Customs Unions and Managed Trade*

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Abstract

This paper explores the ability of countries to maintain multilateral cooperation during the formation of customs unions. We assume that countries are limited to self-enforcing multilateral agreements that balance the gains from defection against the consequences of an ensuing trade war. Our analysis is conducted within a managed-trade environment, in which countries are allowed to employ "special-protection" instruments, such as safeguards, in a cooperative equilibrium, when the aggregate trade volume surpasses a critical threshold. We find that during the negotiation period, countries can sustain a relatively low level of overall protection, given the probability the customs unions will actually materialize is not too low. Nevertheless, once the customs unions are fully formed, countries need to engage in heavy utilization of "special-protection" tools so that multilateral cooperation does not break down.

Keywords: Customs unions; Managed trade; Multilateral cooperation; Market power

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1 Introduction

The overriding objective of the World Trade Organization (WTO) is to provide a framework within which international trade can be liberalized. While the cornerstone of its agreements, such as the General Agreement on Tariffs and Trade (GATT), is in many ways the principle of non-discrimination (or the most-favored-nation clause as it is widely known), certain exceptions to this rule are allowed. Most remarkably, under specific conditions, a set of countries can enter into a regional integration arrangement offering preferential trade-barrier reductions to each other and thus, discriminate against the rest of the WTO members.[1] Two predominant types of such preferential trading arrangements may be identified: a free-trade area and a customs union. Under a free-trade agreement, trade is free between the member countries, but the latter retain the right to unilaterally choose their import tariffs with respect to goods from nonmember states. In contrast, the countries comprising a customs union still trade freely with each other, but they also select common external tariffs on all goods imported into the union.

This paper investigates the ability of countries to maintain multilateral cooperation during the formation of customs unions. We assume that countries are limited to self-enforcing multilateral agreements, that balance the gains from defection against the costs of an ensuing trade war. Furthermore, they operate within a managed-trade environment, in which they are allowed to use "special-protection" tools, such as safeguards or antidumping (AD) protection, in a cooperative equilibrium, when the aggregate trade volume surpasses a critical threshold. As customs-union agreements are negotiated and subsequently, implemented, the incentives countries face are not stationary, and thus, trade policies need to be adjusted accordingly so that the highest sustainable level

[1] These conditions are spelled out in Paragraphs 4 to 10 of Article XXIV of GATT, the Enabling Clause, and Article V of the General Agreement on Trade in Services.

of cooperation is achieved at all times. In particular, during the negotiation period, countries can afford a low level of overall protection if the probability the customs unions will actually materialize is sufficiently high. Nevertheless, once the customs unions come into full effect, countries need to increase the level of "special protection," while they keep the "baseline" level of protection unchanged.

Understanding the ramifications of regional agreements for the international trading system has become all-important, as over the past fifteen years, the world has been experiencing an unprecedented proliferation of preferential trading groups. Currently, over 170 regional trade areas are in place. Furthermore, it is estimated that by the end of 2005, if regional trade agreements reportedly planned or already under negotiation are carried out, the total number of regional arrangements in force might well approach 300.[2]

Trade theorists have not been slow to respond, focusing on two questions. The first one is whether preferential trade agreements have positive or negative implications for world welfare. The answer seems to depend on the interplay of a number of factors. First of all, we need to take into account the effect of such arrangements on external tariffs. For example, as Bhagwati (1993) argues, if we allow for trade policy to be endogenous, reduced protection between member states is likely to be accompanied by increased protection against nonmember countries.[3] In addition, as it has originally been noted by Viner (1950), the establishment of preferential trade areas leads to both trade creation and trade diversion, that have offsetting welfare consequences. In particular, a preferential trade agreement results in expanded trade between the member countries, benefiting especially the efficient firms located therein. However, it likewise diverts trade away from efficient producers from nonmember states to inefficient

[2] This information is contained in the WTO website <http://www.wto.org>.

[3] According to Bhagwati and Panagariya (1996, p. 38), Mexico, just after the 1994 crisis, raised its external tariffs on 502 products from 20 percent or less to 35 percent.

suppliers from within the bloc. The extensive literature analyzing preferential trade agreements from the standpoint of world, member-country, and/or outside-country welfare includes Krugman (1991), Bhagwati (1993), Deardorff and Stern (1994), Bhagwati and Panagariya (1996), Panagariya and Findlay (1996), and Krishna and Bhagwati (1997).[4]

The second question trade theorists have explored, distinct from the first one but at times analytically interrelated, is how preferential trade agreements affect multilateral tariff cooperation. More precisely, do regional trade arrangements make it easier or harder for member and nonmember countries to negotiate and maintain low cooperative tariffs among them? Or, using the phraseology that Bhagwati has introduced (1991, p. 77), are preferential trade agreements "building blocs" or "stumbling blocs" with regard to multilateral trade liberalization? This question embodies the concerns raised by many prominent economists that preferential trade agreements hinder multilateral cooperation, undermine the multilateral trading system and will ultimately prevent us from reaching the principal goal of multilateral free trade. The burgeoning literature on this issue, reinforcing for the most part the skepticism towards preferential trading groups, includes Bhagwati (1993), Bhagwati and Panagariya (1996), Bond and Syropoulos (1996), Panagariya and Findlay (1996), and Bagwell and Staiger (1997a, 1997b).[5]

This paper is clearly in the latter tradition, as we present a theoretical dynamic model capable of addressing how the ability of countries to multilaterally cooperate evolves during the formation of customs unions. A first divergence from a number of the aforementioned papers is that we assume that countries are limited to only multilateral trade agreements that are self-enforcing. This

[4] See also Viner (1950), Lipsey (1957), Kemp and Wan (1976), De Melo, Panagariya and Rodrik (1993), Krugman (1993), Wonnacott (1996), and Panagariya (1997).

[5] See also Bhagwati (1991), Krugman (1991, 1993), Levy (1997), Bagwell and Staiger (1998), Ethier (1998a, 1998b), Krishna (1998), and Bagwell and Staiger (1999).

assumption is in conformity with the widespread belief among trade economists and policymakers that the enforcement mechanisms at the international level for any trade policy (e.g., tariff cuts) agreed upon under the WTO auspices are very feeble. Nonetheless, the fact that countries interact repeatedly over time enables them to sustain, along the lines suggested by Dixit (1987), explicit or tacit cooperation, whose degree, though, depends decisively on the severity of retaliation that can be credibly threatened against an offender by its trading partners. As Dam (1970, p. 81) puts it:

> [T]he GATT system, unlike most legal systems (including public international law), is not designed to exclude self-help in the form of retaliation. Rather, retaliation, subjected to established procedures and kept within prescribed bounds, is made the heart of the GATT system.

In this setting, as countries attempt to maintain cooperative trade policies, each one of them constantly weighs the gains from unilaterally deviating from the cooperative course against the discounted expected future benefits from adhering to the latter, with the understanding that should it defect, a trade war would ensue and these benefits would be sacrificed. Countries will choose not to defect as long as the discounted expected future benefits from presently maintaining multilateral cooperation exceed the onetime gains from defecting. It is apparent that a change in either the current or the expected future economic conditions might tip the scales one way or the other, and thus, induce the modification of the existing trade policies, so that the highest sustainable level of multilateral cooperation is attained. As customs-union agreements are negotiated and subsequently, executed, such a change in economic conditions does take place. It is this basic observation that is central to our results.

On a different note, the previous literature on preferential trade agreements, in its entirety, examines the various issues of interest within traditional tariff frameworks. However, the postwar history of industrialized countries has been characterized by a dramatic multilateral reduction in tariffs and a concurrent surge in the use of "special" forms of protection, such as Orderly Market Arrangements, Voluntary Export Restraints, or especially after 1980, AD protection. Bagwell and Staiger (1990) have claimed that these episodes of "special" protection are an indispensable part of self-enforcing multilateral trade agreements in a variable environment. In essence, they argue that if for any reason the trade volumes countries face surge, with unchanged trade policies, multilateral cooperation is likely to be rendered unviable because the incentive to defect for all countries becomes too high. Thus, they suggest that as countries strive to uphold cooperation amid volatile trade swings, we should expect a relatively low level of "baseline" protection (e.g., tariffs or quotas) during periods of "moderate" trade volumes to be coupled with an increasing employment of "special-protection" instruments when the aggregate trade volume surpasses a critical threshold.[6]

We depart from past work on regional agreements and conduct our analysis within an international trading environment characterized by exogenous aggregate-trade-volume shocks, and as a result, the existence of both "baseline" and "special" protection. On this ground, we pose the following questions: Does the level of "baseline" protection increase or decrease during the establishment of customs unions? Moreover, does the level of "special" protection increase or decrease as customs unions are negotiated and subsequently, fully

[6] Dam (1970, pp. 106-107) similarly states with regard to the GATT ecsape clause, one of the "special-protection" instruments:

> One may conclude that the GATT escape clause is a useful safety valve for protectionist pressures and does not undercut in any serious way the advantages of the GATT tariff negotiating system. Insofar as the escape clause is a political "prerequisite" to the membership in the GATT of certain contracting parties–most notably, the United States–the argument in its favor is even stronger.

formed?

We model an international trading relationship between four countries that passes through three phases. In phase I, countries trade normally with each other, but they are all aware that at some point in the future it might become politically feasible for each one of them to commence bilateral trade negotiations with an exogenously determined partner. If the negotiations, once in progress, are successfully concluded, two discrete symmetric customs unions will emerge. Phase II corresponds to a negotiation phase, during which countries keep trading as usual with each other, but in which each country has already begun trade discussions with its prospective customs-union partner. Finally, in phase III, the two customs-union agreements are fully implemented, and the resulting new trading pattern is stationary into the infinite future.[7] To avoid dealing with additional nonstationarities or endogeneities, we simply assume that the probability of moving through the phases is exogenous, and that the customs unions, should they be established, are irreversible and enforceable. Basically, the trading blocs we have in mind will be formed by countries already pursuing a comprehensive regional integration scheme.

Let us note that two of the principal effects of the formation of a customs union are trade diversion and increased market power for its member countries. The former effect is also present during the formation of free-trade areas, and drove our results in our earlier paper "Free Trade Areas and Managed Trade." Nevertheless, the latter effect, which emerges as the pivotal factor in our present paper, only arises in the context of customs unions: under a customs-union agreement, the member countries adopt a common external tariff on imports, and this in turn enables them, as they struggle to enforce multilateral cooper-

[7] Our use of the term "trade diversion" here and throughout the paper refers simply to a reduction in the volume of inter-bloc trade, and is thus somewhat different from the standard usage of the term as defined by Viner (1950), which, in addition to changing trade patterns, stresses the move from a more to a less efficient allocation of resources.

ation, to credibly threaten a higher retaliatory tariff against an offender than if their external tariff were not harmonized. In other words, the market power effect heightens the value of cooperation. But at the same time, it also raises the onetime welfare gain from defection.

While the customs unions are either being envisioned or negotiated, assuming the probability the discussions will be fruitful is not too low, the value of cooperation is high, since countries are aware of the future degree of market power of the prospective customs unions. Nevertheless, once the latter are fully formed, the conditions for multilateral cooperation become less favorable, as the countries' incentive to cheat rises significantly. Thus, it is imperative that in phase III countries maintain a relatively high level of overall protection so that the incentive to defect is kept under control, and as a result, multilateral cooperation is sustained. This is our first conclusion.

More importantly, we show that countries can achieve the desired outcome by engaging in enforcement-targeting. In other words, once the customs-union agreements are put into effect, countries only need to maintain a relatively high level of "special" protection along with a relatively low aggregate-trade-volume threshold above which the employment of "special-protection" instruments starts. Nevertheless, they can afford a low level of "baseline" protection for aggregate trade volumes below this threshold. Essentially, as countries face a relatively high incentive to defect and volatile trade swings, they only have to target the particular aggregate trade volumes for which multilateral cooperation is infeasible at a low level of "baseline" protection.

