Endogenous Trade Bloc Formation in an Asymmetric World

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Abstract

This paper investigates how variations in endowments and the structure of preferences impact on the coalition formation decisions of asymmetric countries. Relatively few general results exist describing the relationship between country characteristics and trade bloc formation. Here, new light is shed on this issue, by systematically simulating bloc formation and, for the first time, explicitly analysing the blocking behaviour of coalitions. A general equilibrium model of world trade is implemented; coalition formation decisions are modelled using the *core*. It is found that global free trade is observed when all countries are similar. Customs unions tend to form between countries with: (i) 'similar' consumer preferences or (ii) who are endowed with 'similar' quantities of their export commodity. In a customs union, common external tariffs tend to be chosen by the member with relatively inelastic preferences or by the member with a relatively larger export endowment. Finally, in contrast to the existing literature but consistent with observed behaviour, it is found that free trade areas often Pareto dominate customs unions, provided national preferences differ sufficiently.

1 Introduction

Since the beginning of the 1980s, preferential trading arrangements have become increasingly popular. In some cases, customs unions (CUs) have been established; the Andean Pact and MERCOSUR in South America for example. Free trade areas (FTAs), however, have usually been preferred. In the 1990s alone, almost every region of the world has witnessed the formation of a FTA: the North American FTA, the 'Group of Three' in South America, the Central European FTA, and the ASEAN FTA in Asia. Numerous other FTAs have also formed or are in an embryonic stage of development.

Free trade areas and CUs eliminate trade barriers between partners. They are distinguished, however, by their treatment of external tariffs. While CUs force members to charge non-members a 'common external tariff' (CET), partners in FTAs are free to maintain their own external rates. Nevertheless, both CUs and FTAs imply discriminatory tariff policy, in favour of their members.

There appears to be no obvious pattern in a country's decision to join a preferential agreement. Some countries have initially joined a FTA only to later secede and join a CU instead. Former members of the Latin American FTA, which was disbanded in 1980, now comprise the entire membership of MERCOSUR as well as being represented in the Andean Pact. Chile, on the other hand, has continued to pursue FTAs. Other nations have joined a FTA when a CU has seemed at least as appropriate. Pomfret (1997) claims that the Central European FTA economies, in transition from the collapse of central planning, wished to preserve established trade flows and increase their bargaining power with respect to the rest of the world. In light of these aims, a CU could have been at least as effective. Still other countries are simultaneously members of FTAs and CUs. Venezuela and Colombia, in addition to being signatories to the Andean Pact, are members of the 'Group of Three' and have individually signed bilateral FTAs with Chile.

Apart from regionality, there is no obvious pattern in trade agreement memberships either. The EU and European FTA are comprised entirely of developed, but asymmetric, economies. The Andean Pact and MERCOSUR consist entirely of developing nations (although at different stages of development) whose sizes vary greatly. In contrast, the NAFTA has brought together the large, advanced economies of North America with (relatively) small, developing Mexico. Perhaps the most intriguing case of all, however, is that of APEC. While its free trade rhetoric has yet to be realized, countries as (economically) diverse as Japan and Papua New Guinea, and as (politically) different as the US and China, have resolved to form a FTA by 2020.

The regionalism literature has had relatively little to say on the types of countries most likely to join trade blocs, and the form such agreements may take. In particular, there has been little systematic analysis of coalition formation between trading nations. A notable exception is Riezman (1985) who pioneered the incorporation of coalition formation into analyses of regional trade agreements. He argued that the *core* (consisting of all Pareto efficient allocations) is a "natural" solution concept to use since allocations in the core are likely to be observed. In our view, however, this approach has yet to be fully exploited. This approach has been adopted by Kennan and Riezman (1990) and Riezman (1999) among others. Invariably, however, such analyses are confined to isolated special cases, usually particular endowment distributions.

Further, where more systematic analyses have been undertaken, coalition formation is usually not the focus. Kennan and Riezman (1990) report how the relative merits of customs unions and global free trade vary with endowments. However, they only examine the case in which all union members are symmetric. This abstracts from issues of disagreement among union members over common external tariff choice. Haveman (1992), in addressing whether or not successive customs union formnation leads to global free trade, only deals with customs unions and reports results for entire blocs rather than individual countries. Syropoulos (1999) analyses the effects of different types of customs unions on inter-bloc tariffs and welfare. However, as in Kennan and Riezman (1990), all countries are assumed to be symmetric. Furthermore, he does not consider other types of preferential trading arrangements, such as free trade areas for example.

Abrego, Riezman and Whalley (2004) also concentrate on customs unions when discussing the possible establishment of regional agreements. While they vary the endowment and preference distributions they do not directly consider how these changes alter the pattern of bloc formation. Rather, their focus is on determining the likelihood that certain propositions in the regional trade agreements literature actually hold. For example, they report that a customs union Pareto dominates global free trade (from the point of view of its members) in up to 30% of the simulated cases they analyze. A customs union is also found to Pareto dominate the unilateral tariff setting equilibrium, in which all countries stand alone, in 50-80% of the cases simulated (depending on the sampling procedure employed). Rather than predicting how likely it is that a regional agreement will be observed, this paper is interested in predicting the conditions (that is, the parameter values) under which particular coalition structures will arise.

Kose and Riezman (2002) also introduce asymmetric countries into their analysis of the "innocent bystander problem". Their approach is closest in spirit to the simulations undertaken here. However, their analysis differs from ours in a number of important respects. First they assume identical Cobb-Douglas preferences across countries. These are never varied. This paper, using CES utilities, will consider how asymmetries in national preferences impact on coalition formation. Second, in the case of a customs union between a large and small country, Kose and Riezman consider only one possible common external tariff rate. As such, there is no way of knowing whether or not this rate is Pareto optimal and, therefore, likely to be observed. In this paper, we consider all Pareto optimal common external tariffs. Third, while comparing the welfare effects of large and small countries under different coalition structures, Kose and Riezman do not directly draw conclusions as to how country characteristics (different endowments in their case) influence coalition formation. This, of course, is not part of their brief. Nevertheless, in this paper explicit predictions are made regarding the relationship between country characteristics and the type of coalition structures likely to be observed.

