

**TRADE BLOC FORMATION
UNDER IMPERFECT COMPETITION**

PAOLA CONCONI

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Trade Bloc Formation Under Imperfect Competition^α

Paola Conconi^β

Abstract

We examine the endogenous formation of trade blocs when markets are characterized by imperfect competition and governments use import tariffs and export subsidies to alter the strategic interaction between oligopolistic firms. Using a simple model of intra-industry trade between three ex-ante symmetric countries, we find that, while 'pure' customs unions—entailing tariff cooperation only—are stepping stones towards global free trade, 'impure' customs unions— involving the coordinated use of both tariffs and subsidies—are stumbling blocs against it. Our analysis suggests that an international ban on export subsidies could help to sustain global free trade.

KEYWORDS: Imperfect Competition, Trade Negotiations.

JEL Classification: F12, F13, L13, L50.

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^βCorrespondence to: Paola Conconi, University of Warwick, Department of Economics, Coventry, CV4 7AL, United Kingdom; Tel: +44 024 76523474; Tel: +44 024 76523032; E-mail: P.Conconi@warwick.ac.uk

1 Introduction

Despite the strengthening of the world trading system through the successful conclusion of the Uruguay Round, there is still some concern that the formation of preferential trade agreements may result in the fragmentation of the world economy.¹ The risk is that “countries that join trading blocs will be more protectionist towards countries outside the blocs than they were before, so that the world as a whole will be hurt more than helped by moves that at first seem to be liberalizing in intent.” (Krugman, 1991, p. 9).

This concern is supported by studies of trade bloc formation focused on perfectly competitive markets, which found that the creation of customs union (CUs), while beneficial to the member countries, can be harmful to non-member countries and may reduce the welfare of the world as a whole.²

In this paper, we want to examine the process of trade bloc formation in the context of imperfectly competitive markets. For this purpose, we employ a simple three-country model of intra-industry trade, in which governments can alter the strategic interaction between oligopolistic firms through the use of import tariffs and export subsidies. The subsidization of firms engaged in international rivalry is common practice in most industrialized countries³, but cannot be explained by traditional trade theories: while

¹According to Fratzscher (1996), 94% of world trade is conducted within or between the European Union (EU), the North American Free Trade Agreement (NAFTA) and the Association for South East Asian Nations (ASEAN). In the period 1948-1994, GATT contracting parties notified 118 preferential trade agreements relating to trade in goods, of which 38 in the five years ending in 1994. Since the completion of the Uruguay Round, 80 additional PTAs covering trade in goods and services have been notified. See Whalley and Hamilton (1996) and Sampson (1996) for more information about the recent increase in the number of preferential trade agreements.

²For example, Kennan and Riezman (1990) and Kose and Riezman (1999) construct a pure exchange general equilibrium model with three countries and three goods, in which trade patterns are determined by comparative advantage considerations. Using simulation techniques to compare optimal tariffs and welfare gains in alternative agreement structures, they show that for certain endowment distributions CUs can pose a threat to the multilateral trading system, since, due to the improvement in their terms of trade, member countries can obtain larger welfare gains than at the free trade equilibrium.

³Since direct payments by the government to exporters are prohibited by GATT/WTO rules, countries often use indirect forms of support. Examples of covert export subsidies are: currency retention schemes which involve a bonus on exports; provision of goods or services for use in the

import tariffs can improve a country's terms of trade, export subsidies do not appear to make much sense, since they improve the terms of trade of the importing country. The literature on strategic trade policy⁴, on the other hand, has shown that imperfect competition can create new motives for the use of import tariffs and export subsidies: when domestic and foreign firms compete in the domestic market, Brander and Spencer (1984a,b) have shown that a tariff can be used to shift rents from foreign firms to the domestic firms and treasury; when domestic and foreign firms compete in a third country, Brander and Spencer (1985) have demonstrated that export subsidies can increase welfare by shifting profits from foreign to domestic firms.⁵

We describe international trade relations as a three-stage process. In the first stage, countries decide whether or not to form cooperative trade agreements. These can take three forms: 'pure' customs unions (CUs), in which member countries eliminate tariffs among themselves and set a common external tariff to maximize their joint welfare⁶; agreements to coordinate the use of export subsidies only; and 'impure' CUs, involving the coordinated use of both policy instruments.⁷ In the second stage, tariffs and subsidies are selected—cooperatively among countries participating in an agreement and non-cooperatively between countries belonging to separate agreements. In the last stage, firms compete in quantities.

There is a presumption that, when they are combined, export subsidies and import tariffs will 'neutralize' each other. This presumption is misleading in our setup, since the optimal response to a foreign export subsidy is never a fully countervailing tariff. A similar result is obtained, in a two-country context, by Dixit (1984, 1988) and Collie

production of exported goods on terms more favourable than those for the production of goods for domestic consumption; export-related exemption, remission or deferral of direct taxes and social welfare charges; excess exemption, remission, or deferral of indirect taxes or import duties; and export credits extended at rates below the government's cost of funds. See Ray (1995) for a discussion.

⁴See Brander (1995) for an extensive review of this literature.

⁵The profit-capture motive of trade intervention is most clearly seen when domestic and foreign firms are competing in a third country, since the home consumer surplus is not at issue.

⁶An example of a pure CU is provided by the Southern Common Market (MERCOSUR).

⁷The European Union can be considered an example of an 'impure' CU: its state aid policy restricts the capacity of national governments to support their firms and delegates to the Commission the task of ensuring that all subsidies granted within the EU are compatible with the single market objectives (see Cini and McGowan, 1998).

(1991).⁸

We analyze the welfare implications of alternative trade arrangements. Then, using the concept of Stable Agreement Structure developed in Conconi and Perroni (2000), we examine the sustainability of the Joint Global Agreement—entailing international cooperation on both policy variables. We find that, if the traded goods are homogeneous, ‘impure’ CUs are stumbling blocs against the attainment of multilateral trade cooperation. If instead products are nationally differentiated, trade bloc formation might or might not pose a threat to multilateral cooperation, depending on the degree of industry concentration and the extent of product differentiation.

We show that the introduction of an international ban on export subsidies could make multilateral trade cooperation sustainable when it would not be otherwise. Therefore our analysis provides a rationale for recent strengthening of GATT/WTO rules against export subsidies (see Laird, 1999).⁹

There has been little attempt to look at trade bloc formation in models of strategic trade policy. Sinclair and Vines (1994) have extended Brander and Spencer (1984a)’s tariff model to consider the impact of the creation of CUs and free trade areas (FTAs) on the Nash equilibrium tariffs. However, they have not considered the welfare implications of trade bloc formation. In an infinitely repeated version of Brander and Spencer (1985)’s export subsidy game, Collie (1993) has shown that free trade can be sustained by the threat of retaliation with the Nash equilibrium export subsidies, provided that countries are similar and the discount factor is sufficiently high. Collie (1997) has employed a multi-country version of this model to study the effects of trade bloc enlargement. Differently from our analysis, all these studies look at the effects of exogenous trade bloc formation, without considering countries’ agreement choices.