The remainder of the paper is devoted to establishing and elaborating on these points. The next section sets out the basics and analyzes the free-trade benchmark. Section 3 characterizes the dynamic behavior of equilibrium multilateral protection within the nonstationary environment of emerging customs unions. Finally, Section 4 concludes.

2 Free Trade

We begin with the characterization of free trade in a simple partial equilibrium model. We assume there are four countries X, Y, W and Z, that produce goods X, Y, W and Z correspondingly. We assume that the output of each product i equals $4+4e$, where e is uniformly distributed on $[-1,1]$. We assume further that the demand functions are symmetric across countries and goods, and that the demand for any good i is independent of the prices of other goods $j \neq i$. Specifically, the demand for good i in country j is given by:

$$C_i^j = \alpha - \beta P_i^j, \tag{1}$$

where $\alpha > 2$ and $\beta > 0$ are constants, and P_i^j is the price of good i in country j. The market-clearing free-trade price of good i is:

$$P^{FT} = \frac{\alpha - 1 - e}{\beta}, \tag{2}$$

which implies that the free-trade consumption level of good i in country j is:

$$C^{FT} = 1 + e. \tag{3}$$

3 Customs Unions

We now develop a nonstationary dynamic model to investigate the ability of countries to maintain multilateral cooperation during the formation of customs unions. As we briefly mentioned above, we assume that the trading relationship between countries passes through three phases.[8] In phase I, countries trade normally with each other, but they know that a time may come at which it becomes politically feasible for each one of them to start bilateral trade negotiations with an exogenously determined partner. In particular, countries are aware that trade discussions will concurrently take place, if at all, between, on the one hand, countries X and Y, and on the other hand, countries W and Z. They also know that should the discussions be successfully concluded, two discrete symmetric customs unions will emerge: one composed of countries X and Y, and another of countries W and Z. Phase II is a transition phase, during which countries still trade as usual with each other, but in which the bilateral trade negotiations are already in progress. Finally, in phase III, the aforementioned customs unions are fully formed. We assume that any new trading patterns that emerge in Phase III remain unchanged into the infinite future.

We choose not to rigorously examine either the political or the customs-union-agreements negotiation process. Instead, we simply assume that in any period, if trade discussions have not yet commenced, then there is an exogenous probability $\rho \in (0,1)$ that both bilateral trade negotiations will begin in the next period. Thus, if countries are in phase I at date t, the probability of being in phase II at date $t+1$ is ρ. Similarly, if in any period countries are already negotiating the customs-union agreements with their prospective customs-union partners, then there is an exogenous probability $\lambda \in (0,1)$ that both customs-union agreements will be finalized and fully implemented by the beginning of the next period. Thus, if countries are in phase II at date t, then the probability of being in phase III at date $t+1$ is λ.

A number of features of our model warrant further discussion. First of all, we

[8] Our modeling approach is clearly inspired by Bagwell and Staiger (1997b). They also assume that as countries form customs unions, their trading relationship passes through three phases. Nevertheless, in their paper, countries operate within a standard tariff framework, whereas we allow countries to employ "special-protection" tools in a cooperative equilibrium when the aggregate trade volume surpasses a critical threshold.

assume that both bilateral trade discussions begin unfolding at the same random date, and that both customs unions are fully established at the same random date. These assumptions are not meant to be literally interpreted. They just ensure that all countries face symmetric situations, and this in turn considerably simplifies our analysis. Moreover, in order to avoid additional nonstationarities or sources of endogeneity, we assume that the formation of the customs unions is completely exogenous and that the customs unions, once formed, are irreversible.[9] Last, in stark contrast to multilateral trade agreements, we treat the trading blocs as being able to commit to removing all trade barriers to intra-bloc trade. In essence, we can think of the customs unions in our model as being part of comprehensive regional integration schemes between the corresponding countries. Such schemes usually entail effective enforcement mechanisms and thus, total tariff elimination on intra-bloc trade can be accomplished.

For this customs-union-agreements game, we examine a class of subgame-perfect equilibria, in which (i) along the equilibrium path, in any given phase of the game, all countries select a common import tariff across goods at all dates within the phase; and (ii) if at any point in the game a deviation from the equilibrium tariff for the corresponding phase occurs, then all countries revert from the following period for all periods within the present phase and if applicable, for all periods in the subsequent phases if reached, to the pertinent static Nash tariffs.

For such equilibria, there will be three cooperative tariff levels, one for each phase. We are interested in the most-cooperative equilibrium, which is defined as the subgame-perfect equilibrium that yields the lowest possible equilibrium tariffs, while satisfying both conditions (i) and (ii). Let τ_1^c, τ_2^c and τ_3^c refer to the corresponding most-cooperative import-tariff levels in phases I, II and III,

[9] We make the assumption that if country i cheats its prospective customs-union partner in phases I or II, the probability the customs union between them will materialize remains unaffected.

respectively.

We solve the game in a recursive fashion. Specifically, we first identify the no-defect condition for phase III and find the lowest tariff that can be supported in this phase in an equilibrium of the desired class. Having solved for τ_3^c, we subsequently turn to phase II, characterize the no-defect condition for this phase using τ_3^c, and then solve for the most-cooperative tariff of this phase, τ_2^c. Finally, having determined both τ_2^c and τ_3^c, we specify the no-defect condition for phase I using both τ_2^c and τ_3^c, and solve for the lowest tariff that satisfies it, τ_1^c. Since the discounted expected value of future cooperation rises as future tariffs fall, and since current tariffs are minimized as the discounted expected value of future cooperation is maximized, solving the game this way provides us with the lowest sustainable tariffs for each phase of the model.

This is the basic outline of our model and of the method we will employ to characterize the most-cooperative tariffs. The next step is to formally derive the no-defect condition for each phase of the game.

3.1 Phase III

We begin our analysis with phase III. During phase III, the customs unions are in full effect. Countries X and Y form one customs union, whereas countries W and Z form another one.

3.1.1 A Static Model

In this section, we characterize the set of static Nash equilibria for phase III. We restrict ourselves to the imposition of specific import tariffs, and so τ_Y for example, represents the *common* tariff levied on good Y by countries W and Z. Assuming that the market for each product i clears, we obtain the following set of equilibrium prices for country X, and similar sets of equations for the other three countries:[10]

$$P_X^X(e,\tau_X) = \frac{\alpha - 1 - e}{\beta} - \frac{1}{2}\tau_X = P_X^Y(e,\tau_X), \tag{4}$$

$$P_Y^X(e,\tau_Y) = \frac{\alpha - 1 - e}{\beta} - \frac{1}{2}\tau_Y = P_Y^Y(e,\tau_Y), \tag{5}$$

$$P_W^X(e,\tau_W) = \frac{\alpha - 1 - e}{\beta} + \frac{1}{2}\tau_W \text{ and} \tag{6}$$

$$P_Z^X(e,\tau_Z) = \frac{\alpha - 1 - e}{\beta} + \frac{1}{2}\tau_Z. \tag{7}$$

The prices above result in the following market-clearing import volumes for country X, where M_i^j is the level of imports of good i into country j:

$$M_Y^X(e,\tau_Y) = 1 + e + \frac{\beta}{2}\tau_Y, \tag{8}$$

$$M_W^X(e,\tau_W) = 1 + e - \frac{\beta}{2}\tau_W \text{ and} \tag{9}$$

$$M_Z^X(e,\tau_Z) = 1 + e - \frac{\beta}{2}\tau_Z. \tag{10}$$

The market-clearing import volumes for the rest of the countries are described by similar equations.

Letting $W_3^X(e,\tau_X,\tau_Y,\tau_W,\tau_Z)$ represent country X's welfare, given by the

[10] We assume that the import tariffs chosen by the four countries do not prohibit trade. As far as good X, for example, is concerned, this implies that:

$$\tau_X < \frac{6(1+e)}{\beta}.$$

sum of consumer surplus, producer surplus, and import-tariff revenue, we have:

$$
\begin{aligned}
W_3^X(e,\tau_X,\tau_Y,\tau_W,\tau_Z) = & \int_{P_X^X(e,\tau_X)}^{\frac{\alpha}{\beta}} C(P)\,dP \\
& + \int_{P_Y^X(e,\tau_Y)}^{\frac{\alpha}{\beta}} C(P)\,dP + \int_{P_W^X(e,\tau_W)}^{\frac{\alpha}{\beta}} C(P)\,dP \\
& + \int_{P_Z^X(e,\tau_Z)}^{\frac{\alpha}{\beta}} C(P)\,dP + \int_{0}^{P_X^X(e,\tau_X)} (4+4e)\,dP \\
& + \tau_W M_W^X(e,\tau_W) + \tau_Z M_Z^X(e,\tau_Z)\,. \qquad (11)
\end{aligned}
$$

The welfare functions of the other three countries are similarly defined.

Let's consider now the optimal import tariffs for the customs union formed by countries X and Y. We obtain the first-order derivatives of the welfare function of country X with respect to τ_W and τ_Z[11]:

$$\frac{dW_3^X(\cdot)}{d\tau_W} = \frac{1}{2}(1+e) - \frac{3\beta}{4}\tau_W \text{ and} \qquad (12)$$

$$\frac{dW_3^X(\cdot)}{d\tau_Z} = \frac{1}{2}(1+e) - \frac{3\beta}{4}\tau_Z. \qquad (13)$$

Thus, $W_3^X(\cdot)$ is strictly concave in both τ_W and τ_Z. The welfare-maximizing responses are:

$$\tau_W^R = \frac{2(1+e)}{3\beta} = \tau_Z^R. \qquad (14)$$

We could carry out a similar analysis for the other customs union.

At this point, we should note that given the symmetry in our model, no basis apparently exists for asymmetric tariffs across products or customs unions. Let us now define the static tariff game to be the game in which both customs

[11] Equivalently, we could obtain the first-order derivatives of the welfare function of country Y with respect to τ_W and τ_Z.

unions simultaneously select an external import tariff for all goods, with each customs union seeking to maximize its own welfare per member country. Since each customs union's best-response tariff is independent of the tariff imposed by the other customs union, we have that the Nash equilibrium of the static tariff game occurs when each customs union selects the import tariff given by:

$$\tau_3^N(e) = \frac{2(1+e)}{3\beta}. \tag{15}$$

3.1.2 A Dynamic Model

We now extend the model to allow for repeated interaction. The dynamic model we consider is simply the static game described above infinitely repeated. In other words, at the start of any period, a common value for e is observed by all. Current period protection policies are then set, and current welfare is determined. At the beginning of the following period, all past choices are observed and a new value for e is realized. We assume that e is drawn from the same uniform distribution independently every period.

The phase-III most-cooperative tariff, $\tau_3^c = \tau_3^c(e)$, must provide each customs union with no incentive to defect. In other words, for any e, the discounted expected welfare to each member of a customs union under the strategy $\tau_3^c(e)$ must be no less than the per-member-country welfare when the customs union defects and its members thereafter receive the discounted expected welfare associated with the static Nash equilibrium described by (15). It is obvious that a customs union choosing to defect does best by picking a tariff on its reaction curve. This implies that if a customs union decides to defect, then it will deviate to its best-response Nash tariff:

$$\tau_3^D(e) = \frac{2(1+e)}{3\beta} = \tau_3^N(e). \tag{16}$$

We now fix both e and τ_3^c. The per-member-country static gain when the associated customs union cheats, given the symmetry in our model, is:

$$\Omega_3\left(e, \tau_3^D(e), \tau_3^c\right) \equiv W_3\left(e, \tau_3^N(e), \tau_3^c\right) - W_3\left(e, \tau_3^c, \tau_3^c\right). \tag{17}$$

Now, we find that:

$$\frac{d\Omega_3\left(e, \tau_3^D(e), \tau_3^c\right)}{de} = \tau_3^N(e) - \tau_3^c \text{ and} \tag{18}$$

$$\frac{d\Omega_3\left(e, \tau_3^D(e), \tau_3^c\right)}{d\tau_3^c} = -(1+e) + \frac{3\beta}{2}\tau_3^c. \tag{19}$$

This implies that $\Omega_3\left(e, \tau_3^D(e), \tau_3^c\right)$ is strictly increasing in e and strictly decreasing in τ_3^c if and only if:

$$\tau_3^c < \frac{2(1+e)}{3\beta} = \tau_3^N(e). \tag{20}$$

Given that the most-cooperative tariff is below the static Nash one, the incentive to defect for a customs union from a fixed τ_3^c is larger the greater is e and the smaller is τ_3^c. These conditions are very simple to interpret. As the production of the goods and thus, the underlying free-trade volume increases, the incentive to defect gets larger. This happens because the terms-of-trade gains from defection are applied to a larger trade volume and thus, more tariff revenue is collected from one's trading partners. The incentive to defect can be mitigated by increasing the most-cooperative import tariff, which reduces the volume of trade. In other words, one should expect production and thus, trade-volume surges to be accompanied by higher tariffs.