Finally, with respect to all the existing literature, this paper is unique in two important additional aspects. First, when modelling customs unions between asymmetric countries, the existing literature selects the union's common external tariff according to some exogenously imposed rule. In the case of Kose and Riezman (2002), for example, the large country makes this choice unilaterally. In Riezman (1999) an average external tariff rate is chosen. In contrast, this paper deals with the issue by considering all Pareto optimal (and therefore 'plausible') common external tariff rates.

Gatsios and Karp's (1991, 1995) analysis of delegation shows that the ad hoc choice of common external tariffs is a potentially hazardous practice. The implication of their analysis is that customs union common external tariffs are best determined endogenously. Syropoulos (2002) demonstrates that in a traditional Heckscher-Ohlin framework, whether union members should delegate authority over common external tariff choice to the most- or least-well endowed partner depends crucially on the strategic relationship between the common external tariff and non-member tariffs; that is, whether they are strategic substitutes oir complements. Melatos and Woodland (2004) have also shown that, by choosing the union's common external tariff rate exogenously, one may neglect to consider Pareto optimal customs unions or, alternatively, consider a Pareto dominated union that is, therefore, unlikely to be observed.

Another source of this paper's uniqueness is that, for the first time, the blocking behaviour of coalitions is explicitly investigated. This analysis turns out to sheds new light on a number of unresolved issues in the regionalism literature, including: (i) whether preferential trade agreements help or hinder the move to global free trade and (ii) the apparent inconsistency between the observed popularity of free trade areas and the theoretical primacy of customs unions.

This paper uses a perfectly competitive, pure exchange, general equilibrium model to investigate the impact of changes in the world endowment distribution and the structure of preferences on coalition formation. The flexibility of CES utility functions is exploited to investigate how differences in the implied substitution elasticity among countries affects their partnership decisions. Attention focuses, not only on the characteristics of coalition members, but also on the types of blocs they form. Countries can stand alone or take part in a global free trade agreement. Alternatively, they may join a free trade area or a customs union. Asymmetric countries forming a customs union can also choose how to share authority over the choice of common external tariff amongst themselves.

The mechanics of coalition formation are modelled using cooperative game theory. While a number of solution concepts are available, the core is judged to be the most suitable. For the first time, the blocking behaviour of coalitions is also investigated. This provides additional insight into the relative welfare merits of different trade blocs, and helps to motivate the observed pattern of coalition formation between trading nations.

In the following section, the trade model is described and the mechanics of coalition formation are discussed. Section 3 reports the results of simulations when preferences and export endowments are varied. Section 4 deals with the blocking behaviour of coalitions. These simulations strongly suggest that when all countries are sufficiently similar global free trade is observed. Customs unions tend to form between countries with: (i) similar consumer preferences or (ii) similar export endowments. In a customs union, common external tariffs tend to be chosen by the member with relatively inelastic preferences or the larger export endowment. Contrary to the existing literature, coalition structures characterized by free trade areas, or all nations standing alone, are also often observed, although never as the unique elements of the core. Moreover, the explicit analysis of coalition blocking behaviour shows that free trade areas often Pareto dominate customs unions provided national preferences differ sufficiently. To the best of the authors' knowledge, this is the first time that free trade areas have been demonstrated to welfare dominate customs unions within a perfectly competitive framework. Nevertheless, this result is consistent with the observed popularity of free trade areas relative to customs unions. Finally, as a by-product of our analysis, the results in this paper offer a different interpretation on the unresolved issue of whether trade agreements are a help or hindrance in the quest for global free trade.

2 The Model

2.1 Introduction

World trade is modelled within a pure exchange, general equilibrium framework. There are 3 countries trading internationally in 3 goods. Nations are endowed with a fixed amount of each commodity and it is assumed that, in equilibrium, each country is the sole exporter of one good and an importer of the other two goods.[1] Without loss of generality, it is assumed that country i exports good i. There is no on-selling - each country obtains its imports directly from its sole exporter.

Countries may stand alone in a unilateral tariff setting framework, join a preferential trade agreement (either a free trade agreement or a customs union), or join a global free trade agreement. The formation of trade policy and the resulting equilibrium is modeled as a two-stage game. In the first stage, nations form coalitions. In the second stage, given the trade blocs that have been established, optimal tariffs are chosen and the trading equilibrium is determined. The game is solved backwards to obtain a subgame perfect Nash equilibrium. The following sub-section details the various trading equilibria (second stage), given the coalition structure formed at the first stage of the game. The subsequent sub-sections then deals with coalition formation in the model.

2.2 Calculating Trading Equilibria

It is assumed that countries comprise one representative agent with preferences $U^i(c_1^i, c_2^i, c_3^i)$ over the consumption vector $c^i = (c_1^i, c_2^i, c_3^i)$ for country i. Each consumer choose the consumption vector to maximize utility subject to the budget constraint., taking world prices and trade taxes as given. Country i's national income is represented by $m_i = \sum_{j=1}^{3} p_j^w \left(1 + t_j^i\right) \omega_j^i + T^i$ where $T^i = \sum_{j=1}^{3} t_j^i p_j^w \left(c_j^i - \omega_j^i\right)$ is tariff revenue, p_j^w is the world price of good j, t_j^i is the tariff levied by country i

[1] This special trade pattern allows trade blocs such as customs unions and free trade areas, which levy discriminatory tariff rates, to be analysed within a relatively simple non-discriminatory tariff framework.

on imports of good j and ω_j^i is i's endowment of good j.[2] Country i's national income is represented by $m_i = \sum_{j=1}^{3} p_j^w \left(1 + t_j^i\right) \omega_j^i + T^i$ where $T^i = \sum_{j=1}^{3} t_j^i p_j^w \left(c_j^i - \omega_j^i\right)$ is tariff revenue, p_j^w is the world price of good j, t_j^i is the tariff levied by country i on imports of good j and ω_j^i is i's endowment of good j.