Our analysis is close in spirit to Yi (1996), who employs a multi-country extension of Brander and Spencer (1984a)’s tariff model to describe endogenous trade bloc formation under imperfect competition. He addresses the issue of the sustainability of global free

⁸Dixit (1984, 1988) and Collie (1991) describe the following three-stage game: in the first stage, the foreign country sets its export subsidy; in the second stage, the domestic country chooses optimal tariffs; finally, domestic and foreign firms engage in Cournot competition. Both studies find that the optimal retaliation against a foreign export subsidy is a partially countervailing tariff.

⁹An alternative rationale is suggested by Bagwell and Staiger (1994). In their model, export subsidies are used to coordinate the entry decision of firms. They show that, when subsidy coordination does more to prevent entry than to promote entry, the world as a whole can be better off when export subsidies are banned.

trade under alternative rules of CU formation.¹⁰ The main difference with our analysis is that Yi (1996) assumes that import tariffs are the only available instrument, so that 'pure' CUs are the only potential threat to the global trading system. This allows him to reach a more optimistic conclusion about the sustainability of multilateral trade cooperation in the case of three ex-ante symmetric countries.

A general results emerging from our analysis is that modelling trade negotiations as being on tariffs only can be misleading, i.e. might result in drawing incorrect conclusions about the negotiation outcomes.

Various studies have examined how international tariff negotiations might be affected by the existence of alternative policy instruments. For example, Coopeland (1990) has analyzed the general case of bilateral tariff negotiations when there exist non-negotiable domestic policy instruments. Gatsios and Karp (1992) have looked at the imperfect harmonization of trade and industrial policies and note the possibility of welfare reducing preferential trade agreements when members coordinate only the use of tariffs. A similar result is obtained by Richardson (1999), who shows that the uncoordinated use of domestic taxes/subsidies can render a 'pure' CU unattractive. More recently, Richardson (1999), focusing on the interaction between trade and competition policies, finds that the formation of a CU improves members' welfare only if it goes beyond mere trade coordination. However, none of these studies examines the endogenous formation of trade blocs and the issue of the sustainability of multilateral trade cooperation.

The paper is structured as follows. In Section 2, we present a simple three-country model of intra-industry trade. In Section 3, we look at the welfare implications of alternative trade arrangements. In Section 4, we examine the stability of such arrangements. Section 5 considers the effects of the introduction of an international ban on export subsidies. Finally, section 6 contains some concluding remarks.

2 The Model

In this section, we describe a simple model of intra-industry trade between three ex-ante

¹⁰Yi (1996) finds that CUs are stepping stones towards global free trade if membership of a trade agreement is open to all players, but they might be stumbling blocs towards free trade if the formation of a trade bloc requires the agreement of all potential members and the number of negotiating countries exceeds a critical value. In the case of three countries, he finds that global free trade is always sustainable.

symmetric countries. The specification of production draws on the reciprocal-markets trade model first proposed by Brander (1981) and elaborated by Brander and Krugman (1983) and Dixit (1984).

Each country $i \in I = \{1, 2, 3\}$ is endowed with an amount M_i of a numeraire good, which is transferred across countries to settle the balance of trade. Let n be the number of firms located in each market.¹¹ We assume that all firms in a particular country produce an identical product at constant marginal cost c , but allow national product differentiation. Let q_{ik} be sales in country k (destination) by a firm located in country i (origin), and $Q_k = \sum_i q_{ik}$ be total sales in country k .

A crucial assumption of the reciprocal-markets model is that markets are segmented, in the sense that firms make separate strategic decisions concerning different markets, rather than selling their output in a unified or integrated world market and relying on arbitrage to distribute it to different locations.¹² This assumption is appropriate for sectors of the economy in which firms have the ability to price discriminate between countries, thus maintaining a dominant position in their domestic markets.¹³

Preferences of a representative consumer in country k can be described by the following quasilinear utility function

$$u_k(M_k; Q_k; \mu) = M_k + v_k = M_k + aQ_k + b \sum_i \frac{\mu}{2} Q_k^2 + \frac{1-\mu}{2} \sum_k q_{ik}^2; \quad k \in I; \quad (1)$$

where M_k is the consumption of the numeraire good¹⁴, q_{ik} is country k 's consumption of a good produced in country i , and $Q_k = \sum_i q_{ik}$ is k 's total consumption. The product differentiation parameter μ ranges from 0 (independent goods) to 1 (homogeneous

¹¹We assume that the number of firms in each country is fixed. This can be regarded as a short-run situation or as a situation in which there are legal or technical entry barriers. See Brander and Krugman (1983) and Markusen and Venables (1988) for an analysis of the implications of trade liberalization with free entry.

¹²Alternatively, one could assume that oligopolistic firms compete in an integrated market (see, for example, Horstmann and Markusen, 1986) or make a two stage decision, setting first their world-wide capacity, and then market specific quantities or prices (Venables, 1990).

¹³For example, there is some evidence of markets segmentation in the European car market (see Flam and Nordstrom, 1994) and in the market for computer chips (see Baldwin and Krugman, 1988).

¹⁴We assume that M_i is large enough to guarantee a positive consumption of the numeraire good.

goods). Country k 's inverse demand for country i 's good is given by

$$P_{ik} = a_i - b[(1 - \mu)q_{ik} + \mu Q_k] \quad (2)$$

Governments can alter the strategic interaction between oligopolistic firms through the use of import tariffs and export subsidies. Let t_{ik} denote country k 's tariffs on imports from country i and s_{ki} be its export subsidy (for home firms' exports to country i).

The sequential structure of the model consists of three stages. In the first stage, countries decide whether to select policies unilaterally or form cooperative trade agreements.¹⁵ Countries may choose to coordinate the use of tariffs only. In this case, we assume that they form 'pure' customs unions (CU), eliminating tariffs among themselves¹⁶ and selecting a common external tariff so as to maximize their joint welfare.¹⁷ Alternatively, countries may decide to form agreements to cooperatively select export subsidies. A third option is to form 'impure' CUs, involving the coordinated use of both tariffs and subsidies. We rule out international transfers.¹⁸

In the second stage, tariffs and subsidies are selected— cooperatively among countries participating in an agreement and non-cooperatively between countries belonging to separate agreements. In the final stage, firms compete by choosing quantities in each market. As usual, we start by analyzing the last stage of the game, and solve for the equilibrium for the full game by backward induction.

¹⁵We assume that countries can credibly commit to trade cooperation and that international trade agreements are binding. Our analysis thus differs from the strand of the literature which argues against the legitimacy of assuming binding commitments in international trade negotiations (e.g. Bagwell and Staiger, 1997).

¹⁶One might also consider the more general case in which the CUs are characterized by non-zero tariffs between members. One institutional justification for the internal zero-tariff assumption is the fact that the General Agreement on Tariffs and Trade (GATT) permits the formation of preferential trade agreements provided that "the duties and other restrictive regulations of commerce are eliminated on substantially all trade between the constituents territories in products originating in such territories" (Article XXIV).

¹⁷As underlined by Gatsios and Karp (1995) and Park (2000), trade negotiations will generally involve a conflict between countries of different sizes. However, by focusing on symmetric countries, we remove the possibility of the emergence of this conflict.

¹⁸While it may be that transfers are important, to analyze them one has to first know what happens in their absence. The role of side-payments in international trade negotiations is analyzed by Kowalczyk (1994).