Having characterized the static incentive to defect, our next step is to characterize the expected future loss suffered by a customs union that defects. Let

$\delta \in (0,1)$ be the discount factor between the different periods, and E be the expectations operator with expectations taken over e. Then, the present discounted value for each member country of the expected future gain from their customs union not defecting today is:

$$\frac{\delta}{1-\delta}\left[EW_3\left(e,\tau_3^c\left(e\right),\tau_3^c\left(e\right)\right)-EW_3\left(e,\tau_3^N\left(e\right),\tau_3^N\left(e\right)\right)\right]\equiv\omega_3\left(\tau_3^c\left(\cdot\right)\right). \quad (21)$$

Since e is i.i.d. across periods, ω_3 is independent of the current realization of e as well as the current value of $\tau_3^c(e)$. The function $\tau_3^c(\cdot)$ will affect ω_3, though, since its distributional characteristics influence the pertinent expected value. Note that ω_3 is strictly positive as long as $\delta > 0$ and $\tau_3^c(e) < \tau_3^N(e)$, $\forall e$, in which case the threat of future punishment is meaningful.

Straightforward calculation shows that for any distribution of e:

$$\omega_3\left(\tau_3^c\left(\cdot\right)\right)=\frac{\delta}{1-\delta}\Big\{\frac{2\left(Var\left(e+1\right)+\left(E\left(e+1\right)\right)^2\right)}{9\beta} - \frac{\beta}{2}\left[Var\left(\tau_3^c\left(e\right)\right)+\left(E\left(\tau_3^c\left(e\right)\right)\right)^2\right]\Big\}. \quad (22)$$

The expected future gain from current cooperation is higher when $Var(e+1)$ and $E(e+1)$ are higher, for a given $\tau_3^c(e)$.

The fundamental no-defect condition is that the benefit of cheating is less than the present discounted value of the expected future gain from cooperating today. That is:

$$\Omega_3\left(e,\tau_3^D\left(e\right),\tau_3^c\left(e\right)\right)\leq\omega_3\left(\tau_3^c\left(\cdot\right)\right). \quad (23)$$

There will be in general more than one functions that satisfy the condition above. To obtain the most-cooperative tariff function, we first hold ω_3 fixed at a constant level and solve for the lowest, nonnegative τ_3^c satisfying (23).

To begin, fix $\omega_3 > 0$. If $e = -1$ and $\tau_3^c = 0$, the no-defect condition is satisfied since:

$$\Omega_3\left(-1, \tau_3^D(-1), 0\right) = 0 < \omega_3. \tag{24}$$

Holding τ_3^c fixed at zero and raising e, we know from (18) that $\Omega_3\left(e, \tau_3^D(e), 0\right)$ increases monotonically. If ω_3 is not too large, which is always true if δ is not too large, then there exists a critical value of e, $\overline{e}_3$, such that:

$$\Omega_3\left(\overline{e}_3, \tau_3^D(\overline{e}_3), 0\right) = \omega_3. \tag{25}$$

Solving (25) explicitly gives:

$$\overline{e}_3 = \sqrt{3\beta\omega_3} - 1. \tag{26}$$

Free trade is sustainable for $e \in [-1, \overline{e}_3]$.

If $e \in (\overline{e}_3, 1]$, the no-defect condition will be violated at $\tau_3^c = 0$. Thus, τ_3^c must rise to restore (23). Explicit calculation yields the following representation of the most-cooperative import tariff:

$$\tau_3^c(e, \omega_3) = \begin{cases} 0, & if \quad e \in [-1, \overline{e}_3] \\ \frac{2\left(1+e-\sqrt{3\beta\omega_3}\right)}{3\beta}, & if \quad e \in [\overline{e}_3, 1] \end{cases}. \tag{27}$$

In other words, if the underlying free-trade volume is low, the current incentive to defect is low even if $\tau_3^c = 0$. As the underlying free-trade volume exceeds a critical level, the incentive to cheat becomes too big and thus, τ_3^c needs to rise so as to keep the latter in check.

The above analysis was conducted under an exogenously given ω_3. Nevertheless, it is clear from (22) that ω_3 depends on the $\tau_3^c(\cdot)$ function, as $\omega_3 = \omega_3(\tau_3^c(\cdot))$. Thus, we must ensure that the ω_3 with which we began is also the ω_3 value that $\tau_3^c(e, \omega_3)$ generates. Using (22), (26) and (27), we can write the resulting equation as $\widetilde{\omega}_3(\omega) = \omega$. The most-cooperative import tariff can then be represented as $\tau_3^c = \tau_3^c(e)$, when the largest $\widehat{\omega}_3$ such that $\widehat{\omega}_3 \in \left(0, \frac{4}{3\beta}\right)$ and $\widetilde{\omega}_3(\widehat{\omega}_3) = \widehat{\omega}_3$ is substituted into $\tau_3^c(e, \omega)$. Let the aforementioned $\widehat{\omega}_3$ be called ω^{III}.

We can easily prove that such a fixed point exists. First, note that at $\omega = 0$:

$$\tau_3^c(e, 0) = \frac{2(1+e)}{3\beta} = \tau_3^N(e) \implies \widetilde{\omega}_3(0) = 0. \tag{28}$$

So, a fixed point does exist at $\omega = 0$, corresponding to the continual play of the static Nash equilibrium. To explore the possibility of a strictly positive root, we explicitly calculate $E(\tau_3^c(e))$ from (26) and (27), and use (22) to get for any distribution of e:

$$\widetilde{\omega}_3(\omega) = \frac{\delta}{1-\delta}\frac{2}{9\beta}[Var(e+1) + (E(e+1))^2 - \int_{\overline{e}_3}^{1}\left(1 + e - \sqrt{3\beta\omega}\right)^2 dG(e)], \tag{29}$$

if $\omega \in [0, \frac{4}{3\beta}]$, where G is the cumulative distribution function of e. Now, let's use the fact that e is uniformly distributed on $[-1, 1]$, which implies that $e+1$ is uniformly distributed on $[0, 2]$. It can be easily shown that:

$$\widetilde{\omega}_3(\omega) = \frac{\delta}{1-\delta}\frac{\left(\sqrt{3\beta\omega}\right)^3 - 18\beta\omega + 12\sqrt{3\beta\omega}}{27\beta}. \tag{30}$$

Let's define:

$$F(x) = x^{\frac{3}{2}} - 6x + 12x^{\frac{1}{2}}, \text{ with} \tag{31}$$

$$F\prime(x) = \frac{3}{2\sqrt{x}}\left(\sqrt{x} - 2\right)^2 > 0, \text{ iff } x \neq 4, \text{ and} \tag{32}$$

$$F\prime\prime(x) = \frac{3(x-4)}{4x^{\frac{3}{2}}} < 0, \text{ iff } x < 4. \tag{33}$$

Thus, equation (30) can be rewritten as:

$$\widetilde{\omega}_3(\omega) = \frac{\delta}{1-\delta}\frac{F(3\beta\omega)}{27\beta}. \tag{34}$$

It is direct to verify that:

$$\widetilde{\omega}_3(0) = 0, \tag{35}$$

$$\widetilde{\omega}_3\prime(\omega) = \frac{\delta}{1-\delta}\frac{F\prime(3\beta\omega)}{9} > 0, \text{ iff } \omega \neq \frac{4}{3\beta}, \tag{36}$$

$$\widetilde{\omega}_3\prime(0) = \infty, \tag{37}$$

$$\widetilde{\omega}_3\prime\left(\frac{4}{3\beta}\right) = 0 \text{ and} \tag{38}$$

$$\widetilde{\omega}_3\prime\prime(\omega) = \frac{\delta}{1-\delta}\frac{\beta}{3}F\prime\prime(3\beta\omega) < 0, \text{ iff } \omega < \frac{4}{3\beta}. \tag{39}$$

Equation (35) verifies that a fixed point exists at $\omega = 0$, and equations (35)-(39) imply that a necessary and sufficient condition for a unique fixed point $\omega^{III} \in \left(0, \frac{4}{3\beta}\right)$ is that $\widetilde{\omega}_3\left(\frac{4}{3\beta}\right) < \frac{4}{3\beta}$, or

$$\delta < \frac{9}{11}. \tag{40}$$

If instead (40) fails, then $\widetilde{\omega}_3\left(\frac{4}{3\beta}\right) \geq \frac{4}{3\beta}$. But $\forall\omega \geq \frac{4}{3\beta}$, $\tau_3^c(e,\omega) = 0$, and thus, free trade is sustainable for any e in this case. That is, we need to assume that $\delta \in \left(0, \frac{9}{11}\right)$ to avoid either of the extreme polar cases in which the phase-III most-cooperative tariff equals to zero or the noncooperative tariff $\tau_3^N(e)$.

Lemma 1

$$\tau_3^c\left(e,\omega^{III}\right) < \tau_3^N(e).$$

3.2 Phase II

We turn next to phase II. Phase II is a transition phase, during which negotiations among the countries, that might lead to the full implementation of the aforementioned two customs-union agreements by the beginning of the next period, have already begun. We maintain the assumption that if the countries are in phase II at date t, then there is an exogenous probability $\lambda \in (0,1)$ of being in phase III at date $t+1$.

3.2.1 A Static Model

In this section, we characterize the set of static Nash equilibria for phase II. Given that we restrict ourselves to the imposition of only specific import tariffs, and assuming that the markets for all goods clear, we obtain the following set of equilibrium prices for country X, and similar sets of equations for the other three countries:[12]

$$P_X^X(e, \tau_X^Y, \tau_X^W, \tau_X^Z) = \frac{\alpha - 1 - e}{\beta} - \frac{1}{4}\left(\tau_X^Y + \tau_X^W + \tau_X^Z\right), \tag{41}$$

$$P_Y^X(e, \tau_Y^X, \tau_Y^W, \tau_Y^Z) = \frac{\alpha - 1 - e}{\beta} - \frac{1}{4}\left(\tau_Y^W + \tau_Y^Z\right) + \frac{3}{4}\tau_Y^X, \tag{42}$$

$$P_W^X\left(e, \tau_W^X, \tau_W^Y, \tau_W^Z\right) = \frac{\alpha - 1 - e}{\beta} - \frac{1}{4}\left(\tau_W^Y + \tau_W^Z\right) + \frac{3}{4}\tau_W^X \text{ and} \tag{43}$$

$$P_Z^X\left(e, \tau_Z^X, \tau_Z^Y, \tau_Z^W\right) = \frac{\alpha - 1 - e}{\beta} - \frac{1}{4}\left(\tau_Z^Y + \tau_Z^W\right) + \frac{3}{4}\tau_Z^X. \tag{44}$$

[12] We assume that the import tariffs chosen by the four countries do not prohibit trade. This implies for good X, for example, that:

$$\tau_X^Y + \tau_X^W + \tau_X^Z < \frac{12\,(1+e)}{\beta}.$$

The equilibrium prices above result in the following market-clearing import volumes for country X:

$$M_Y^X(e, \tau_Y^X, \tau_Y^W, \tau_Y^Z) = 1 + e + \frac{\beta}{4}\left(\tau_Y^W + \tau_Y^Z - 3\tau_Y^X\right), \tag{45}$$

$$M_W^X(e, \tau_W^X, \tau_W^Y, \tau_W^Z) = 1 + e + \frac{\beta}{4}\left(\tau_W^Y + \tau_W^Z - 3\tau_W^X\right) \text{ and} \tag{46}$$

$$M_Z^X(e, \tau_Z^X, \tau_Z^Y, \tau_Z^W) = 1 + e + \frac{\beta}{4}\left(\tau_Z^Y + \tau_Z^W - 3\tau_Z^X\right). \tag{47}$$

The market-clearing import volumes for the rest of the countries are described by similar equations.