The demand function for country i may be expressed generally as $c^i = \varphi^i(p^w, t^i)$, where p^w is a 3×1 vector of world prices, with elements p_j^w, and t^i is a 3×1 vector of tariffs (elements t_j^i). These demand functions can be substituted back into the agent's utility function to yield the indirect utility function $v^i = V^i\left(p^w, t^i\right)$ and also yield the net export functions

$$x^i \equiv \omega^i - c^i = \omega^i - \varphi^i(p^w, t^i) \equiv X^i\left(p^w, t^i\right), \tag{1}$$

where ω^i is a 3×1 vector (elements ω_j^i) of i's endowments and x^i is country i's 3×1 vector of net exports(elements x_j^i).

In equilibrium, the market for each good clears, i.e.

$$\sum_{i=1}^{3} X^i\left(p^w, t^i\right) = 0. \tag{2}$$

Making good 3 the numeraire and applying Walras' Law, the world prices of goods 1 and 2 are obtained as functions of tariffs and the model parameters, i.e. $p_j^w = p_j^w\left(t^1, t^2, t^3\right),\ j = 1, 2$. Thus the indirect utility of country i takes the form $v^i = V^i\left(p^w\left(t^1, t^2, t^3\right), t^i\right),\ i = 1, 2, 3$.

2.2.1 Unilateral Tariff Setting

The Unilateral Tariff Setting (UTS) equilibrium occurs when *all* countries decide to stand alone and undertake independent trade policy settings. Given zero trade taxes on exports,[3] the optimal tariff equilibrium in which each country stands alone can be obtained by solving the following system of six implicit tariff reaction functions (first order maximization conditions) - two for each country - for the six tariff rates $(t_2^1, t_3^1, t_1^2, t_3^2, t_1^3, t_2^3)$:

$$\frac{dV^i\left(p^w\left(t^1, t^2, t^3\right), t^i\right)}{dt_j^i} = 0, \qquad i = 1, 2, 3;\ j = 1, 2, 3;\ j \neq i. \tag{3}$$

Solving system 3, yields expressions for the tariff vectors t^1, t^2 and t^3 in terms of the exogenous parameters (i.e. endowments and preferences) of the model. Thus, world prices and country welfare can also be written in terms of these parameters.

2.2.2 Global Free Trade

Under global free trade (also called the 'grand coalition'), each country levies zero trade taxes on all imports. That is, all world trade is duty free ($t_j^i = 0, \quad \forall i, j$). In this case, there are no optimal tariff conditions to solve and, hence, equation system (2) is sufficient to solve for the equilibrium world prices purely as functions of the parameters of the model.

2.2.3 Free Trade Areas

The FTA equilibrium arises whenever any two countries, say k and l, establish a free trade area, $FTA(k,l)$. A FTA represents an agreement by members to levy zero trade tax rates on trade with each other. However, the members are free to independently set tariffs on trade with non-member

[2] This definition of national income implies that all tax revenue is redistributed to domestic consumers in a lump sum manner and that there are no international transfers of income between countries.

[3] As is well known, optimal tariff vectors can be normalized in this way. See, for example, Woodland (1982, p.301) for an explanation of why this assumption does not detract from the robustness of the model.

countries. By ruling out on-selling, we are assuming that rules of origin are completely effective in deterring trade deflection.

Given the assumed pattern of trade, whereby country i exports good i and imports the other goods, trade between the $FTA(k,l)$ members k and l is only in goods k and l. Accordingly, this FTA represents an agreement by members to levy zero trade tax rates on trade in these two goods, that is, they set $t_l^k = t_k^l = 0$.

Thus, the optimal tariff conditions for a world characterized by $FTA(k,l)$ may be expressed as:

$$\begin{aligned} \frac{dV^i\left(p^w\left(t^1,t^2,t^3\right),t^i\right)}{dt_j^i} &= 0, \qquad i=k,l; \quad j\neq k,l \\ \frac{dV^n\left(p^w\left(t^1,t^2,t^3\right),t^n\right)}{dt_j^n} &= 0, \qquad n\neq k,l; \quad j\neq n. \end{aligned} \tag{4}$$

The first set of equations determine the two optimal tariffs levied (one by each member) on imports from the rest of the world. The second group of equations are the first order optimality conditions for the two optimal tariffs (one directed at each FTA member) comprising the non-member's tariff-setting strategy. For example, under the free trade area $FTA(1,2)$, the first set of conditions determine tariff rates t_3^1 and t_3^2 while the second set of conditions determine country 3's tariff rates t_1^3 and t_2^3. Given the model parameters, system (4) can be solved for the four optimal trade taxes expressed in terms of the preference and endowment parameters of the model.

2.2.4 Customs Unions

The CU equilibrium arises whenever any two countries, say k and l, establish a customs union, $CU(k,l)$. In forming a CU, both nations agree (i) that all trade between them will be free, and (ii) to levy identical trade tax rates (common external tariffs) on the good imported from the non-member nation. It is the latter requirement that distinguishes a customs union from a free trade area in which external tariff rates can be different for the members.

Consistent with the trade pattern described above, member k (l) exports good k (l) to its partner and the ROW and both members import the other product (i.e., good $j\neq k,l$) from outside the union. Accordingly, in forming a customs union $CU(k,l)$, both nations agree (i) to set $t_l^k = t_k^l = 0$ (free internal trade) and (ii) to set a common external tariff rate on imports of the remaining good j from the non-member, i.e., $t_j^k = t_j^l = t_j^{CET}$ for $j \neq k,l$.