In the absence of transport costs¹⁹, the effective cost of supplying the traded good to country k for the firm located in country i is $c_i + t_{ik} - s_{ik}$ and its profits are given by

$$\pi_{ik} = (P_{ik} + s_{ik} - c_i - t_{ik})q_{ik}; \quad (3)$$

with associated first-order condition²⁰

$$\frac{\partial \pi_{ik}}{\partial q_{ik}} = a_i - c_i - b(1+n)q_{ik} - b\mu \sum_{j \in i} q_{jk} + s_{ik} - t_{ik} = 0; \quad (4)$$

Equation (4) represents the reaction functions (in implicit form) for the firms supplying market k . It shows the best-reply output of a firm, given whatever level of output is produced by the other firms. Notice that the profit function satisfies Hahn (1962)'s condition for stability of a Cournot equilibrium:

$$\frac{d\pi_{ik}}{dq_{jk}} < 0; \quad \forall i \neq j;$$

that is, each firm's marginal revenue in one market declines as the output of any other firm rises.²¹ Solving (4) for all $k \in I$, we obtain domestic and foreign sales in country k at the Cournot equilibrium:

$$q_{kk}(t_{ik}; s_{ik}) = \frac{\theta(1+n_i - \mu n) + \mu n(P_{i \in k} t_{ik} - P_{i \in k} s_{ik})}{\pm}; \quad (5)$$

$$q_{ik}(t_{ik}; s_{ik}) = \frac{\theta(1+n_i - \mu n) + (1+n+n_i\mu n)(s_{ik} - t_{ik}) + \mu n t_{jk}}{\pm}; \quad (6)$$

where $\theta = a_i - c_i$ is a measure of market size and is assumed to be positive (since otherwise a firm will never produce any output), $\pm = b(1+n_i - \mu n)(1+n+2\mu n) > 0$, and t_{ik} and s_{ik} are the vectors of tariffs and subsidies for all firms selling in country k .

¹⁹Differently from Brander (1981) and Brander and Krugman (1983), we assume that firms do not incur any transport costs in supplying foreign markets. However, such costs are assumed to be prohibitive for any third-party arbitrageurs.

²⁰With linear demand, since profits functions are concave, the second-order conditions for profit-maximization are satisfied and there exist a unique Cournot-Nash equilibrium.

²¹Expression (2) also implies that the strategic variables q_{ik} and q_{jk} are strategic substitutes as defined by Bulow et al. (1985).

Notice that the quantities produced for market k do not depend on variables in markets other than k . As noted by Brander (1981), this separability property depends crucially on the assumption of constant marginal costs.²²

Negative solutions to equations (5)-(6) are possible but not meaningful, so the reaction functions are truncated at zero. We rule out corner solutions, assuming that in equilibrium each firm produces a strictly positive outcome. Since all firms sell both at home and abroad, market equilibrium involves intra-industry trade, even when firms located in different countries sell homogeneous products (cross-hauling).

Equations (5)-(6) imply the following comparative statics effects:

$$\frac{dq_{ik}}{ds_{ik}} = \frac{1 + n_i \mu n}{\pm} > 0; \quad (7)$$

$$\frac{dq_{kk}}{ds_{ik}} = \frac{dq_{jk}}{ds_{ik}} = -i \frac{\mu n}{\pm} < 0; \quad (8)$$

$$\frac{dq_{ik}}{dt_{ik}} = -i \frac{1 + n_i + \mu n}{\pm} < 0; \quad (9)$$

$$\frac{dq_{kk}}{dt_{ik}} = \frac{dq_{jk}}{dt_{ik}} = \frac{\mu n}{\pm} > 0; \quad (10)$$

From (7) and (8) it follows that, when a country increases its subsidy for exports to a given market, its sales in that market increase, while the sales of all other countries fall. Equations (9) and (10) imply that, when a country increases its tariff on imports from a given country, imports from that country fall, while imports from other countries and its own domestic sales increase.

Given the quasilinearity of the utility function, if profits and tax revenues are rebated back uniformly to all consumers, country k 's welfare can be written as the sum of domestic consumer surplus (CS), government revenues (GR), and total profits of domestic firms in all markets (Π). Using (4), we can express a firm's domestic and foreign profits as $\pi_{kk} = bq_{kk}^2(t_{ik}; s_{ik})$ and $\pi_{ki} = bq_{ki}^2(t_{ki}; s_{ki})$, respectively. Welfare can thus be written as

$$W_k(t_{ik}; s_{ik}; t_{ki}; s_{ki}) = CS_k + GR_k + \Pi_k$$

²²If marginal costs depended on production levels, market separability would be lost and one could not rule out the kind of strategies considered by Krugman (1984), where an advantage given to a firm in one market spills over into a further advantage in another market.

$$\begin{aligned}
& \sum_k v_k(t_{ik}; S_{Tk}) + \sum_k n_{q_{ik}}(t_{ik}; S_{Tk}) p_{ik}(t_{ik}; S_{Tk}) + \\
& \sum_{i \in k} t_{ik} q_{ik}(t_{ik}; S_{Tk}) + \sum_k S_{ki} q_{ki}(t_{ki}; S_{ki}) \mathbf{A} + \\
& \sum_{i \in k} b_{q_{kk}}^2(t_{ik}; S_{Tk}) + \sum_{i \in k} b_{q_{ki}}^2(t_{ki}; S_{ki}) \mathbf{A} : \tag{11}
\end{aligned}$$

In the model described above, there are two sorts of gains from trade: the pro-competitive gains generated by the reduced market power of the domestic industry, and the increase in the variety of goods available to consumers. It is important to notice that, due to the quasilinearity of the utility function and to the assumption of market segmentation, there are no terms of trade effects.²³

3 Agreement Structures and Welfare

In this section, we examine the welfare implications of alternative trade arrangements. Since the countries are symmetric, we can limit our analysis to the following nine agreement structures:²⁴

1. Joint Global Agreement (JGA):
 $f, t_1; t_2; t_3; g; s_1; s_2; s_3; gg;$
2. No agreement on either issue (Nash Equilibrium):
 $f, t_1; g; t_2; g; t_3; g; s_1; g; s_2; g; s_3; gg;$
3. Global tariff agreement, no agreement on subsidies:
 $f, t_1; t_2; t_3; g; s_1; g; s_2; g; s_3; gg;$
4. Global agreement on subsidies, no tariff agreement:
 $f, t_1; g; t_2; g; t_3; g; s_1; s_2; s_3; gg;$
5. Partial agreement on subsidies, no tariff agreement:
 $f, t_1; g; t_2; g; t_3; g; s_1; s_2; g; s_3; gg;$

²³As remarked by Yi (1996), terms of trade effects are placed solely on the numeraire good.

²⁴Notice that we exclude the scenario in which one country coordinates the use of export subsidies with one partner and the use of export subsidies with another, i.e. agreement structure $f, t_1; t_2; g; t_3; g; s_1; g; s_2; s_3; gg$ and its mirror images.

