 0$. In this case of simultaneous choice of Q at time $\tau_N = 0$, the type of agreements is determined by a fair lottery, as we assumed. So, the expected welfare levels are $\frac{1}{2}H^*(0)[W^P + W^F]$ for South and $\frac{1}{2}H(0)[W^{*P} + W^{*F}]$ for North. However, if each delays its decision for a time of $\Delta_N > 0$, their expected welfare levels are at least $H^*(0)W^P$ for South and $H(0)W^{*F}$ for North. Then for an instant time $\Delta_N > 0$, $H^*(\Delta_N)W^P > \frac{1}{2}H^*(0)[W^P + W^F]$ and $H(\Delta_N)W^{*F} > \frac{1}{2}H(0)[W^{*P} + W^{*F}]$. So both countries can make a better expected welfare gain by delaying for $\Delta_N > 0$ with probability one. This is contradictory to $H(0) > 0$ and $H^*(0) > 0$. If $H(0) > 0$ and $H^*(0) = 0$, then South gets worse than the case of $H(0) = 0$ and $H^*(0) = 0$. If $H(0) = 0$ and $H^*(0) > 0$, then North gets worse.

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