The choice of the common external tariff rate by the customs union depends upon the nature of the customs union contract established as part of the agreement between the members. Here we follow the model specified and analyzed by Melatos and Woodland (2004). According to this specification, the customs union chooses its common external tariff to maximize a social welfare function for the union, which is expressed as a linear function of members' utility functions and given by

$$W^{kl}\left(p^w\left(t^1,t^2,t^3\right),t^k,t^l\right) = \sum_{i=k,l} d_i V^i\left(p^w\left(t^1,t^2,t^3\right),t^i\right) \tag{5}$$

where (d_k, d_l) is the vector of weights.

The common external tariff of the customs union is chosen to maximize the union's social welfare function defined above. In our three-country, three-product model common external tariff $t_j^C = t_j^k = t_j^l$ is on imports of good j from non-member country j. Accordingly, the CET t_j^C is chosen to maximize $W^{kl}\left(p^w\left(t^1,t^2,t^3\right),t^k,t^l\right)$, where it is recalled that $t_j^k = t_j^l = t_j^C$ and $t_l^k = t_k^l = 0$.

The Nash equilibria for the model characterized by $CU(k,l)$, is therefore obtained by solving the following three-equation system:

$$\begin{aligned} \frac{dW^{kl}\left(p^w\left(t^1,t^2,t^3\right),t^k,t^l\right)}{dt_j^C} &= d_k\frac{dV^k}{dt_j^k}+d_l\frac{dV^l}{dt_j^l}=0, \qquad j\neq k,l \\ \frac{dV^n\left(p^w\left(t^1,t^2,t^3\right),t^n\right)}{dt_j^n} &= 0, \qquad n\neq k,l; \quad j\neq n. \end{aligned} \tag{6}$$

The first equation specifies the optimal CET condition for the union. The second group of equations represents the first order conditions for the ROW's two optimal tariffs pertaining to imports from the two union members. Given the model parameters and the SWF weights, system (6) can be solved for the three optimal trade taxes as functions of the model's preference and endowment parameters.

It is clear that the choice of CET and the equilibrium for a coalition structure involving a customs union will depend upon the union's choice of weights (d_k, d_l) in the social welfare function. While it is ostensibly plausible to restrict attention to non-negative weights, Melatos and Woodland (2004) argue that the customs union will seek a utility outcome that is Pareto efficient for the union members. They show that non-negative weights are neither necessary nor sufficient for a Pareto efficient outcome. Hence, the union should consider any weights (positive or negative) that generate a Pareto efficient outcome for the members. Accordingly, the signs of the weights are not restricted in the current model.

It will be convenient to express the weight vector as $(d_k, d_l) = (\cos\theta, \sin\theta)$ with θ being the angle of direction of the vector d.[4] Customs unions will then be distinguished by the member countries and by the weights (measured by the angle) in the social welfare function as in $CU(k, l; \theta)$.

2.3 Coalition Formation

Having determined the welfare implications of each potential coalition structure (stage 2), countries are in a position to choose their preferred option from the menu of possible outcomes (stage 1 of the game). There are a number of ways to determine which coalition structures are likely to be observed. Following Riezman (1985, 1999), the solution concept employed here is the *core*.

2.3.1 The Core

Before, defining the core, an important distinction must be made between a *coalition* and a *coalition structure*. The former summarizes the membership details of a particular bloc only. For example, the coalition $CU(k, l)$ comprises a customs union of countries k and l. A coalition structure, on the other hand, is an exhaustive description of the membership details of every country in the world, regardless of which coalition (if any) they belong to. Hence, the coalition structure $\{CU(k, l), \{h\}\}$ says that countries k and l are members of the union $CU(k, l)$ while country h stands alone.

A coalition structure resides in the *core* if it is not blocked by any coalition. A coalition, S, blocks a coalition structure, T, if for all countries i in S, $U^i(S) \geq U^i(T)$, with strict inequality for at least one member of S. In other words, a coalition (or trade agreement) blocks a coalition structure if the former Pareto dominates the latter from the point of view of the trade agreement's membership. In this way, elements of the core represent stable outcomes in the sense that players cannot regroup in any way so as to improve their payoffs.

While the core assigns a set of outcomes (coalition structures, here) to each game, it provides no guidance as to which of these outcomes is more or less likely to occur. The core may consist of multiple outcomes, in which case a coarser predictive mechanism is required to provide an unambiguous prediction. The core may also be empty, in which case it provides no information

[4] The parameter θ measures the degree of influence exercised by each CU partner in CET choice. At $\theta = 0$, for instance, only country 1's utility has any value to the union and so it exerts total control. At $\theta = 90$, however, country 2 is omnipotent. For values of θ between 0 and 90 the weights are both positive; for values of θ outside this range, one of the weights is negative.

whatsoever on likely equilibrium coalition structures. Hence, one must appeal to a finer cooperative solution concept in order to obtain predictions of likely outcomes.

2.3.2 Implementing the Core

The general approach for identifying the contents of the core consists of three steps: (1) solve for the equilibrium utilities associated with each coalition structure, (2) determine the value of each coalition to its members and (3) apply the core definition. Section 2 dealt with the first step of this process, explaining how the various coalition structure equilibria are calculated. The latter two steps are explained in the Appendix, available upon request. A numerical example will help explain these steps and enhance understanding of the results of the next section.