6. Partial tariff agreement, no agreement on subsidies ('pure' CU):
 $ff_{t_1}; t_2g; ft_3g; fs_1g; fs_2g; fs_3gg;$
7. Partial overlapping agreements on tariffs and subsidies ('impure' CU):
 $ff_{t_1}; t_2g; ft_3g; fs_1; s_2g; fs_3gg;$
8. Global tariff agreement and partial agreement on subsidies:
 $ff_{t_1}; t_2; t_3g; fs_1; s_2g; fs_3gg;$
9. Global agreement on subsidies and partial tariff agreement:
 $ff_{t_1}; t_2g; ft_3g; fs_1; s_2; s_3gg.$

For simplicity, and without loss of generality, in the rest of our analysis we set $\alpha = \beta = 1$. We first consider the case in which the traded goods are homogeneous ($\mu = 1$), and then examine the case in which firms produce nationally differentiated goods ($\mu < 1$).

3.1 The Case of Homogeneous Goods

The optimal policies and equilibrium welfare functions for the case of homogeneous goods can be found in the Appendix. Table 1 reports the welfare gains obtained in different agreement structures, under alternative assumptions about the number of firms located in each market.

As expected, welfare gains increase with the number of firms located in each market. This is due to pro-competitive effects associated with the decrease in industry concentration. Notice that, as n increases, the difference between the welfare gains obtained in different structures falls. The intuition behind this result is that, as markets become more competitive, the profit-shifting incentives for the use of import tariffs and export subsidies tend to disappear.²⁵

The analysis of Table 1 also reveals that agreement structures 1, 4 and 9 and agreement structures 5 and 7 yield the same welfare gains. This implies that tariff coordination is irrelevant for countries that are already coordinating the use of export subsidies.

Comparing the welfare gains obtained under alternative agreement structures, we obtain the following result:

²⁵This can also be seen from Figures 3 and 4 in the Appendix. The analytical results presented in the Appendix show that, as $n \rightarrow 1$, optimal tariffs and subsidies in all agreement structures tend to zero.

Table 1: Agreement Structures and Countries' Welfare (Homogeneous Goods)
 $(\mu = 1)$

Agreement Structure	Countries' Welfare		
	n = 1	n = 5	n = 8
1) fft ₁ ; t ₂ ; t ₃ g; fs ₁ ; s ₂ ; s ₃ gg	$W_k = 0:5$	$W_k = 0:5$	$W_k = 0:5$
2) fft ₁ g; ft ₂ g; ft ₃ g; fs ₁ g; fs ₂ g; fs ₃ gg	$W_k = 0:4339$	$W_k = 0:4902$	$W_k = 0:4952$
3) fft ₁ ; t ₂ ; t ₃ g; fs ₁ g; fs ₂ g; fs ₃ gg	$W_k = 0:4922$	$W_k = 0:4994$	$W_k = 0:4997$
4) fft ₁ g; ft ₂ g; ft ₃ g; fs ₁ ; s ₂ ; s ₃ gg	$W_k = 0:5$	$W_k = 0:5$	$W_k = 0:5$
5) fft ₁ g; ft ₂ g; ft ₃ g; fs ₁ ; s ₂ g; fs ₃ gg	$W_{1,2} = 0:51$ $W_3 = 0:4$	$W_{1,2} = 0:5007$ $W_3 = 0:4871$	$W_{1,2} = 0:5003$ $W_3 = 0:4941$
6) fft ₁ ; t ₂ g; ft ₃ g; fs ₁ g; fs ₂ g; fs ₃ gg	$W_{1,2} = 0:4873$ $W_3 = 0:4229$	$W_{1,2} = 0:4989$ $W_3 = 0:4891$	$W_{1,2} = 0:4995$ $W_3 = 0:4948$
7) fft ₁ ; t ₂ g; ft ₃ g; fs ₁ ; s ₂ g; fs ₃ gg	$W_{1,2} = 0:51$ $W_3 = 0:4$	$W_{1,2} = 0:5007$ $W_3 = 0:4871$	$W_{1,2} = 0:5003$ $W_3 = 0:4941$
8) fft ₁ ; t ₂ ; t ₃ g; fs ₁ ; s ₂ g; fs ₃ gg	$W_{1,2} = 0:5625$ $W_3 = 0:3437$	$W_{1,2} = 0:5208$ $W_3 = 0:4549$	$W_{1,2} = 0:5139$ $W_3 = 0:4707$
9) fft ₁ ; t ₂ g; ft ₃ g; fs ₁ ; s ₂ ; s ₃ gg	$W_k = 0:5$	$W_k = 0:5$	$W_k = 0:5$

Lemma 1 In the case of homogeneous goods, the welfare ranking is always as follows:
 $W_{1;2}^8 > W_{1;2}^{5;7} > W_k^{1;4;9} > W_k^3 > W_{1;2}^6 > W_k^2 > W_3^6 > W_3^{5;7} > W_3^8$.

PROOF: See the Appendix.

Therefore, relative to the Nash Equilibrium, all preferential trade agreements will always increase the welfare of the member countries and decrease the welfare of the non-member country.

Compared to the Joint Global Agreement, two countries will always lose by coordinating tariffs only (structure 6) and gain by coordinating the use of export subsidies (structures 5 and 7 and 8). The reason behind this result is that, by forming a preferential trade agreement on subsidies, two countries are able to shift rents from the firms located in the non-member country to their domestic firms and treasury.²⁶

3.2 The Case of Heterogeneous Goods

We now turn our attention to the case of differentiated goods. Tables 2 and 3 report the welfare gains obtained in the nine agreement structures, under different assumptions about the degree of product differentiation and the number of firms located in each country.²⁷

From Tables 2 and 3, we can see that welfare gains increase with the degree of product differentiation (i.e. decrease with μ). The reason behind this result is that, since individuals enjoy variety, an increase in product differentiation implies an increase in consumer surplus.

By comparing the welfare gains obtained in the nine agreement structures, we obtain the following result:

Lemma 2 In the case of heterogeneous goods, the welfare ranking of alternative agreement structures depends on the degree of product differentiation and on the number of firms located in each market.

²⁶This can be seen by comparing the equilibrium policies reported in the Appendix. It is easy to verify that, relative to the JGA, in structures 5, 7 and 8, countries 1 and 2 always choose to subsidize less their exports to country 3 and to subsidize more their exports to each other's markets.

²⁷The analytical expressions for the equilibrium policies and welfare functions used to derive the results in Tables 2 and 3 can be obtained upon request.

Table 2: Agreement Structures and Countries' Welfare (Heterogeneous Goods)
(n = 1)