Letting $W_2^X\left(e, \tau_Y^X, \tau_W^X, \tau_Z^X, \tau_X^Y, \tau_W^Y, \tau_Z^Y, \tau_X^W, \tau_Y^W, \tau_Z^W, \tau_X^Z, \tau_Y^Z, \tau_W^Z\right)$ represent the welfare of country X, given by the sum of consumer surplus, producer surplus, and tariff revenue, we have:

$$\begin{aligned}
&W_2^X\left(e, \tau_Y^X, \tau_W^X, \tau_Z^X, \tau_X^Y, \tau_W^Y, \tau_Z^Y, \tau_X^W, \tau_Y^W, \tau_Z^W, \tau_X^Z, \tau_Y^Z, \tau_W^Z\right) = \\
&\quad \int_{P_X^X(e,\tau_X^Y,\tau_X^W,\tau_X^Z)}^{\frac{\alpha}{\beta}} C(P)\,dP + \int_{P_Y^X(e,\tau_Y^X,\tau_Y^W,\tau_Y^Z)}^{\frac{\alpha}{\beta}} C(P)\,dP \\
&\quad + \int_{P_W^X\left(e,\tau_W^X,\tau_W^Y,\tau_W^Z\right)}^{\frac{\alpha}{\beta}} C(P)\,dP + \int_{P_Z^X\left(e,\tau_Z^X,\tau_Z^Y,\tau_Z^W\right)}^{\frac{\alpha}{\beta}} C(P)\,dP \\
&\quad + \int_0^{P_X^X(e,\tau_X^Y,\tau_X^W,\tau_X^Z)} (4+4e)\,dP + \tau_Y^X M_Y^X(e, \tau_Y^X, \tau_Y^W, \tau_Y^Z) \\
&\quad + \tau_W^X M_W^X\left(e, \tau_W^X, \tau_W^Y, \tau_W^Z\right) + \tau_Z^X M_Z^X\left(e, \tau_Z^X, \tau_Z^Y, \tau_Z^W\right).
\end{aligned} \tag{48}$$

The welfare functions of the other three countries are similarly defined.

Let's consider now the optimal tariffs for country X. We calculate the first-order derivatives of the welfare function with respect to τ_Y^X, τ_W^X and τ_Z^X:

$$\frac{dW_2^X(\cdot)}{d\tau_Y^X} = \frac{1}{4}(1+e) + \frac{\beta}{16}\left(\tau_Y^W + \tau_Y^Z - 15\tau_Y^X\right), \tag{49}$$

$$\frac{dW_2^X(\cdot)}{d\tau_W^X} = \frac{1}{4}(1+e) + \frac{\beta}{16}\left(\tau_W^Y + \tau_W^Z - 15\tau_W^X\right) \text{ and} \tag{50}$$

$$\frac{dW_2^X(\cdot)}{d\tau_Z^X} = \frac{1}{4}(1+e) + \frac{\beta}{16}\left(\tau_Z^Y + \tau_Z^W - 15\tau_Z^X\right). \tag{51}$$

Thus, $W_2^X(\cdot)$ is strictly concave in all τ_Y^X, τ_W^X and τ_Z^X. The best-response correspondences for country X are:

$$\tau_Y^{X^R} = \frac{4(1+e)}{15\beta} + \frac{1}{15}\left(\tau_Y^W + \tau_Y^Z\right), \tag{52}$$

$$\tau_W^{X^R} = \frac{4(1+e)}{15\beta} + \frac{1}{15}\left(\tau_W^Y + \tau_W^Z\right) \text{ and} \tag{53}$$

$$\tau_Z^{X^R} = \frac{4(1+e)}{15\beta} + \frac{1}{15}\left(\tau_Z^Y + \tau_Z^W\right). \tag{54}$$

We can carry out a similar analysis for the rest of the countries.

Nevertheless, as in phase III, given the symmetry of our model, no basis exists for asymmetric tariffs across countries or products. Thus, we have a unique Nash tariff applied by all countries on all of their imports. The phase-II Nash tariff is:

$$\tau_2^N(e) = \frac{4(1+e)}{13\beta} < \tau_3^N(e) = \frac{2(1+e)}{3\beta}. \tag{55}$$

The Phase-III Nash tariff strictly exceeds the Phase-II one because of the increased market power possessed by the countries once they get organized into customs unions.

3.2.2 A Dynamic Model

Now, we extend the model in the same fashion as above to allow for repeated interaction. In particular, at the beginning of every period, a common value for e is observed by all, current protection policies are implemented, and current welfare is determined. At the start of the following period, all past choices are observed and a new value for e is obtained by all four countries.

The phase-II most-cooperative tariff, τ_2^c, must provide each country with no incentive to defect. In other words, for any e, the expected discounted welfare to each country under the strategy τ_2^c must be no less than the welfare achieved by the country when defecting and thereafter receiving the expected discounted welfare associated with facing in both phases II and III (if reached) the corresponding static Nash-equilibrium tariffs. A country choosing to defect obviously does best by picking a tariff on its reaction curve. This implies that if country i decides to defect, then:

$$\tau_2^{i^D}\left(e,\tau_2^c\right)=\frac{4\left(1+e\right)}{15\beta}+\frac{2}{15}\tau_2^c. \tag{56}$$

Fixing both e and τ_2^c, the static incentive to defect for country i is:

$$\Omega_2^i\left(e,\tau_2^{i^D}\left(e,\tau_2^c\right),\tau_2^c\right)\equiv W_2^i\left(e,\tau_2^{i^D}\left(e,\tau_2^c\right),\tau_2^c\right)-W_2^i\left(e,\tau_2^c,\tau_2^c\right). \tag{57}$$

Using the envelope theorem, we get:

$$\frac{d\Omega_2^i\left(e,\tau_2^{i^D}\left(e,\tau_2^c\right),\tau_2^c\right)}{de}=\frac{3\left[\tau_2^{i^D}\left(e,\tau_2^c\right)-\tau_2^c\right]}{4}\text{ and} \tag{58}$$

$$\frac{d\Omega_2^i\left(e,\tau_2^{i^D}\left(e,\tau_2^c\right),\tau_2^c\right)}{d\tau_2^c}=-\frac{3}{4}\left(1+e\right)+\frac{\beta}{16}\left[6\tau_2^{i^D}\left(e,\tau_2^c\right)+33\tau_2^c\right]. \tag{59}$$

This implies that $\Omega_2^i\left(e,\tau_2^{i^D}\left(e,\tau_2^c\right),\tau_2^c\right)$ is strictly increasing in e and strictly decreasing in τ_2^c if and only if:

$$\tau_2^c < \frac{4(1+e)}{13\beta} = \tau_2^N(e). \quad (60)$$

Now, if country i chooses not to defect, the present discounted value of the expected future gains from its cooperation today is:

$$\delta \sum_{r=1}^{\infty} \lambda (1-\lambda)^{r-1} \{ \sum_{q=1}^{r-1} \delta^{q-1} \left[EW_2^i(e, \tau_2^c(e), \tau_2^c(e)) - EW_2^i\left(e, \tau_2^N(e), \tau_2^N(e)\right) \right]$$
$$+ \sum_{k=r}^{\infty} \delta^{k-1} \left[EW_3^i\left(e, \tau_3^c\left(e, \omega^{III}\right), \tau_3^c\left(e, \omega^{III}\right)\right) - EW_3^i\left(e, \tau_3^N(e), \tau_3^N(e)\right) \right] \}$$
$$\equiv \omega_2^i\left(\tau_2^c(\cdot), \tau_3^c(\cdot)\right), \quad (61)$$

where r indexes the period at which phase III begins, with $r = 1$ meaning that phase III begins in the next period, and where q and k correspond to periods within phases II and III, respectively.[13] With some further algebra, we obtain the easier-to-use form:

$$\omega_2^i\left(\tau_2^c(\cdot), \tau_3^c(\cdot)\right) = \frac{(1-\lambda)\delta}{1-(1-\lambda)\delta} [EW_2^i(e, \tau_2^c(e), \tau_2^c(e))$$
$$- EW_2^i\left(e, \tau_2^N(e), \tau_2^N(e)\right)]$$
$$+ \frac{\lambda}{1-(1-\lambda)\delta} \frac{\delta}{1-\delta} [EW_3^i\left(e, \tau_3^c\left(e, \omega^{III}\right), \tau_3^c\left(e, \omega^{III}\right)\right)$$
$$- EW_3^i\left(e, \tau_3^N(e), \tau_3^N(e)\right)]. \quad (62)$$

Since e is i.i.d. across periods and countries, ω_2^i is independent of the current values of both e and $\tau_2^c(e)$. Nevertheless, the function $\tau_2^c(\cdot)$, as well as the function $\tau_3^c(\cdot)$, will affect ω_2^i, since both functions' distributional characteristics influence the pertinent expected values. ω_2^i will be strictly positive when $\delta > 0$,

[13] We assume that: $\sum_{q=1}^{0} \delta^{q-1} \left[EW_2^i(e, \tau_2^c(e), \tau_2^c(e)) - EW_2^i\left(e, \tau_2^N(e), \tau_2^N(e)\right) \right] \equiv 0$.

in which case the threat of future punishment is meaningful.

Simple calculation reveals that for any distribution of e:

$$\omega_2^i\left(\tau_2^c(\cdot)\right) = \frac{(1-\lambda)\delta}{1-(1-\lambda)\delta}\{\frac{6}{169\beta}[Var(e+1)+(E(e+1))^2] - \frac{3\beta}{8}[Var(\tau_2^c(e))+(E(\tau_2^c(e)))^2]\} + \frac{\lambda}{1-(1-\lambda)\delta}\omega^{III}. \quad (63)$$

The expected future gain from current cooperation is higher when $Var(e+1)$ and $E(e+1)$ are higher, for a given $\tau_2^c(e)$.

Given that equations (57) and (63) are identical across countries, we can drop the superscripts. The fundamental no-defect condition is that the benefit of cheating is less than the present discounted value of the expected future gain from cooperating today. That is:

$$\Omega_2\left(e, \tau_2^D\left(e, \tau_2^c(e)\right), \tau_2^c(e)\right) \leq \omega_2\left(\tau_2^c(\cdot)\right). \quad (64)$$

There will be in general more than one functions satisfying the condition above. To obtain the most-cooperative tariff function, we first hold ω_2 fixed at a constant level and solve for the lowest, nonnegative τ_2^c satisfying (64).