A Numerical Example To implement the above model numerically, it is assumed that the consumers have preferences that take the CES form. Specifically, the utility function for country i is assumed to be

$$U^i = \left[\sum_{j=1}^{3} \gamma_j^i \left(c_j^i\right)^{\frac{\sigma_i - 1}{\sigma_i}}\right]^{\frac{\sigma_i}{\sigma_i - 1}} \quad ; \quad \gamma_j^i = \frac{1}{3} \quad \forall i, j \quad \text{and} \quad \sigma_i \neq 1, \tag{7}$$

where γ_j^i are consumption weights and σ_i is the elasticity of substitution. All countries are assumed to have preferences that approximate the Cobb-Douglas form, with each country having a substitution elasticity $\sigma^i = 0.99$. **(Check this)** In this example, the endowment distribution provided in table 1.

	good 1	**good 2**	**good 3**
country 1	0.1	0.005	0.005
country 2	0.005	0.5	0.005
country 3	0.005	0.005	1

Table 1: Example Endowment Distribution

Table 2 presents the equilibrium utilities for each of 35 possible coalition structures. These include the global free trade (GFT) and unilateral tariff setting (UTS) structures, three possible free trade agreement structures and nine possible customs union structures. The latter comprise three equilibria for each of three families of customs unions $CU\,(i,j)$, These three equilibria are associated with SWFs characterized by $\theta = 0, 50, 90$.[5] Countries may only belong to one coalition at any one time. In other words, overlapping trade agreements are not considered here.

The value to each nation of standing alone in this example is provided in table 3. The values for singleton coalitions are obtained by assuming that countries standing alone expect the worst of all possible outcomes. For example, to evaluate $U^1\left(\{1\}\right)$ it is clear from table 2 that the minimum utility country 1 is guaranteed by standing alone is approximately $U^1 = 0.04$,which occurs under coalition structure 14. This was achieved by comparing 1's payoff from coalition structures 2,5 and 12-14. Hence, when deciding to stand alone, country 1 believes that the coalition structure that will eventuate is $\{CU(2,3;\theta=90),\{1\}\}$. The other elements of the table may be similarly computed.

The core for this example consists of a single element - global free trade. This is because it is the only coalition structure that is not blocked by some coalition. In particular, it is noted that:

- All coalition structures, except for those involving $FTA(1,2)$ and $FTA(1,3)$, are blocked by global free trade. For example, the utility vector $U(GFT) = (0.1184,\ 0.13189, 0.1337)$ Pareto dominates UTS utility vector $U(UTS) = (0.0530, 0.0808, 0.0938)$. However, comparing the utility vector $U(GFT) = (0.1184,\ 0.13189, 0.1337)$, with the vectors $U(FTA(1,2)) =$

[5] Just three choices of angle θ are used to keep the illustrative example simple.

Coalition Structure		National Utility Levels		
Number	Label	U^1	U^2	U^3
1	GFT	0.1184	0.13189	0.1337
2	UTS	0.0530	0.0808	0.0938
3	$FTA(1,2)$	0.0750	0.0822	0.137
4	$FTA(1,3)$	0.0841	0.13192	0.0932
5	$FTA(2,3)$	0.1064	0.1180	0.119
6	$CU(1,2;\theta=0)$	0.0815	0.0904	0.0875
7	$CU(1,2;\theta=50)$	0.082	0.0905	0.0868
8	$CU(1,2;\theta=90)$	0.0816	0.0905	0.0863
9	$CU(1,3;\theta=0)$	0.0912	0.0815	0.1026
10	$CU(1,3;\theta=50)$	0.0913	0.0807	0.1027
11	$CU(1,3;\theta=90)$	0.0913	0.0801	0.1028
12	$CU(2,3;\theta=0)$	0.0432	0.1308	0.1326
13	$CU(2,3;\theta=50)$	0.0431	0.1308	0.1326
14	$CU(2,3;\theta=90)$	0.0430	0.1308	0.1326

Table 2: Equilibrium utilities for the example parameter distribution

	U^1	U^2	U^3
$\{1\}$	0.0430	0.1308	0.1326
$\{2\}$	0.0913	0.0801	0.1028
$\{3\}$	0.0816	0.0905	0.0863

Table 3: Singleton Coalition Values

$(0.075, 0.0822, 0.137)$ and $U(FTA(1,3)) = (0.0841, 0.13192, 0.0932)$, it is clear that $U^3\,(GFT) < U^3\,(FTA(1,2))$ and $U^2\,(GFT) < U^2\,(FTA(1,3))$.

- The coalition structure that features $FTA(1,2)$ is blocked by all $CU(1,2)$s, regardless of θ. Comparing, for example, the utility vector $U(CU(1,2;\theta=50) = (0.082, 0.0905, 0.0868)$ with $U(FTA(1,2)) = (0.075, 0.0822, 0.137)$, it is clear that $U^i\,(CU(1,2;\theta=50) > U^i\,(FTA(1,2))$ for $i = 1,2$.

- The coalition structure featuring $FTA(1,3)$ is blocked by all $CU(1,3)$s, regardless of θ. Comparing, for example, the utility vector $U(CU(1,3;\theta=50) = (0.0913, 0.0807, 0.1027)$ with $U(FTA(1,3)) = (0.0841, 0.13192, 0.0932)$ it is clear that $U^i\,(CU(1,3;\theta=50) > U^i\,(FTA(1,3))$ for $i = 1,3$.

- None of the free trade, customs union or singleton coalitions block global free trade. For example, members of any customs union are both worse off than under global free trade. In $FTA(1,2)$ and $FTA(1,3)$ at least one member is worse off. Similarly, from table 3 we see that $U^i\,(\{i\}) < U^i\,(GFT)\,,\ \forall i$, and hence no singleton coalition blocks global free trade. For example, $U^1\,(\{1\}) = 0.043 < U^1\,(GFT) = 0.1184$.

3 Equilibrium Coalition Structures

In the remainder of the paper, the theoretical framework introduced above is used to simulate endogenous trade bloc formation in a world of asymmetric countries. In particular, we examine how national differences in endowments and preferences influence coalition formation. A pure exchange model of trade in three products betweeen three countries is analysed. Consumer preferences are represented by CES utility functions. The general distribution of endowments that will be employed throughout is given in Table 4. Notice that world supply for each good is normalised to unity. Given a country's endowment of its export commodity, the remaining quantity of the good is divided evenly between the importing countries.