Agreement Structure	Countries' Welfare		
	$\mu = 2=10$	$\mu = 1=2$	$\mu = 8=10$
1) fft ₁ ; t ₂ ; t _{3g} ; fs ₁ ; s ₂ ; s _{3gg}	W _k = 1:0088	W _k = 0:7222	W _k = 0:5655
2) fft _{1g} ; ft _{2g} ; ft _{3g} ; fs _{1g} ; fs _{2g} ; fs _{3gg}	W _k = 0:7551	W _k = 0:5907	W _k = 0:4856
3) fft ₁ ; t ₂ ; t _{3g} ; fs _{1g} ; fs _{2g} ; fs _{3gg}	W _k = 0:8907	W _k = 0:6817	W _k = 0:5526
4) fft _{1g} ; ft _{2g} ; ft _{3g} ; fs ₁ ; s ₂ ; s _{3gg}	W _k = 1:0088	W _k = 0:7222	W _k = 0:5655
5) fft _{1g} ; ft _{2g} ; ft _{3g} ; fs ₁ ; s _{2g} ; fs _{3gg}	W _{1,2} = 0:9101 W ₃ = 0:0:6957	W _{1,2} = 0:6903 W ₃ = 0:5203	W _{1,2} = 0:5574 W ₃ = 0:4329
6) fft ₁ ; t _{2g} ; ft _{3g} ; fs _{1g} ; fs _{2g} ; fs _{3gg}	W _{1,2} = 0:8306 W ₃ = 0:7334	W _{1,2} = 0:6491 W ₃ = 0:5650	W _{1,2} = 0:5356 W ₃ = 0:4672
7) fft ₁ ; t _{2g} ; ft _{3g} ; fs ₁ ; s _{2g} ; fs _{3gg}	W _{1,2} = 0:9101 W ₃ = 0:6957	W _{1,2} = 0:6903 W ₃ = 0:5203	W _{1,2} = 0:5574 W ₃ = 0:4329
8) fft ₁ ; t ₂ ; t _{3g} ; fs ₁ ; s _{2g} ; fs _{3gg}	W _{1,2} = 0:9788 W ₃ = 0:7987	W _{1,2} = 0:7426 W ₃ = 0:5500	W _{1,2} = 0:6068 W ₃ = 0:4072
9) fft ₁ ; t _{2g} ; ft _{3g} ; fs ₁ ; s ₂ ; s _{3gg}	W _k = 1:088	W _k = 0:7222	W _k = 0:5655

Table 3: Agreement Structures and Countries' Welfare (Heterogeneous Goods)
(n = 8)

Agreement Structure	Countries' Welfare		
	$\mu = 2=10$	$\mu = 1=2$	$\mu = 8=10$
1) fft ₁ ; t ₂ ; t ₃ g; fs ₁ ; s ₂ ; s ₃ gg	W _k = 1:0683	W _k = 0:7485	W _k = 0:5760
2) fft ₁ g; ft ₂ g; ft ₃ g; fs ₁ g; fs ₂ g; fs ₃ gg	W _k = 0:9320	W _k = 0:6973	W _k = 0:5585
3) fft ₁ ; t ₂ ; t ₃ g; fs ₁ g; fs ₂ g; fs ₃ gg	W _k = 0:9547	W _k = 0:7140	W _k = 0:5705
4) fft ₁ g; ft ₂ g; ft ₃ g; fs ₁ ; s ₂ ; s ₃ gg	W _k = 1:0683	W _k = 0:7485	W _k = 0:5760
5) fft ₁ g; ft ₂ g; ft ₃ g; fs ₁ ; s ₂ g; fs ₃ gg	W _{1,2} = 1:0242 W ₃ = 0:8606	W _{1,2} = 0:7440 W ₃ = 0:6320	W _{1,2} = 0:5766 W ₃ = 0:5291
6) fft ₁ ; t ₂ g; ft ₃ g; fs ₁ g; fs ₂ g; fs ₃ gg	W _{1,2} = 0:9531 W ₃ = 0:8926	W _{1,2} = 0:7148 W ₃ = 0:6639	W _{1,2} = 0:5694 W ₃ = 0:5449
7) fft ₁ ; t ₂ g; ft ₃ g; fs ₁ ; s ₂ g; fs ₃ gg	W _{1,2} = 1:0242 W ₃ = 0:8606	W _{1,2} = 0:7440 W ₃ = 0:6320	W _{1,2} = 0:5766 W ₃ = 0:5291
8) fft ₁ ; t ₂ ; t ₃ g; fs ₁ ; s ₂ g; fs ₃ gg	W _{1,2} = 1:0356 W ₃ = 0:8793	W _{1,2} = 0:7542 W ₃ = 0:6401	W _{1,2} = 0:5867 W ₃ = 0:5278
9) fft ₁ ; t ₂ g; ft ₃ g; fs ₁ ; s ₂ ; s ₃ gg	W _k = 1:0683	W _k = 0:7485	W _k = 0:5760

PROOF: from Tables 2 and 3, we can see that countries' preferences over alternative trade arrangements vary with n and μ . For example, in Table 2 countries 1 and 2 obtain higher welfare gains in structure 8 than in structure 1, if $\mu = 1=2$ and $\mu = 8=10$ but not if $\mu = 2=10$.²⁸ This implies that multilateral cooperation is more attractive when the traded goods are more dissimilar. Also notice that in Table 2 countries 1 and 2 never gain by moving from structure 1 to structure 7; in Table 3, however, this move is profitable for the case in which $\mu = 8=10$. Therefore multilateral cooperation is more attractive when the industry is more concentrated. Q.E.D.

4 The Outcome of the Trade Negotiations

Having examined the welfare implications of alternative trade arrangements, we can now turn to the analysis of the first stage of the game, i.e. countries' agreement choices. As a solution, we use the concept of Stable Agreement Structure developed in Conconi and Perroni (2000). Here we just recall the two key definitions:

Definition 1 A Stable Agreement Structure is a structure which cannot be blocked.

Definition 2 A coalition of one or more players constitutes a blocking objection to a proposed agreement structure if and only if: (i) it is profitable, i.e. at least one member of the blocking coalition gains from the deviation and no member loses; and (ii) it is immune from further deviations.

The stability definition is recursive: to be stable, a structure must not be blocked; and to block, an objection must involve an arrangement that is itself stable. This consistency requirement rules out coalitional deviations which are not themselves immune from further deviations.

Applying Definitions 1 and 2 to the case of homogeneous goods, we obtain the following result:

Proposition 1 In the case of homogeneous goods, 'impure' CUs are the only stable negotiation outcome.

²⁸It is easy to verify that, when $n = 1$, $W_k^{1;4;9} > W_{1;2}^8$ if and only if $\mu < 0.1305$.

PROOF: from Lemma 1, we know that structure 7 is welfare improving for countries 1 and 2, relative to all other agreement structures except structure 8. However, the latter is not stable, since country 3 will always object to it by leaving the tariff agreement. Structure 7, on the other hand, cannot be blocked by country 3. It follows that the 'impure' CU structure is the only stable negotiation outcome.²⁹

Therefore 'impure' CUs are stumbling blocs against the attainment of multilateral trade cooperation. Since world welfare is always lower in the case of an 'impure' CU than in the JGA, Proposition 1 supports the concern that the world as a whole will be hurt more than helped by the formation of regional trading blocs.

Moving to the cases of heterogeneous products, we find:

Proposition 2 When the goods are nationally differentiated, international trade negotiations will result in the formation of the JGA or of an 'impure' CU, depending on the degree of industry concentration and on the extent of product differentiation.

PROOF: from Table 2, we can see that the welfare gains achieved in structure 1 (and in the equivalent structures 4 and 9) are larger than the gains obtained in any other agreement structure. This suggests that, when goods are differentiated and the industry is extremely concentrated (only 3 national firms are competing in each market), the JGA will be the only stable outcome. In this case, the members of an 'impure' CU gain more (in terms of product variety and increased domestic competition) by including the third country than they gain (in terms of profit-shifting) by excluding it. Table 3 shows that, if the industry is more competitive (24 firms are competing in each market) and traded goods are characterized by a low degree of product differentiation (e.g. $\mu = 8=10$), countries 1 and 2 can gain by putting forward structure 7, which country 3 will not be able to block. Therefore, if the product variety and pro-competitive effects of trade liberalization are small, 'impure' CUs represent a threat to multilateral trade cooperation. Q.E.D.