To begin, fix $\omega_2 > 0$. If $e = -1$ and $\tau_2^c = 0$, the no-defect condition is satisfied, since:

$$\Omega_2\left(-1, \tau_2^D(-1,0), 0\right) = 0 < \omega_2. \quad (65)$$

Holding τ_2^c fixed at zero and raising e, we know from (58) that $\Omega_2\left(e, \tau_2^D(e,0), 0\right)$ increases monotonically. If ω_2 is not too large, which is true if δ is not too high, then there exists a critical value of e, $\overline{e}_2$, such that:

$$\Omega_2\left(\overline{e}_2, \tau_2^D(\overline{e}_2, 0), 0\right) = \omega_2. \quad (66)$$

Solving explicitly yields:

$$\overline{e}_2 = \sqrt{10\beta\omega_2} - 1. \tag{67}$$

Free trade is sustainable for $e \in [-1, \overline{e}_2]$. If $e \in (\overline{e}_2, 1]$, the no-defect condition will be violated at $\tau_2^c = 0$. Thus, τ_2^c must rise to restore (64). Explicit calculation reveals that:

$$\tau_2^c(e, \omega_2) = \begin{cases} 0, & if \quad e \in [-1, \overline{e}_2] \\ \frac{4\left(1+e-\sqrt{10\beta\omega_2}\right)}{13\beta}, & if \quad e \in [\overline{e}_2, 1] \end{cases}. \tag{68}$$

The above analysis was conducted under an exogenous ω_2. It is clear from (63) that ω_2 depends on the $\tau_2^c(\cdot)$ function, as $\omega_2 = \omega_2(\tau_2^c(\cdot))$. Now, using (63), (67) and (68), we can write the resulting equation as $\widetilde{\omega}_2(\omega) = \omega$. The most-cooperative import tariff can then be represented as $\tau_2^c = \tau_2^c(e)$, when the largest $\widehat{\omega}_2$ such that $\widehat{\omega}_2 \in \left(0, \frac{4}{10\beta}\right)$ and $\widetilde{\omega}_2(\widehat{\omega}_2) = \widehat{\omega}_2$ is substituted into $\tau_2^c(e, \omega)$. Let the aforementioned $\widehat{\omega}_2$ be called ω^{II}.

We explicitly calculate $E(\tau_2^c(e))$ from (67) and (68), and use (63) to get for any distribution of e:

$$\begin{aligned} \widetilde{\omega}_2(\omega) = \frac{(1-\lambda)\delta}{1-(1-\lambda)\delta}\frac{6}{169\beta}[Var(e+1) + (E(e+1))^2 \\ - \int_{\overline{e}_2}^{1}\left(1+e-\sqrt{10\beta\omega}\right)^2 dG(e)] + \frac{\lambda}{1-(1-\lambda)\delta}\omega^{III}, \end{aligned} \tag{69}$$

if $\omega \in \left[0, \frac{4}{10\beta}\right]$, where G is the cumulative distribution function of e.

If we use the fact that e is uniformly distributed on $[-1, 1]$, then, (69) becomes:

$$\widetilde{\omega}_2(\omega) = \frac{(1-\lambda)\delta}{1-(1-\lambda)\delta}\frac{\left(\sqrt{10\beta\omega}\right)^3 - 60\beta\omega + 12\sqrt{10\beta\omega}}{169\beta} + \frac{\lambda}{1-(1-\lambda)\delta}\omega^{III}. \tag{70}$$

Let's first prove that there exists a fixed point on $\left(0, \frac{4}{10\beta}\right)$. Using (31), we can rewrite the preceding equation as:

$$\widetilde{\omega}_2(\omega) = \frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{F(10\beta\omega)}{169\beta} + \frac{\lambda}{1-(1-\lambda)\delta}\omega^{III}. \tag{71}$$

It is easy to show that:

$$\widetilde{\omega}_2(0) = \frac{\lambda}{1-(1-\lambda)\delta}\omega^{III} > 0, \tag{72}$$

$$\widetilde{\omega}_2\prime(\omega) = \frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{10}{169}F\prime(10\beta\omega) > 0 \text{ iff } \omega \neq \frac{4}{10\beta}, \tag{73}$$

$$\widetilde{\omega}_2\prime(0) = \infty, \tag{74}$$

$$\widetilde{\omega}_2\prime\left(\frac{4}{10\beta}\right) = 0 \text{ and} \tag{75}$$

$$\widetilde{\omega}_2\prime\prime(\omega) = \frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{100\beta}{169}F\prime\prime(10\beta\omega) < 0 \text{ iff } \omega < \frac{4}{10\beta}. \tag{76}$$

Equations (72)-(76) imply that a necessary and sufficient condition for a unique fixed point $\omega^{II} \in \left(0, \frac{4}{10\beta}\right)$ is $\widetilde{\omega}_2\left(\frac{4}{10\beta}\right) < \frac{4}{10\beta}$. To guarantee this, given that it is convenient to ensure that free trade is never supportable, we further require that:

$$\delta < \frac{45}{11\sqrt{30}+15} \equiv \delta^*, \tag{77}$$

which in addition implies that $\widetilde{\omega}_3\left(\frac{4}{10\beta}\right) < \frac{4}{10\beta}$, or that $\omega^{III} \in \left(0, \frac{4}{10\beta}\right)$.

Lemma 2 *If $\delta \in (0, \delta^*)$, then $\omega^{II} \in \left(0, \frac{4}{10\beta}\right)$.*

Proof. *We know that* $\omega^{II} \in \left(0, \frac{4}{10\beta}\right)$ *iff* $\widetilde{\omega}_2\left(\frac{4}{10\beta}\right) < \frac{4}{10\beta}$. *From (71):*

$$\widetilde{\omega}_2\left(\frac{4}{10\beta}\right) = \frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{8}{169\beta} + \frac{\lambda}{1-(1-\lambda)\delta}\omega^{III}.$$

Given that $\delta < \delta^*$ *and thus,* $\omega^{III} < \frac{4}{10\beta}$, *it suffices to show that:*

$$\frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{8}{169\beta} + \frac{\lambda}{1-(1-\lambda)\delta}\frac{4}{10\beta} < \frac{4}{10\beta} \Longleftrightarrow \delta < \frac{169}{189},$$

which holds if $\delta < \delta^*$. ■

We assume that $\delta \in (0, \delta^*)$ in all that follows. We, now, compare ω^{II} and ω^{III} through a sequence of lemmas.

Lemma 3 *Fix* $\alpha > 0$ *and consider the function:*

$$Q_\alpha(x) = \sqrt{3\alpha}x - 4\left(\sqrt{\alpha}+\sqrt{3}\right)\sqrt{x} + 12.$$

Then $Q_\alpha(x)$ *is strictly decreasing on* $\left(0, \frac{4}{3}\right)$.

Proof. *We have:*

$$Q_\alpha\prime(x) = \sqrt{3\alpha} - \frac{2\left(\sqrt{\alpha}+\sqrt{3}\right)}{\sqrt{x}} < \sqrt{3\alpha} - \frac{2\sqrt{\alpha}}{\sqrt{x}} = \frac{\sqrt{\alpha}\left(\sqrt{3x}-2\right)}{\sqrt{x}},$$

which is strictly negative iff $x \in \left(0, \frac{4}{3}\right)$. ■

Lemma 4 *Fix* $\alpha > 0$ *and consider the function:*

$$R_\alpha(x) = \frac{F(\alpha x)}{F(3x)} = \sqrt{\frac{\alpha}{3}}\frac{\alpha x - 6\sqrt{\alpha x}+12}{3x - 6\sqrt{3x}+12}.$$

(i) If $\alpha < 3$, *then* $R_\alpha(x)$ *is strictly increasing on* $\left(0, \frac{4}{3}\right)$.

(ii) If $\alpha > 3$, *then* $R_\alpha(x)$ *strictly decreases on* $(0, x_0)$ *and strictly increases on* $\left(x_0, \frac{4}{3}\right)$. *Here,* x_0 *denotes the unique solution to the equation* $Q_\alpha(x) = 0$

that lies in the interval $\left(0, \frac{4}{3}\right)$.

Proof. *Except for a strictly positive factor,* $R_{\alpha}\prime(x)$ *is equal to:*

$$\left(\alpha - \frac{3\sqrt{\alpha}}{\sqrt{x}}\right)\left(3x - 6\sqrt{3x} + 12\right) - \left(3 - \frac{3\sqrt{3}}{\sqrt{x}}\right)\left(\alpha x - 6\sqrt{\alpha x} + 12\right).$$

In particular, $R_{\alpha}\prime(x)$ *has the same sign as:*

$$\left(\alpha\sqrt{x} - 3\sqrt{\alpha}\right)\left(x - 2\sqrt{3x} + 4\right) - \left(\sqrt{x} - \sqrt{3}\right)\left(\alpha x - 6\sqrt{\alpha x} + 12\right).$$

Note that the last expression can also be written in the form:

$$\left(3\sqrt{\alpha} - \alpha\sqrt{3}\right)x + 4\left(\alpha - 3\right)\sqrt{x} + 12\left(\sqrt{3} - \sqrt{\alpha}\right).$$

The latter equals to:

$$\left(\sqrt{3} - \sqrt{\alpha}\right)Q_{\alpha}(x).$$

Case 1: *If* $\alpha < 3$, *then the expression inside the parentheses is strictly positive. Moreover, from Lemma 3:*

$$Q_{\alpha}(x) > Q_{\alpha}\left(\frac{4}{3}\right) = \frac{4\sqrt{3}}{3}\left(\sqrt{3} - \sqrt{\alpha}\right) > 0.$$

Thus, $R_{\alpha}\prime(x)$ *is strictly positive on* $\left(0, \frac{4}{3}\right)$.

Case 2: *If* $\alpha > 3$, *then the expression inside the parentheses is strictly negative. In addition, we have that:*

$$Q_{\alpha}(0) = 12 > 0 \text{ and}$$

$$Q_{\alpha}\left(\frac{4}{3}\right) = \frac{4\sqrt{3}}{3}\left(\sqrt{3} - \sqrt{\alpha}\right) < 0.$$

Thus, from Lemma 3, it is clear that $R_{\alpha}\prime(x)$ *is strictly negative up to the point*

x_0 where $Q_\alpha(x_0) = 0$, and it is strictly positive afterwards. ■

With Lemma 4 in place, we obtain:

Lemma 5

$$\omega^{II} < \omega^{III}.$$

Proof.

$$\omega^{II} < \omega^{III} \Longleftrightarrow \widetilde{\omega}_2\left(\omega^{III}\right) < \omega^{III} \Longleftrightarrow$$

$$\Longleftrightarrow \frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{F\left(10\beta\omega^{III}\right)}{169\beta} + \frac{\lambda}{1-(1-\lambda)\delta}\omega^{III} < \omega^{III} \Longleftrightarrow$$

$$\Longleftrightarrow \frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{F\left(10\beta\omega^{III}\right)}{169\beta} < \frac{(1-\lambda)(1-\delta)}{1-(1-\lambda)\delta}\omega^{III} \Longleftrightarrow$$

$$\Longleftrightarrow \frac{F\left(10\beta\omega^{III}\right)}{169} < \frac{F\left(3\beta\omega^{III}\right)}{27}.$$

Given $0 < \omega^{III} < \frac{4}{10\beta} < \frac{4}{3\beta}$, it suffices to verify that $R_{10}(x) = \frac{F(10x)}{F(3x)} < \frac{169}{27}$, for $x \in \left(0, \frac{4}{3}\right)$. According to Lemma 4, $R_{10}(x)$ strictly decreases up to some point and then strictly increases. Thus:

$$R_{10}(x) < \max\left(R_{10}(0), R_{10}\left(\frac{4}{3}\right)\right) = \max\left(\sqrt{\frac{10}{3}}, \frac{19\sqrt{30}-90}{9}\right) =$$

$$= \sqrt{\frac{10}{3}} < \frac{169}{27},$$

and this concludes our proof. ■

We conclude this section by comparing $\overline{e}_2$ and $\overline{e}_3$, as well as $\tau_2^c\left(e, \omega^{II}\right)$ and $\tau_3^c\left(e, \omega^{III}\right)$.