To isolate the role of country preferences in trade bloc formation, national elasticities of substitution are varied for a fixed endowment distribution. In particular, σ_1 and σ_2, the elasticities of substitution of countries 1 and 2 respectively, are permitted to vary in the range $[0.6, 2.4]$, while country 3's elasticity of substitution is fixed at $\sigma_3 = 0.9$. To neutralize the role played by endowments, it is assumed that countries are symmetrically identical in their fixed endowments of the three goods. In particular, it is assumed that $\omega_1^1 = \omega_2^2 = \omega_3^3 = 0.99$ in Table 4. That is, countries are allocated 0.99 units of their exportable good and 0.005 units of each importable. The fact that countries are endowed with relatively small amounts of their importables ensures that, more often than not, they will import these goods in equilibrium - consistent with the trade pattern assumption implicit in the simulation model.[6]

Endowments	**good 1**	**good 2**	**good 3**
country 1	ω_1^1	$\frac{(1-\omega_2^2)}{2}$	$\frac{(1-\omega_3^3)}{2}$
country 2	$\frac{(1-\omega_1^1)}{2}$	ω_2^2	$\frac{(1-\omega_3^3)}{2}$
country 3	$\frac{(1-\omega_1^1)}{2}$	$\frac{(1-\omega_2^2)}{2}$	ω_3^3

Table 4: Endowment Distribution

To determine the influence that the endowment distribution has on the formation of trade agreements, endowments are varied holding country elasticities of substitution fixed. In particular, $\sigma_1 = \sigma_2 = \sigma_3 = 0.999$ and $\omega_3^3 = 0.97$ is assumed.[7] Country 1 and 2's endowments of their export goods are varied in the range $(\omega_1^1, \omega_2^2) \in (0, 1)$.

We consider 413 possible coalition structures, which are listed in Table 5. Note that, with only three countries in the trading world, each coalition implies a unique coalition structure. Thus, for example, the coalition $CU(1, 2; \theta = 45)$ implies one and only one coalition structure, namely $\{CU(1, 2; \theta = 45), \{3\}\}$. For simplicity, coalition structures will from hereon be referred to using the coalition structure labels defined in Table 5.

Coalition Structure Number	Coalition Structure Label	Coalition Structure
1	Global Free Trade (GFT)	$\{\{1, 2, 3\}\}$
2	Unilateral Tariff Setting (UTS)	$\{\{1\}, \{2\}, \{3\}\}$
3	$FTA(1, 2)$	$\{FTA(1, 2), \{3\}\}$
4	$FTA(1, 3)$	$\{FTA(1, 3), \{2\}\}$
5	$FTA(2, 3)$	$\{FTA(2, 3), \{1\}\}$
6-141	$CU(1, 2; \theta = -15 \text{ to } 120)$	$\{CU(1, 2; \theta), \{3\}\}$
142-277	$CU(1, 3; \theta = -15 \text{ to } 120)$	$\{CU(1, 3; \theta), \{2\}\}$
278-413	$CU(2, 3; \theta = -15 \text{ to } 120)$	$\{CU(2, 3; \theta), \{1\}\}$

Table 5: Possible Coalition Structures

Figures 1 and 2 provide a summary of how the composition of the core varies with country preferences and endowments respectively.

(Insert Figures 1 and 2 here)

In Figure 1, each cell represents the results for a particular combination of elasticities of substitution for countries 1 and 2, σ_1 and σ_2 (with country 3's elasticity of substitution being fixed at $\sigma_3 = 0.9$). The highlighted (bolded border) cell at $(\sigma_1, \sigma_2) = (0.9, 0.9)$ represents the situation in

[6] A second case, in which $\omega_1^1 = 1.3$ and $\omega_2^2 = 1$, was also considered. In this case, country 1 is endowed with more of its export good than either country 2 or 3. Since the results obtained from this case are qualitatively similar to those obtained from the first, it has been omitted from the following discussion.

[7] Remember that as $\sigma_i \to 1$ a country's preferences approximate the Cobb-Douglas form.

which all three countries are identically symmetric - that is, the 'benchmark' case for our preference analysis.

In Figure 2, each cell represents the results for a particular combination of export endowments for countries 1 and 2, ω_1^1 and ω_2^2 (with country 3's export endowment being fixed at $\omega_3^3 = 0.97$). The highlighted (bolded border) cell at $(\omega_1^1, \omega_2^2) = (0.97, 0.97)$ represents the situation in which all three countries are identically symmetric - the 'benchmark' case for our endowment analysis.

For each cell, trading equilibria have been calculated for all 413 possible coalition structures specified in Table 5. The shaded regions in the figure identify the predominant coalition structure prevailing in each cell.[8] The numbers within each cell provide additional detail about the core solution. Numbers **prefixed by a '+'** signify the existence of additional coalition structures in the core - that is, structures in addition to that suggested by the cell's shading. For example, at $(\sigma_1, \sigma_2) = (0.7, 0.8)$ in Figure 1, the core consists of global free trade (coalition structure 1) and $FTA(1,3)$ (coalition 4).

Numbers **not prefixed by a '+'** appear in those cells in which a customs union is observed.[9] These numbers signify the Pareto optimal common external tariff rates that union members will choose to levy on imports from the rest of the world. Where many Pareto optimal common external tariff rates reside in the core, we provide the relevant range. Therefore, at $(\sigma_1, \sigma_2) = (1.2, 2.4)$ in Figure 1 for example, the core consists of the unilateral tariff setting equilibrium in which all countries stand alone as well as a number of $CU(1,2)$s whose (*ad valorem*) common external tariff rates range from 1300% to 2000%.