Notice that the rather pessimistic results obtained in our analysis are in contrast with the more optimistic conclusions obtained by Yi (1996) who, assuming that import tariffs are the only available policy instrument, finds that free trade is the only stable outcome of the tariff negotiations between three ex-ante symmetric countries.³⁰

²⁹This implies that structure 5—which is equivalent to structure 7—is also a stable outcome.

³⁰Yi (1996) employs a multi-country extension of Brander and Spencer (1984a)'s tariff game and

5 An International Ban on Export Subsidies

Export subsidies are prohibited by GATT rules.³¹ However, governments are often able to use indirect forms of export support. These include: more favourable credit conditions (the difference between these and the normal conditions applied to producers for the home market is paid by the government); insurance of certain risks (for example, that the foreign imported defaults) paid by the government; and promotional activities (such as trade fairs, advertising, etc.) organized by public agencies. For this reason, the WTO has recently attempted to strengthen the rules against the use of export subsidies (see Laird, 1999).³²

In this section, we examine how the introduction of an effective ban on export subsidies would affect the outcome of the trade negotiations between three ex-ante symmetric countries. When import tariffs are the only available policy instrument, there are only three possible agreement structures, which, given the symmetry assumption, can be restricted to the following three:

1. Global Free Trade:

$t_1; t_2; t_3$

focuses on the case in which only one firm is located in each country ($n = 1$). He computes the critical number of countries such that free trade is a stable outcome under both the open regionalism and unanimous regionalism rules. This is an increasing function of the degree of product differentiation. For example, for $\mu = 0.1$, free trade is a stable outcome if there are less than 15 countries, while for $\mu = 1$, the critical value is 4.

³¹In the original GATT agreement in 1947 there was very little discipline on subsidies. The first substantial obligations regarding the use of export subsidies were introduced in 1955 (see Article XVI, paragraphs 2-5). A Subsidies Code was adopted at the Tokyo Round and revised at the Uruguay Round by the "Agreement on Subsidies and Countervailing Measures". The latter distinguishes between prohibited, actionable and nonactionable subsidies. See Jackson (1998) for a discussion of the evolution of the rules on subsidies and countervailing duties.

³²A panel adopted by the WTO Dispute Settlement Body (DSB) in February 2000, requires, for the first time, a company to repay in full an illegal member subsidy from a member government. This case involves a dispute brought against Australia by the US over A\$30 million in export subsidies to a producer of automotive leather. Two other recent cases involve export subsidies worth billions of \$US: one rules against US tax exemptions for exporters; the other rules that Brazil has failed to lift the export subsidies to its jet aircraft industries, as required in a previous panel.

2. Nash Equilibrium:

$\tau_1; \tau_2; \tau_3$

3. Partial tariff agreement ('pure' CU):

$\tau_1; \tau_2; \tau_3$

Tables 4-6 report the welfare gains obtained in the tariff-only agreement formation game, for the same parameter combinations considered in Tables 1-3.³³

Comparing the welfare gains obtained in the three alternative agreement structures, we find:

Lemma 3 When governments are banned from using export subsidies, the welfare ranking is always as follows: $W_1^1 > W_{1;2}^3 > W_k^2 > W_3^3$.

PROOF: This result emerges from the analysis of Tables 4-6. Numerical simulations show that Lemma 3 holds for any degree of product differentiation and industry concentration, i.e. $0 < \mu < 1$, $n \geq 1$. The reason behind this result is that the gains associated with multilateral trade liberalization (i.e. the increase in domestic competition, product variety and export profits) always outweigh the corresponding welfare costs (i.e. the fall in domestic profits and government revenues). Q.E.D.

The result in Lemma 3 can also be seen from Figures 1 and 2, where we plot the welfare functions corresponding to the three agreement structures for the case of homogeneous goods ($\mu = 1$) and the case in which each country has only one firm ($n = 1$).

This result follows directly from Lemma 3:

Proposition 3 When governments are banned from using export subsidies, global free trade is the only stable negotiation outcome.

PROOF: since global free trade (structure 1) yields larger welfare gains than any other tariff arrangements, no country will ever want to deviate from it. Q.E.D.

Combining Propositions 1-3, we can thus conclude that, in the case of three ex-ante symmetric countries, the introduction of an effective ban on subsidies would make multilateral trade cooperation sustainable when it would not be otherwise.

³³The analytical expressions for optimal policies and equilibrium welfare functions for the tariff-only game can be obtained upon request.

Table 4: Agreement Structures and Countries' Welfare (Homogeneous Goods)
 $(\mu = 1)$

Agreement Structure	Countries' Welfare		
	$n = 1$	$n = 5$	$n = 8$
1) $fft_1; t_2; t_3gg$	$W_k = 0:4688$	$W_k = 0:4981$	$W_k = 0:4992$
2) $fft_1g; ft_2g; ft_3gg$	$W_k = 0:42$	$W_k = 0:4893$	$W_k = 0:4949$
3) $fft_1; t_2g; ft_3gg$	$W_{1,2} = 0:4574$ $W_3 = 0:4055$	$W_{1,2} = 0:4967$ $W_3 = 0:4880$	$W_{1,2} = 0:4986$ $W_3 = 0:4944$

Table 5: Agreement Structures and Countries' Welfare (Heterogeneous Goods)
 $(n = 1)$

Agreement Structure	Countries' Welfare		
	$\mu = 2=10$	$\mu = 1=2$	$\mu = 8=10$
1) $fft_1; t_2; t_3gg$	$W_k = 0:8854$	$W_k = 0:6667$	$W_k = 0:5324$
2) $fft_1g; ft_2g; ft_3gg$	$W_k = 0:7517$	$W_k = 0:58$	$W_k = 0:4710$
3) $fft_1; t_2g; ft_3gg$	$W_{1,2} = 0:8262$ $W_3 = 0:7297$	$W_{1,2} = 0:6356$ $W_3 = 0:5523$	$W_{1,2} = 0:5151$ $W_3 = 0:4491$

Figure 1: Welfare Gains (Homogeneous Goods).

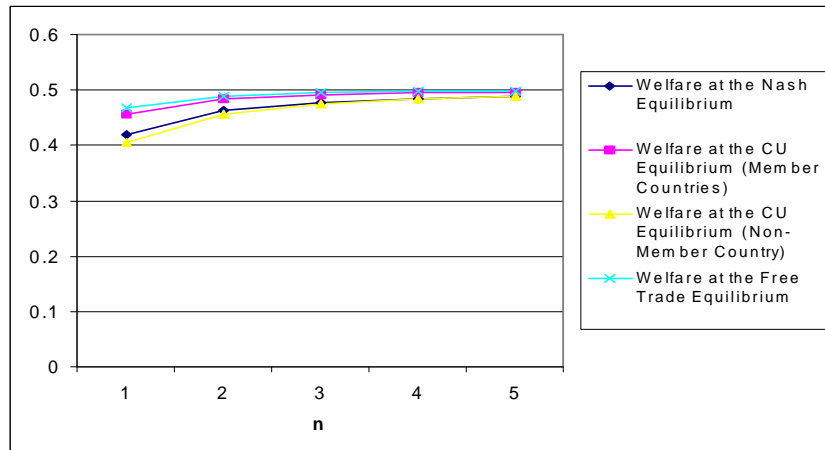


Figure 2: Welfare Gains (n = 1).