Lemma 6

$$\overline{e}_2 \geq \overline{e}_3 \text{ iff } \lambda \geq \frac{237-237\delta}{1420-237\delta} = \lambda^*.$$

Proof.

$$\overline{e}_2 \geq \overline{e}_3 \Longleftrightarrow 10\beta\omega^{II} \geq 3\beta\omega^{III} \Longleftrightarrow$$

$$\Longleftrightarrow \widetilde{\omega}_2\left(\frac{3}{10}\omega^{III}\right) \geq \frac{3}{10}\omega^{III} \Longleftrightarrow$$

$$\Longleftrightarrow \frac{\delta\left(1-\lambda\right)}{1-\left(1-\lambda\right)\delta}\frac{F\left(3\beta\omega^{III}\right)}{169\beta} + \frac{\lambda}{1-\left(1-\lambda\right)\delta}\omega^{III} \geq \frac{3}{10}\omega^{III} \Longleftrightarrow$$

$$\Longleftrightarrow \frac{\left(1-\lambda\right)\left(1-\delta\right)}{1-\left(1-\lambda\right)\delta}\frac{27}{169}\omega^{III} + \frac{\lambda}{1-\left(1-\lambda\right)\delta}\omega^{III} \geq \frac{3}{10}\omega^{III} \Longleftrightarrow$$

$$\Longleftrightarrow \lambda \geq \frac{237-237\delta}{1420-237\delta} = \lambda^*,$$

and this concludes our proof. ■

Proposition 1 *If* $\lambda \in [\lambda^*, 1)$*:* $\tau_3^c\left(e,\omega^{III}\right) = \tau_2^c\left(e,\omega^{II}\right) = 0$ *if* $e \in [-1, \overline{e}_3]$*, and* $\tau_3^c\left(e,\omega^{III}\right) > \tau_2^c\left(e,\omega^{II}\right)$ *if* $e \in (\overline{e}_3, 1]$.

The intuition behind these results is quite simple. The Phase-III incentive to cheat and per-period value of cooperation are both higher than the Phase-II ones, given the increased market power the countries obtain once they form the customs unions.[14] When λ is sufficiently large, the Phase-III and Phase-II present discounted expected values of cooperation are almost equal, which implies that a higher overall level of protection is required in Phase III than in Phase II so that multilateral cooperation does not break down.

When λ is sufficiently small, the Phase-III present discounted expected value of cooperation is significantly larger than the Phase-II one. Nevertheless, the Phase-III incentive to cheat as a function of e rises very steeply. Thus, initially, a higher level of protection is required in Phase II than in Phase III. But eventually the incentive-to-cheat effect dominates and the Phase-III required level of protection surpasses the Phase-II one.

[14]It turns out the Phase-III market-power effect dominates the Phase-III trade-diversion effect.

Figures 1 and 2 in the Appendix depict the phase-II and phase-III most-cooperative tariffs when $\lambda \in [\lambda^*, 1)$ and $\lambda \in (0, \lambda^*)$, respectively.

3.3 Phase I

During phase I, all countries are aware that negotiations, that might in the end lead to the aforementioned customs unions, might start by the beginning of the next period. More precisely, we assume that if the countries are in phase I at date t, then there is a probability of $\rho \in (0, 1)$ of being in phase II at date $t + 1$.

3.3.1 Static Model

The structure of the static model in phase I is identical to the structure of the static one in phase II, and thus, all the relationships we found there, also hold here. Most importantly:

$$\tau_1^N (e) = \tau_2^N (e) = \frac{4(1+e)}{13\beta}. \tag{78}$$

3.3.2 A Dynamic Model

Let's extend the model to allow for repeated interaction. The phase-I most-cooperative tariff, τ_1^c, must provide each country with no incentive to defect. In other words, for any e, the expected discounted welfare to each country under the strategy τ_1^c must be no less than the welfare achieved by the country when defecting and thereafter receiving the expected discounted welfare associated with facing in all three phases I, II (if reached) and III (if reached) the corresponding static Nash-equilibrium tariffs.

The incentive to cheat is described by identical equations in both phases I and II, and so, we have the following equations for a fixed $\omega_1 > 0$:

$$\overline{e}_1 = \sqrt{10\beta\omega_1} - 1 \text{ and} \tag{79}$$

$$\tau_1^c(e,\omega_1) = \begin{cases} 0, & if \quad e \in [-1, \overline{e}_1] \\ \frac{4\left(1+e-\sqrt{10\beta\omega_1}\right)}{13\beta}, & if \quad e \in [\overline{e}_1, 1] \end{cases}. \tag{80}$$

If a country chooses not to cheat, the present discounted value of the expected future gains from cooperating today is:

$$\omega_1\left(\tau_1^c(\cdot), \tau_2^c(\cdot), \tau_3^c(\cdot)\right) = \delta \sum_{s=1}^{\infty} \rho (1-\rho)^{s-1}$$
$$\{\sum_{t=1}^{s-1} \delta^{t-1} [EW_1(e, \tau_1^c(e,\omega_1), \tau_1^c(e,\omega_1)) - EW_1\left(e, \tau_1^N(e), \tau_1^N(e)\right)]$$
$$+ \delta^{s-1}([EW_2\left(e, \tau_2^c\left(e,\omega^{II}\right), \tau_2^c\left(e,\omega^{II}\right)\right) - EW_2\left(e, \tau_2^N(e), \tau_2^N(e)\right)]$$
$$+ \omega_2\left(\tau_2^c\left(e,\omega^{II}\right), \tau_3^c\left(e,\omega^{III}\right)\right))\}, \tag{81}$$

where s indexes the period at which phase II begins, with $s = 1$ meaning that phase II begins in the next period, and where t represents periods within phase I. Simple algebra reveals that:

$$\omega_1\left(\tau_1^c(\cdot), \tau_2^c(\cdot), \tau_3^c(\cdot)\right) = \frac{(1-\rho)\delta}{1-(1-\rho)\delta} [EW_1(e, \tau_1^c(e,\omega_1), \tau_1^c(e,\omega_1))$$
$$- EW_1\left(e, \tau_1^N(e), \tau_1^N(e)\right)] + \frac{\rho\delta}{1-(1-\rho)\delta}$$
$$\{\frac{[EW_2\left(e, \tau_2^c\left(e,\omega^{II}\right), \tau_2^c\left(e,\omega^{II}\right)\right) - EW_2\left(e, \tau_2^N(e), \tau_2^N(e)\right)]}{1-(1-\lambda)\delta}$$
$$+ \frac{\lambda\delta}{[1-(1-\lambda)\delta](1-\delta)} [EW_3\left(e, \tau_3^c\left(e,\omega^{III}\right), \tau_3^c\left(e,\omega^{III}\right)\right)$$
$$- EW_3\left(e, \tau_3^N(e), \tau_3^N(e)\right)]\}. \tag{82}$$

Since e is i.i.d. across periods and countries, ω_1 is independent of the current values of both e and $\tau_1^c(e)$. Nevertheless, the function $\tau_1^c(\cdot)$, as well as the functions $\tau_2^c(\cdot)$ and $\tau_3^c(\cdot)$, will affect ω_1, since all functions' distributional characteristics influence the pertinent expected values. ω_1 will be strictly positive when $\delta > 0$, in which case the threat of future punishment has significance.

Straightforward calculations reveal that for any distribution of e, we have:

$$\omega_1 (\tau^c (\cdot)) = \frac{(1-\rho)\delta}{1-(1-\rho)\delta} \{ \frac{6}{169\beta} [Var(e+1) + (E(e+1))^2] - \frac{3\beta}{8} [Var(\tau_1^c(e)) + (E(\tau_1^c(e)))^2] \} + \frac{\rho}{1-(1-\rho)\delta} \frac{\omega^{II} - \lambda\omega^{III}}{1-\lambda}. \quad (83)$$

The expected future gain from current cooperation is higher when $Var(e+1)$ and $E(e+1)$ are higher, for a given $\tau_1^c(e)$.

Equation (80) was obtained under the assumption of a fixed $\omega_1 > 0$. It is clear from (83) that ω_1 depends on the $\tau_1^c(\cdot)$ function, as $\omega_1 = \omega_1(\tau_1^c(\cdot))$. Now, using (83), (79) and (80), we can write the resulting equation as $\widetilde{\omega}_1(\omega) = \omega$. The most-cooperative import tariff can then be represented as $\tau_1^c = \tau_1^c(e)$, when the largest $\widehat{\omega}_1$ such that $\widehat{\omega}_1 \in \left(0, \frac{4}{10\beta}\right)$ and $\widetilde{\omega}_1(\widehat{\omega}_1) = \widehat{\omega}_1$ is substituted into $\tau_1^c(e, \omega)$. Let the aforementioned $\widehat{\omega}_1$ be called ω^I.

We explicitly calculate $E(\tau_1^c(e))$ from (79) and (80), and use (83) to get for any distribution of e:

$$\widetilde{\omega}_1(\omega) = \frac{(1-\rho)\delta}{1-(1-\rho)\delta} \frac{6}{169\beta} [Var(e+1) + (E(e+1))^2 - \int_{\overline{e}_1}^{1} \left(1 + e - \sqrt{10\beta\omega}\right)^2 dG(e)] + \frac{\rho}{1-(1-\rho)\delta} \frac{\omega^{II} - \lambda\omega^{III}}{1-\lambda}, \quad (84)$$

if $\omega \in \left[0, \frac{4}{10\beta}\right]$, where G is the cumulative distribution function of e.

Using both the fact that e is uniformly distributed on $[-1, 1]$ and equation

(31), we can rewrite (84) as:

$$\widetilde{\omega}_1(\omega) = \frac{(1-\rho)\delta}{1-(1-\rho)\delta}\frac{\left(\sqrt{10\beta\omega}\right)^3 - 60\beta\omega + 12\sqrt{10\beta\omega}}{169\beta}$$
$$+ \frac{\rho}{1-(1-\rho)\delta}\frac{\omega^{II} - \lambda\omega^{III}}{1-\lambda} =$$
$$= \frac{(1-\rho)\delta}{1-(1-\rho)\delta}\frac{F(10\beta\omega)}{169\beta} + \frac{\rho}{1-(1-\rho)\delta}\frac{\omega^{II} - \lambda\omega^{III}}{1-\lambda}. \quad (85)$$

Let's first prove that a fixed point ω^I does exist on $\left(0, \frac{4}{10\beta}\right)$.

Lemma 7

$$\omega^{II} > \lambda\omega^{III}.$$

Proof.

$$\omega^{II} - \lambda\omega^{III} = \widetilde{\omega}_2(\omega) = \frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{F\left(10\beta\omega^{II}\right)}{169\beta} + \frac{\lambda}{1-(1-\lambda)\delta}\omega^{III} - \lambda\omega^{III} =$$

$$= \frac{\delta(1-\lambda)}{1-(1-\lambda)\delta}\frac{F\left(10\beta\omega^{II}\right)}{169\beta} + \frac{\lambda(1-\lambda)\delta}{1-(1-\lambda)\delta}\omega^{III} > 0,$$

and this concludes our proof. ■

With Lemma 7 in place, it is direct to show that:

$$\widetilde{\omega}_1(0) = \frac{\rho}{1-(1-\rho)\delta}\frac{\omega^{II} - \lambda\omega^{III}}{1-\lambda} > 0\,, \quad (86)$$

$$\widetilde{\omega}_1\prime(\omega) = \frac{(1-\rho)\delta}{1-(1-\rho)\delta}\frac{10}{169}F\prime(10\beta\omega) > 0, \text{ iff } \omega \neq \frac{4}{10\beta}, \quad (87)$$

$$\widetilde{\omega}_1\prime(0) = \infty, \quad (88)$$

$$\widetilde{\omega}_1\prime\left(\frac{4}{10\beta}\right) = 0 \text{ and} \quad (89)$$

$$\widetilde{\omega}_1\prime\prime(\omega) = \frac{(1-\rho)\delta}{1-(1-\rho)\delta}\frac{100\beta}{169}F\prime\prime(10\beta\omega) < 0 \text{ iff } \omega < \frac{4}{10\beta}. \quad (90)$$

Thus, a necessary and sufficient condition for a unique fixed point $\omega^I \in \left(0, \frac{4}{10\beta}\right)$ is $\widetilde{\omega}_1\left(\frac{4}{10\beta}\right) < \frac{4}{10\beta}$. This is true as long as $\delta \in (0, \delta^*)$.