Finally, those cells in which customs unions figure in the core also contain **bracketed numbers**. These identify the range of θ values associated with observed customs unions. That is, the bracketed numbers identify the range of Pareto optimal social welfare function weights for the custome union. Once again considering $(\sigma_1, \sigma_2) = (1.2, 2.4)$ in Figure 1, the core consists of $CU(1, 2; \theta = 4 \text{ to } 90)$. When $\theta = 4$, the common external tariff levied by countries 1 and 2 on the excluded country 3 is 2000%. When $\theta = 90$, the common external tariff levied by countries 1 and 2 on the excluded country 3 falls to 1300%. As another example, consider $(\sigma_1, \sigma_2) = (1.4, 1.6)$ in Figure 1. Here, the core consists of a range of customs unions involving countries 1 and 2, $CU(1, 2; \theta = -15 \text{ to } 21)$. If the weights of the social welfare function selected by union members are characterised by $\theta = -15$, then a common external tariff rate of 1790% will be levied on the excluded country 3. On the other hand, if countries 1 and 2 choose their social welfare function from the other extreme of the Pareto optimal range (i.e. $\theta = 21$) then the common external tariff rate will be 1700%. Finally note that in various regions of Figures 1 and 2 (such as along the main diagonal), customs unions can be observed between symmetrically identical nations. In this case the complete range of social welfare function weights lie in the core. This is because the union's social welfare function is invariant to the choice of θ. As a result, the union's optimal external tariffs and members' equilibrium welfare levels are identical regardless of how authority over common external tariff choice is shared between them. In such situations, the range of Pareto optimal social welfare function weights is labelled ["all"].

Finally, with respect to Figure 1, note that when σ_1 or σ_2 become too large or small, the trade pattern becomes inconsistent with that assumed in the underlying theoretical model. The affected area is labelled in the diagrams. The results from the endowment simulations are read from Figure 2 in exactly the same way.

Inspection of Figures 1 and 2 suggests a number of propositions relating country preferences and export endowments to observed coalition structures. The first of these concerns global free trade.

Proposition 1 *Global Free Trade is an element of the core when* <u>*all*</u> *countries have 'similar' preferences (respectively, endowments of their export good).*

[8] Only the upper half of the table is shaded, since the lower half will be symmetric due to the symmetry of the model specification.

[9] To avoid clutter, full details are only provided for selected cells.

In fact, when all countries have 'sufficiently similar' preferences or export endowments, global free trade is the sole element of the core. This is the case for cells in the vicinity of the bolded border cell at $(\sigma_1, \sigma_2) = (0.9, 0.9)$ in Figure 1 and around $\left(\omega_1^1, \omega_2^2\right) = (0.97, 0.97)$ in Figure 2. As country characteristics diverge, global free trade may first share the core with other coalition structures, before disappearing from it altogether. For example, at $(\sigma_1, \sigma_2) = (0.7, 0.9)$ in Figure 1, free trade cohabits the core with $FTA(1,2)$ and $FTA(1,3)$ (coalitions 3 and 4). At $(\sigma_1, \sigma_2) = (0.8, 1.4)$, free trade shares the core with the unilateral tariff setting outcome in which all countries stand alone, as well as with a range of possible $CU(2,3;\theta)$ agreements. At $(\sigma_1, \sigma_2) = (0.8, 1.5)$, however, global free trade no longer figures in the core, the customs union $CU(1,3;\theta = -15)$ being the sole surviving coalition structure. In Figure 2 a similar pattern is evident. If as one moves further away from the benchmark case at $\left(\omega_1^1, \omega_2^2\right) = (0.97, 0.97)$, global free trade is displaced in the core by a customs union. Note that, unlike in the preferences case illustrated in Figure 1, global free trade never shares the core with any other coalition structure. If free trade is in the core, it is there alone.

A second proposition identifies when customs unions will form and who their members will be.

Proposition 2 *A customs union between countries with 'similar' preferences (resp. export endowments) is the only element of the core when the* <u>*excluded*</u> *country's preferences (export endowments) are 'sufficiently different'.*

Starting at the bolded border cell in Figure 1 and moving diagonally down to the right, countries 1 and 2 have identical preferences, which differ increasingly from those of country 3. This divergence in preferences results in $CU(1,2;\theta)$ agreements displacing global free trade in the core. Alternatively, starting at $(\sigma_1, \sigma_2) = (0.9, 0.9)$ and moving horizontally to the right, country 2's preferences deviate increasingly from those of countries 1 and 3. As a consequence, global free trade is eventually replaced in the core by a range of $CU(1,3;\theta)$ agreements. In each case, customs unions are formed by the countries with the most similar preferences (as measured by the elasticity of substitution).

The exact interpretation of the conditions 'similar' and 'sufficiently different' is dictated by the shaded regions in Figure 1. For example, if $\sigma_1 = 0.9$, country 2's preferences are 'sufficiently different' compared to countries 1 and 3 (whose preferences are, in fact, identical) when $\sigma_2 \geq 1.6$. Similarly, when $\sigma_1 = \sigma_2$ (along the main diagonal of the matrix), country 3's preferences (given by $\sigma_3 = 0.9$) are 'sufficiently different' compared to those of countries 1 and 2 when $\sigma_1 = \sigma_2 \geq 1.2$.

Considering Figure 2, it is clear that Proposition 2 holds for variations in export endowments. Starting at $\left(\omega_1^1, \omega_2^2\right) = (0.97, 0.97)$ and moving diagonally up and to the left results in country 3 becoming increasingly dissimilar (in terms of export endowment only) to both countries 1 and 2 which remain symmetrically identical. Eventually, one or more $CU(1,2)$s replace global free trade in the core.