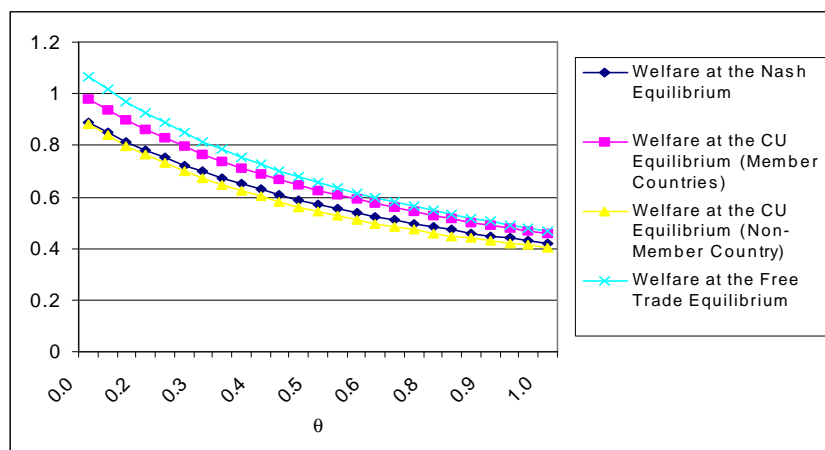


Table 6: Agreement Structures and Countries' Welfare (Heterogeneous Goods)
(n = 8)

Agreement Structure	Countries' Welfare		
	$\mu = 2=10$	$\mu = 1=2$	$\mu = 8=10$
1) $fft_1; t_2; t_3gg$	$W_k = 1:0642$	$W_k = 0:7474$	$W_k = 0:5757$
2) $fft_1g; ft_2g; ft_3gg$	$W_k = 1:0492$	$W_k = 0:7384$	$W_k = 0:5677$
3) $fft_1; t_2g; ft_3gg$	$W_{1;2} = 1:0581$ $W_3 = 1:0435$	$W_{1;2} = 0:7449$ $W_3 = 0:7315$	$W_{1;2} = 0:5743$ $W_3 = 0:5611$

Proposition (3) is in line with the results obtained by Yi (1996) for the case of three ex-ante symmetric countries. Notice, however, that his optimistic conclusion about the sustainability of free trade would be misleading if countries were able to use export subsidies.

6 Concluding Remarks

In this paper we have studied the formation of trade blocs when markets are imperfectly competitive and governments can alter the strategic interaction between oligopolistic firms through the use of import tariffs and export subsidies.

Using a simple model of intra-industry trade between three ex-ante symmetric countries, we have obtained the following results:

- ² Three factors determine whether preferential trade agreements pose a threat to the multilateral trading system: which policy instruments are at government disposal, the degree of industry concentration, and the extent of product differentiation;
- ² When both import tariffs and export tariffs are available, and the traded goods

are homogeneous, 'impure' CUs—involving the coordinated use of both policy instruments—are always stumbling blocs towards multilateral trade cooperation;

- ² When both policy instruments are available and firms sell nationally differentiated products, multilateral cooperation is sustainable if the degrees of product differentiation and industry concentration are large enough;
- ² When countries are banned from using export subsidies, global free trade is the only stable negotiation outcome.

These findings provide a rationale for the recent attempts to strengthen international rules against the use of export subsidies.

A more general point emerges from our analysis: when governments can use different trade policy instruments, trade bloc formation should be described as a multi-dimensional agreement formation game; focusing on one policy dimension only might result in drawing incorrect conclusions about the negotiation outcomes.

We conclude by pointing out three directions of further research. First, it would be important to employ a multi-country version of our model to examine how the trade negotiation outcome are affected by changes in the number of parties involved. Second, it would be interesting to look at the case of heterogeneous countries; this would require the analysis of intra-agreement bargaining problems, in order to understand how agreement members divide total surplus. Finally, the strategic trade policy literature has shown that governments can use a wide range of instruments (import tariffs, export subsidies, domestic subsidies, voluntary export restraints, R&D subsidies, competition policy, etc.) to shift rents from foreign to domestic firms. One could consider how the availability of different policy instruments can alter the process of trade bloc formation.

Appendix

In what follows, we report the optimal policies and the corresponding welfare functions for the nine feasible agreement structures. We look at the case in which n firms are located in each country, selling homogeneous products ($\mu = 1$).

1. $ft_1; t_2; t_3g; fs_1; s_2; s_3gg$:

$$\begin{aligned} t_{ik}^1 &= 0; \\ s_{ik}^1 &= \frac{1}{2n}; \\ W_k^1 &= \frac{1}{2}; \end{aligned} \tag{12}$$

2. $fft_1g; ft_2g; ft_3g; fs_1g; fs_2g; fs_3gg$:

$$\begin{aligned} t_{ik}^2 &= \frac{1+n}{1+7n+11n^2+3n^3}; \\ s_{ik}^2 &= \frac{1+3n+3n^2}{1+7n+11n^2+3n^3}; \\ W_k^2 &= \frac{n(6+49n+136n^2+154n^3+66n^4+9n^5)}{2(1+7n+11n^2+3n^3)}. \end{aligned} \tag{13}$$

3. $fft_1; t_2; t_3g; fs_1g; fs_2g; fs_3gg$:

$$\begin{aligned} t_{ik}^3 &= 0; \\ s_{ik}^3 &= \frac{1+n}{2(3+5n)^2}; \\ W_k^3 &= \frac{8+30n+25n^2}{2(3+5n)^2}. \end{aligned} \tag{14}$$

4. $fft_1g; ft_2g; ft_3g; fs_1; s_2; s_3gg$:

$$t_{ik}^4 = \frac{1}{2n};$$

$$s_{ik}^4 = \frac{1}{n};$$

$$W_k^4 = \frac{1}{2}; \tag{15}$$

5. $fft_1g; ft_2g; ft_3g; fs_1; s_2g; fs_3gg$:

$$t_{12}^5 = t_{21}^5 = \frac{1}{2};$$

$$t_{31}^5 = t_{32}^5 = s_{31}^5 = s_{31}^5 = 0;$$

$$t_{13}^5 = t_{23}^5 = \frac{1 + 2n + 3n^2}{1 + 7n + 9n^2 + 3n^2};$$

$$s_{12}^5 = s_{21}^5 = \frac{2}{n};$$

$$s_{13}^5 = s_{23}^5 = \frac{1 + n}{1 + 7n + 9n^2 + 3n^2};$$

$$W_{1;2}^5 = \frac{1 + 13n + 58n^2 + 78n^3 + 45n^4 + 9n^5}{2(1 + n)(1 + 6n + 3n^2)^2}; \tag{16}$$

$$W_3^5 = \frac{n(6 + 31n + 69n^2 + 45n^3 + 9n^4)}{2(1 + n)(1 + 6n + 3n^2)^2}; \tag{17}$$