Lemma 8 *If $\delta \in (0, \delta^*)$, then $\omega^I \in \left(0, \frac{4}{10\beta}\right)$.*

Proof. *We know that $\omega^I \in \left(0, \frac{4}{10\beta}\right)$ iff $\widetilde{\omega}_1\left(\frac{4}{10\beta}\right) < \frac{4}{10\beta}$. From (85):*

$$\widetilde{\omega}_1\left(\frac{4}{10\beta}\right) = \frac{(1-\rho)\,\delta}{1-(1-\rho)\,\delta}\frac{8}{169\beta} + \frac{\rho}{1-(1-\rho)\,\delta}\frac{\omega^{II}-\lambda\omega^{III}}{1-\lambda}.$$

Given $\omega^{II} < \omega^{III}$, it suffices to show that:

$$\frac{(1-\rho)\,\delta}{1-(1-\rho)\,\delta}\frac{8}{169\beta} + \frac{\rho}{1-(1-\rho)\,\delta}\frac{\omega^{III}-\lambda\omega^{III}}{1-\lambda} =$$

$$= \frac{(1-\rho)\,\delta}{1-(1-\rho)\,\delta}\frac{8}{169\beta} + \frac{\rho}{1-(1-\rho)\,\delta}\omega^{III} < \frac{4}{10\beta}.$$

Given $\delta < \delta^*$ and thus, $\omega^{III} < \frac{4}{10\beta}$, it suffices to show:

$$\frac{(1-\rho)\,\delta}{1-(1-\rho)\,\delta}\frac{8}{169\beta} + \frac{\rho}{1-(1-\rho)\,\delta}\frac{4}{10\beta} < \frac{4}{10\beta} \iff \delta < \frac{169}{189},$$

which holds if $\delta < \delta^*$. ■

Next, we compare ω^I, ω^{II} and ω^{III}:

Lemma 9

$$\omega^I < \omega^{II} < \omega^{III}.$$

Proof. *Given Lemma 5, we only need to prove that $\omega^I < \omega^{II}$. Therefore:*

$$\omega^I < \omega^{II} \iff \widetilde{\omega}_1\left(\omega^{II}\right) < \omega^{II} \iff$$

$$\iff \frac{(1-\rho)\,\delta}{1-(1-\rho)\,\delta}\frac{F\left(10\beta\omega^{II}\right)}{169\beta} + \frac{\rho}{1-(1-\rho)\,\delta}\frac{\omega^{II}-\lambda\omega^{III}}{1-\lambda} < \omega^{II} \iff$$

$$\iff \lambda\omega^{II} < \lambda\omega^{III} \iff \omega^{II} < \omega^{III},$$

and this concludes our proof. ■

Corollary 1

$$\overline{e}_2 > \overline{e}_1.$$

Proposition 2

$$\tau_1^c\left(e,\omega^I\right) = \tau_2^c\left(e,\omega^{II}\right) = 0 \;\; \text{if } e \in [-1,\overline{e}_1] \;\; \text{and}$$

$$\tau_1^c\left(e,\omega^I\right) > \tau_2^c\left(e,\omega^{II}\right) \;\; \text{if } e \in (\overline{e}_1, 1].$$

The intuition is once again straightforward. The Phase-I and Phase-II incentives to cheat are functions of identical trade patterns since the countries in both of the aforementioned phases trade normally with each other. Nevertheless, in Phase I, in comparison to Phase II, the countries are farther away from the high-stakes Phase III, and as a result, the present discounted expected value of cooperation is lower than the Phase-II one. Thus, a higher level of overall protection is required in Phase I than in Phase II so that multilateral cooperation is sustained.

Finally, we compare $\overline{e}_1$ and $\overline{e}_3$, as well as $\tau_1^c\left(e,\omega^I\right)$ and $\tau_3^c\left(e,\omega^{III}\right)$. Figure 3 in the Appendix depicts the phase-I, phase-II and phase-III most-cooperative tariffs if $\lambda \in (0,\lambda^*)$. If instead $\lambda \in [\lambda^*,1)$, we obtain:

Lemma 10 *If* $\delta \in \left(\frac{237}{1420},\delta^*\right)$, $\lambda \in \left(\frac{\lambda^*}{\delta(1-\lambda^*)},1\right)$ *and* $\rho \in [\frac{\lambda^*[1-(1-\lambda)\delta]}{(\lambda-\lambda^*)\delta},1)$*:*

$$\overline{e}_1 \geq \overline{e}_3.$$

Proof.

$$\overline{e}_1 \geq \overline{e}_3 \Longleftrightarrow 10\beta\omega^I \geq 3\beta\omega^{III} \Longleftrightarrow$$

$$\Longleftrightarrow \widetilde{\omega}_1\left(\frac{3}{10}\omega^{III}\right) \geq \frac{3}{10}\omega^{III} \Longleftrightarrow$$

$$\iff (1-\lambda)\left[1-(1-\rho)\,\delta\right]\widetilde{\omega}_1\left(\frac{3}{10}\omega^{III}\right) \geq (1-\lambda)\left[1-(1-\rho)\,\delta\right]\frac{3}{10}\omega^{III} \iff$$

$$\iff (1-\rho)(1-\lambda)(1-\delta)\frac{27}{169}\omega^{III} + \rho\left(\omega^{II} - \lambda\omega^{III}\right) \geq$$

$$(1-\lambda)\left[1-(1-\rho)\,\delta\right]\frac{3}{10}\omega^{III}.$$

The last inequality can be written as:

$$A\omega^{III} + \rho\omega^{II} - \rho\lambda\omega^{III} \geq B\omega^{III}.$$

It is equivalent to the inequality:

$$\omega^{II} \geq \frac{B - A + \rho\lambda}{\rho}\omega^{III}.$$

Now, we write this as:

$$\omega^{II} \geq \Gamma\omega^{III} \iff \widetilde{\omega}_2\left(\Gamma\omega^{III}\right) \geq \Gamma\omega^{III} \iff$$

$$\iff \frac{\delta(1-\lambda)}{1-(1-\lambda)\,\delta}\frac{F\left(10\beta\Gamma\omega^{III}\right)}{169\beta} + \frac{\lambda}{1-(1-\lambda)\,\delta}\omega^{III} \geq \Gamma\omega^{III} \iff$$

$$\iff \frac{\delta(1-\lambda)}{1-(1-\lambda)\,\delta}\frac{F\left(10\beta\Gamma\omega^{III}\right)}{169\beta} \geq \frac{\Gamma - \Gamma(1-\lambda)\,\delta - \lambda}{1-(1-\lambda)\,\delta}\omega^{III} \iff$$

$$\iff \frac{F\left(10\beta\Gamma\omega^{III}\right)}{F\left(3\beta\omega^{III}\right)} \geq \frac{169}{27}\frac{\Gamma - \Gamma(1-\lambda)\,\delta - \lambda}{(1-\lambda)(1-\delta)}.$$

Let's assume $\Gamma > \frac{3}{10}$*. Then, we have:*

$$\frac{F\left(10\beta\Gamma\omega^{III}\right)}{F\left(3\beta\omega^{III}\right)} > 1.$$

So, it suffices to show that:

$$169\left[\Gamma - \Gamma(1-\lambda)\,\delta - \lambda\right] \leq 27(1-\lambda)(1-\delta) \iff$$

$$\iff \Gamma \leq \frac{27\left(1-\lambda\right)\left(1-\delta\right)+169\lambda}{169\left[1-\left(1-\lambda\right)\delta\right]} \iff$$

$$\iff \frac{B-A+\rho\lambda}{\rho} \leq \frac{27\left(1-\lambda\right)\left(1-\delta\right)+169\lambda}{169\left[1-\left(1-\lambda\right)\delta\right]} \iff$$

$$\iff B-A \leq \frac{27\left(1-\lambda\right)\left(1-\delta\right)+169\lambda}{169\left[1-\left(1-\lambda\right)\delta\right]}\rho-\rho\lambda.$$

We have assumed above that:

$$\Gamma > \frac{3}{10} \iff \frac{B-A+\rho\lambda}{\rho} > \frac{3}{10} \iff$$

$$\iff A-B < \left(\lambda-\frac{3}{10}\right)\rho \iff$$

$$\iff \left(1-\delta\right)\left(1-\lambda\right)\left(1-\rho\right)\frac{27}{169}-\left(1-\lambda\right)\left[1-\left(1-\rho\right)\delta\right]\frac{3}{10} < \left(\lambda-\frac{3}{10}\right)\rho \iff$$

$$\iff -\frac{237\left(1-\lambda\right)\left(1-\delta\right)}{1690} < \left[\lambda-\frac{3}{10}+\left(1-\lambda\right)\frac{237\delta+270}{1690}\right]\rho \iff$$

$$\iff -\frac{237\left(1-\lambda\right)\left(1-\delta\right)}{1690} < \left[\frac{1420-237\delta}{1690}\lambda-\frac{237\left(1-\delta\right)}{1690}\right]\rho \iff$$

$$\iff -\lambda^{*}\left(1-\lambda\right) < \left(\lambda-\lambda^{*}\right)\rho,$$

which, given we are assuming $\lambda \geq \lambda^{*}$, holds trivially for all $\rho \in (0,1)$. Thus, we have not made any additional assumptions so far. Returning to our proof, it remains to be shown that:

$$B-A \leq \frac{27\left(1-\lambda\right)\left(1-\delta\right)+169\lambda}{169\left[1-\left(1-\lambda\right)\delta\right]}\rho-\rho\lambda \iff$$

$$\iff B-A \leq \frac{\left(1-\lambda\right)\left(169\lambda\delta+27-27\delta\right)}{169\left[1-\left(1-\lambda\right)\delta\right]}\rho \iff$$

$$\iff \frac{169\lambda\delta+27-27\delta}{169\left[1-\left(1-\lambda\right)\delta\right]}\rho \geq \left[1-\left(1-\rho\right)\delta\right]\frac{3}{10}-\left(1-\delta\right)\left(1-\rho\right)\frac{27}{169} \iff$$

$$\iff \frac{169\lambda\delta+27-27\delta}{169\left[1-\left(1-\lambda\right)\delta\right]}\rho \geq \frac{237\left(1-\delta\right)}{1690}+\frac{237\delta+270}{1690}\rho \iff$$

$$\iff \left[\frac{1690\lambda\delta + 270\,(1-\delta)}{1-(1-\lambda)\,\delta} - 237\delta - 270\right]\rho \geq 237\,(1-\delta) \iff$$

$$\iff \frac{\lambda\,(1420-237\delta) - 237\,(1-\delta)}{1-(1-\lambda)\,\delta}\delta\rho \geq 237\,(1-\delta) \iff$$

$$\iff \frac{(\lambda-\lambda^*)}{1-(1-\lambda)\,\delta}\delta\rho \geq \lambda^* \iff \rho \geq \frac{\lambda^*\,[1-(1-\lambda)\,\delta]}{(\lambda-\lambda^*)\,\delta}.$$

Given $\rho < 1$, this implies:

$$\frac{\lambda^*\,[1-(1-\lambda)\,\delta]}{(\lambda-\lambda^*)\,\delta} < 1 \iff \lambda > \frac{\lambda^*}{\delta\,(1-\lambda^*)}.$$

Given $\lambda < 1$, this further implies that:

$$\frac{\lambda^*}{\delta\,(1-\lambda^*)} < 1 \iff \delta > \frac{237}{1420},$$

and this concludes our proof. ■

Proposition 3 *If $\delta \in \left(\frac{237}{1420}, \delta^*\right)$, $\lambda \in \left(\frac{\lambda^*}{\delta(1-\lambda^*)}, 1\right)$ and $\rho \in [\frac{\lambda^*[1-(1-\lambda)\delta]}{(\lambda-\lambda^*)\delta}, 1)$:*

$$\tau_3^c\left(e, \omega^{III}\right) = \tau_1^c\left(e, \omega^I\right) = 0 \text{ if } e \in [-1, \overline{e}_3] \text{ and}$$

$$\tau_3^c\left(e, \omega^{III}\right) > \tau_1^c\left(e, \omega^I\right) \text{ if } e \in (\overline{e}_3, 1].$$

These results are simple to interpret. The Phase-III incentive to cheat and per-period value of cooperation are both higher than the Phase-I ones. When ρ and λ are both sufficiently high, the Phase-I and Phase-III present discounted expected values of cooperation are almost equal. Thus, a higher level of protection is necessary in Phase III than in Phase I.