6. $fft_1g; ft_2; t_3g; fs_1g; fs_2g; fs_3gg$:

$$t_{12}^6 = t_{21}^6 = 0;$$

$$t_{31}^6 = t_{32}^6 = \frac{1 + 4n + 6n^2}{2 + 14n + 29n^2 + 18n^3};$$

$$t_{13}^6 = t_{23}^6 = \frac{1 + 3n + 3n^2}{1 + 7n + 11n^2 + 3n^3};$$

$$s_{12}^6 = s_{21}^6 = \frac{1 + 4n + 3n^2}{2n + 10n^2 + 9n^3};$$

$$s_{13}^6 = s_{23}^6 = \frac{1 + n}{1 + 7n + 11n^2 + 3n^3};$$

$$s_{31}^6 = s_{31}^6 = \frac{1 + n}{2 + 14n + 29n^2 + 18n^3};$$

$$W_{1;2}^6 = \frac{1}{3^4} n^3 + 82n + 974n^2 + 6568n^3 + 27733n^4 + 76516n^5 + 139835n^6 + 167990n^7 + 128832n^8 + 59418n^9 + 14661n^{10} + 1458n^{11}; \quad (18)$$

$$W_3^6 = \frac{1}{3^4} n(24 + 472n + 4024n^2 + 19476n^3 + 58930n^4 + 115793n^5 + 148298n^6 + 120462n^7 + 58122n^8 + 14661n^9 + 1458n^{10}); \quad (19)$$

where $\frac{1}{3^4} = 2(1 + 2n)(2 + 10n + 9n^2)^2(1 + 7n + 11n^2 + 3n^3)^2$.

7. $fft_1; t_2g; ft_3g; fs_1; s_2g; fs_3gg$:

$$t_{12}^7 = t_{21}^7 = \frac{1}{2};$$

$$t_{31}^7 = t_{32}^7 = s_{31}^5 = s_{31}^5 = 0;$$

$$t_{13}^7 = t_{23}^7 = \frac{1 + 2n + 3n^2}{1 + 7n + 9n^2 + 3n^3};$$

$$s_{12}^7 = s_{21}^7 = \frac{2}{n};$$

$$s_{13}^7 = s_{23}^7 = \frac{1 + n}{1 + 7n + 9n^2 + 3n^3};$$

$$W_{1;2}^7 = \frac{1 + 13n + 58n^2 + 78n^3 + 45n^4 + 9n^5}{2(1 + n)(1 + 6n + 3n^2)^2}; \quad (20)$$

$$W_3^7 = \frac{n(6 + 31n + 69n^2 + 45n^3 + 9n^4)}{2(1 + n)(1 + 6n + 3n^2)^2}; \quad (21)$$

8. $fft_1; t_2; t_3g; fs_1; s_2g; fs_3gg$:

$$t_{12}^8 = t_{21}^8 = t_{31}^8 = t_{32}^8 = t_{13}^8 = t_{23}^8 = s_{31}^8 = s_{31}^8 = 0;$$

$$s_{12}^8 = s_{21}^8 = \frac{1}{n};$$

$$s_{13}^8 = s_{23}^8 = \frac{1 + n}{4n(1 + n)};$$

$$W_{1;2}^8 = \frac{5 + 4n}{8(1 + n)}; \quad (22)$$

$$W_3^8 = \frac{1 + 6n + 4n^2}{8(1 + n)^2}; \quad (23)$$

9. $fft_1; t_2g; ft_3g; fs_1; s_2; s_3gg$:

$$t_{12}^9 = t_{21}^9 = 0;$$

$$t_{31}^9 = t_{32}^9 = t_{13}^9 = t_{23}^9 = s_{12}^9 = s_{21}^9 = \frac{1}{2n};$$

$$s_{13}^9 = s_{23}^9 = s_{31}^9 = s_{31}^9 = \frac{1}{n};$$

$$W_k^9 = \frac{1}{2}; \quad (24)$$

Proof of Lemma 1

From the analysis of equations (12)-(24), it straightforward to verify that, $8 \leq \mu \leq 1$,

$n \geq 1$,

$$W_{1;2}^8 \text{ i } W_{1;2}^{7;5} > 0,$$

$$W_{1;2}^{7;5} \text{ i } W_k^{1;4;9} > 0,$$

$$W_k^{1;4;9} \text{ i } W_k^3 > 0,$$

$$W_k^3 \text{ i } W_{1;2}^6 > 0,$$

$$W_{1;2}^6 \text{ i } W_k^2 > 0,$$

$$W_k^2 \text{ i } W_3^6 > 0,$$

$$W_3^6 \text{ i } W_3^5 > 0,$$

$$W_3^5 \text{ i } W_3^7 > 0.$$

The welfare ranking of Lemma 1 emerges also from the analysis of Figures 3 and 4 in the next page, in which we plot the welfare gains obtained by the three countries under alternative agreement structures.

Q.E.D.

Figure 3: Welfare Gains for Countries 1 and 2

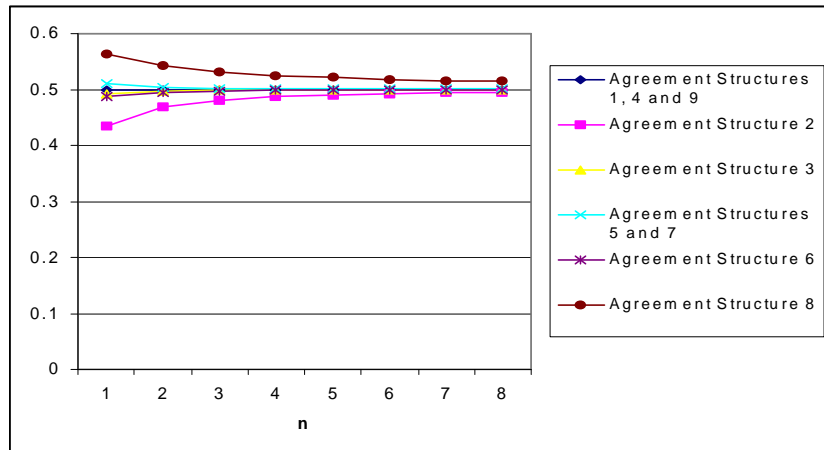
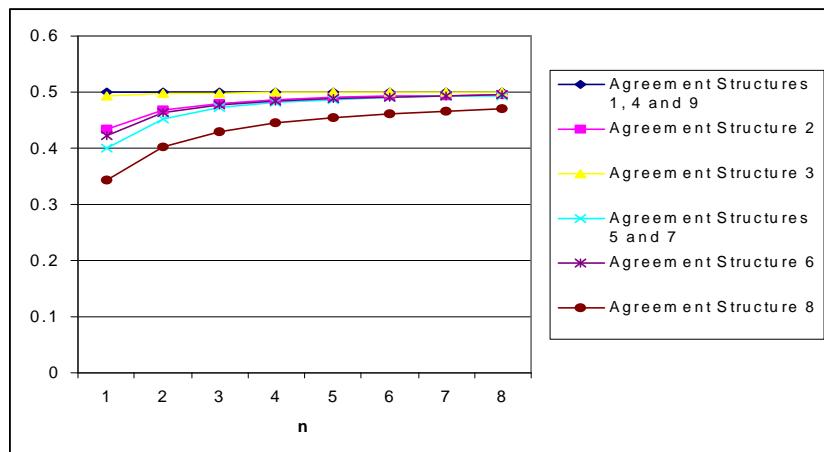


Figure 4: Welfare Gains for Country 3



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