When ρ is sufficiently small, the Phase-III present discounted expected value of cooperation is significantly higher than the Phase-I one. However, at the same, the Phase-III incentive to cheat as a function of e rises very steeply. Hence, initially, a higher level of overall protection is required in Phase I than in Phase III. Nevertheless, eventually, the incentive-to-cheat effect dominates and thus, the Phase-III necessary level of protection surpasses the Phase-I one.

Figure 4 in the Appendix depicts the phase-I, phase-II and phase-III most-cooperative tariffs when the assumptions of Proposition 3 hold. Finally, Figure 5 in the Appendix depicts the aforementioned tariffs when the assumptions of Proposition 3 fail but we still have $\lambda \in [\lambda^*, 1)$.

4 Conclusion

This paper has examined the ability of countries to maintain multilateral cooperation during the formation of customs unions. We have conducted our analysis under the assumptions that countries are limited to self-enforcing multilateral agreements that balance the gains from defection against the consequences of an ensuing trade war, and that they operate within a "managed-trade" environment, in which they are allowed to employ "special-protection" instruments in a cooperative equilibrium, when the aggregate trade volume surpasses a critical threshold.

We find that during the transition period, in which the customs unions are either being envisioned or negotiated, countries can sustain a low level of overall protection, if the probability the customs unions will actually materialize is not too low. Nevertheless, as the customs unions come into full effect, the level of "special" protection needs to be significantly heightened while the level of "normal" protection remains unchanged. Finally, we should note that the increased market power of the customs unions emerges as the pivotal factor in our analysis.

5 Appendix

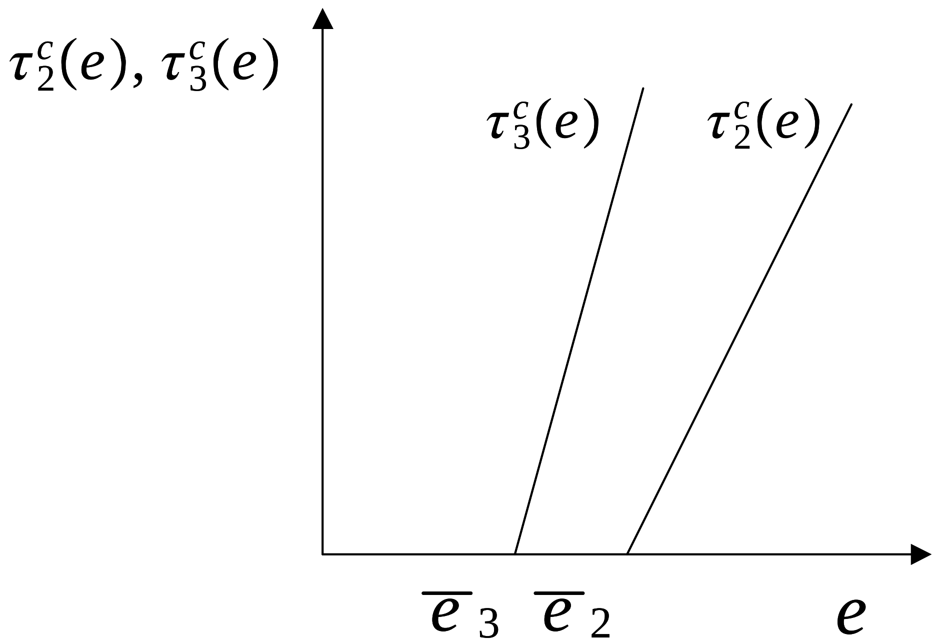

Figure 1

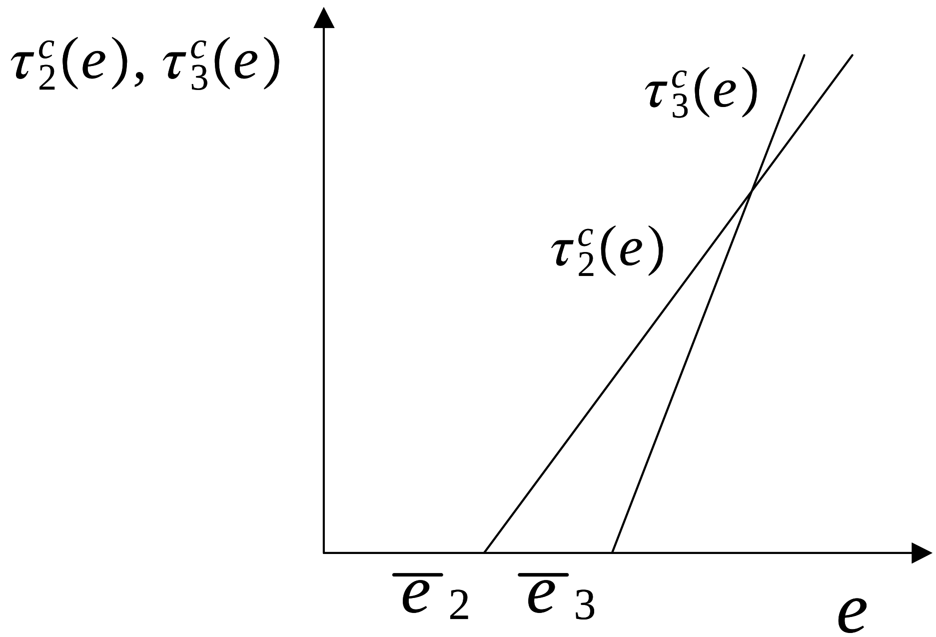

Figure 2

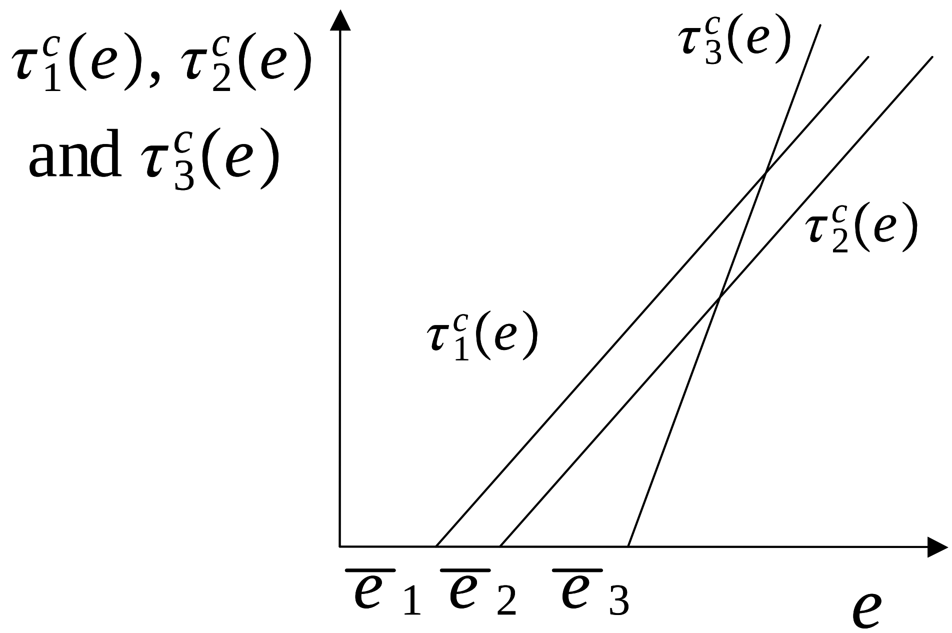
$\tau_1^c(e)$, $\tau_2^c(e)$
and $\tau_3^c(e)$
$\tau_3^c(e)$
$\tau_2^c(e)$
$\tau_1^c(e)$
$\overline{e}_1$ $\overline{e}_2$ $\overline{e}_3$
e

Figure 3

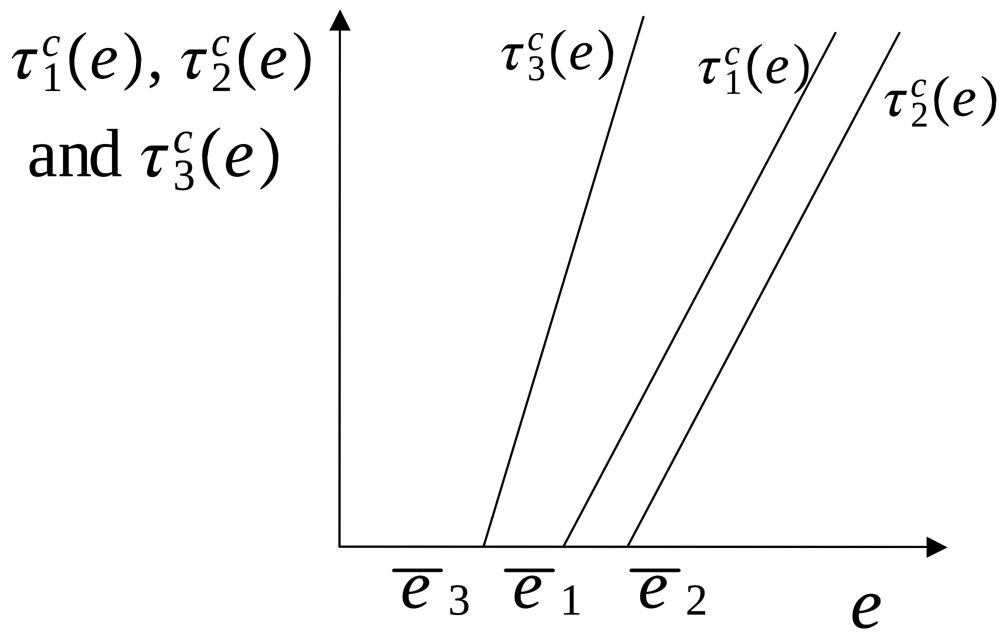
$\tau_1^c(e)$, $\tau_2^c(e)$
and $\tau_3^c(e)$
$\tau_3^c(e)$
$\tau_1^c(e)$
$\tau_2^c(e)$
$\overline{e}_3$ $\overline{e}_1$ $\overline{e}_2$
e

Figure 4

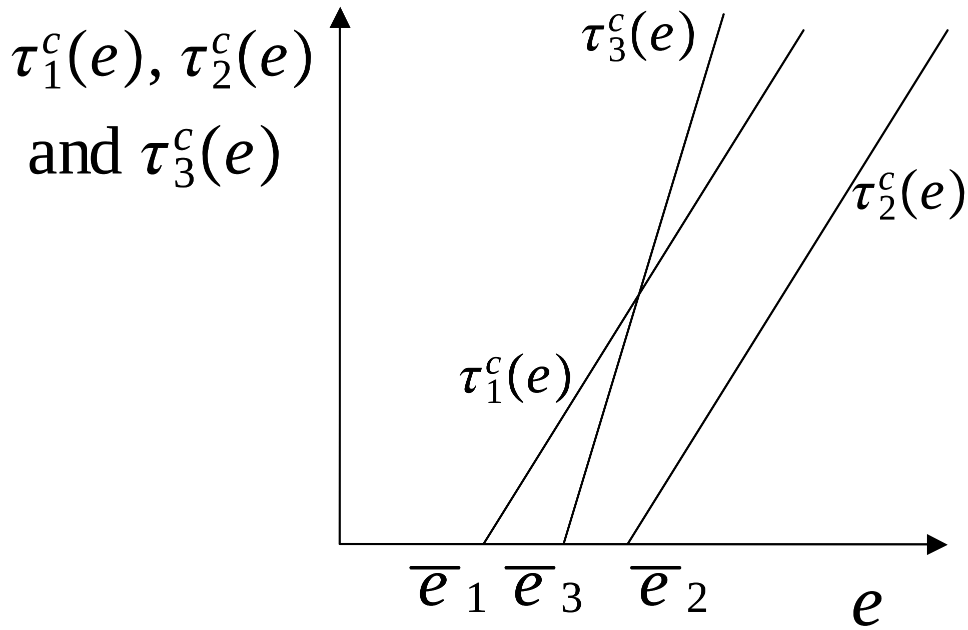

Figure 5

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