Proposition 3 *Customs unions are often observed in which one member's welfare is negatively weighted in the union's social welfare function.*

This result was first observed in Melatos and Woodland (2004). There it was shown that, compared to the unilateral tariff setting outcome, a Pareto efficient customs union could involve one member's utility being negatively weighted in the union's social welfare function. Generalizing the terminology of Gatsios and Karp (1991, 1995), this phenomenon was termed 'super-delegation'. In Melatos and Woodland (2003), however, only two coalition structures were compared - the unilateral tariff setting outcome and a customs union between countries 1 and 2 (with different weights in the union's social welfare function). This left open the possibility that while a $CU(1,2)$ with negative weights may Pareto dominate the unilateral tariff setting equilibrium, it may itself be Pareto dominated by some other coalition structure such as global free trade or, indeed, by another customs union involving only positive welfare weights.

Figures 1 and 2 demonstrate that customs unions characterized by negative welfare weights are, in fact, often observed in the core. Instances of negative weights are indicated by θ values that are outside the $[0, 90]$ range. This is the case, for example, at $(\sigma_1, \sigma_2) = (1.5, 1.5)$ in Figure 1, where $CU(1, 2; \theta)$ agreements involving $\theta < 0$ and $\theta > 90$ are not blocked by any other coalition. Furthermore, it is often the case that customs unions characterized by negative welfare weights are the *only* element of the core. This is true, for example, when $(\sigma_1, \sigma_2) = (0.8, 1.8)$, $(1.1, 2.4)$ and $(1.6, 1.7)$. In the first case, with $\theta = -15 < 0$, a negative weight is placed on country 2's welfare in customs union $CU(1, 2; \theta)$. In the second case, with $\theta = 120 > 90$, a negative weight is placed on country 2's welfare in the union social welfare function. In the third case, country 1's utility is weighted negatively in $CU(1, 2; \theta)$.

Numerous similar cases can be observed in Figure 2, for example at $\left(\omega_1^1, \omega_2^2\right) = (0.76, 0.79)$ where country 1's utility is negatively weighted. Proposition 3 confirms that by considering customs unions characterized by social welfare functions defined over only positive weights, the literature may be considering Pareto inefficient coalition structures while ignoring Pareto efficient outcomes. To the extent that negative weights in customs union social welfare functions are unimplementable, our observation of negative weights strongly suggests that defining customs union social welfare functions is a less than satisfactory way to identify Pareto optimal common external tariff rates.

Given that a customs union resides in the core, the following proposition refers to the nature of the customs union contract that will be observed. Of particular interest is the issue of how union members will share responsibility for the choice of common external tariff.

Proposition 4 *When a customs union is in the core:*

(i) If member preferences (export endowments) differ, even 'slightly', the more inelastic (resp. well-endowed exports-wise) member assumes greater authority in common external tariff choice.

(ii) As member preferences (export endowments) diverge, the range of common external tariff choice rules (values of θ) in the core tends to expand.

Proposition 4(i) can also be verified from Figures 1 and 2. For example, when $\sigma_1 = 0.8$ and $\sigma_2 \in [1.5, 1.8]$, the core consists of $CU(1, 3; \theta = -15)$. Here, country 1 is the relatively inelastic member. Country 1's over-riding authority in common external tariff choice is reflected in the negative weight placed on it's partner's (i.e. country 3's) utility in the union's social welfare function. On the other hand, when $\sigma_1 = 1.1$ and $\sigma_2 = 2.4$, the core consists of $CU(1, 3; \theta = 120)$. Now, authority over the union's choice of common external tariff is concentrated in the hands of country 2. This time, it pays both members to negatively weight country 1's contribution to union welfare. In the same way, above the main diagonal in Figure 1 (where $\sigma_1 < \sigma_2$), country 1 tends to shoulder more responsibility for setting the union's common external tariff rate. In Figure 2 a similar pattern is discernible. Along the main diagonal countries 1 and 2 are endowed with equal amounts of their export commodities. Immediately above the diagonal, country 2 is endowed with (slightly) more of its export good. This difference is sufficient to ensure that authority over common external tariff choice should be placed in the hands of country 2, the relatively well-endowed (export-wise) union member.

The intuition for Proposition 4(ii) is as follows. In a customs union, authority over common external tariff choice is delegated to that member who can induce the non-member nation to levy the lowest tariffs on member exports. This occurs because the parameter and functional form assumptions underlying this analysis invariably produce an inverse relationship between a country's welfare and the tariffs levied on its exports by its trading partners. In Figure 1, it turns out that the relatively elastic member is always the one who can induce the lowest rest of world tariff. Thus, authority over common external tariff choice is delegated (and, in the words of Melatos and Woodland (2004), often 'super-delegated') to this member. Likewise, in Figure 2, the union member with the larger export endowment can induce the non-member to levy lower tariff on customs union exports.

Consistent with Proposition 4(ii), the range of plausible social welfare functions, while expanding, also becomes increasingly skewed towards a higher weight on the welfare of the (increasingly) relatively inelastic member. To see this, start at $(\sigma_1, \sigma_2) = (1.2, 1.3)$ in Figure 1 and move horizontally to the right. Not only does the range of plausible $CU(1,2;\theta)$s expand, but the minimum plausible θ increases from $\theta = -15$ to $\theta = 4$ as σ_2 rises from 1.3 to 2.4. At the same time the maximum plausible θ also rises from $\theta = -15$ to $\theta = 90$. Similarly, starting at $(\sigma_1, \sigma_2) = (2.3, 2.4)$ and moving vertically upwards also confirms Proposition 4(ii).

A similar trend can be identified in Figure 2. That is, as customs union members become more asymmetric, the range of Pareto optimal common external tariff rates and social welfare function weights tends to expand. To see this start, for example, at $\left(\omega_1^1, \omega_2^2\right) = (0.67, 0.73)$ and move horizontally to the right. The range of common external tariff rates increases as does the Pareto optimal range of θ. Similarly, starting at $\left(\omega_1^1, \omega_2^2\right) = (0.82, 0.94)$ and moving vertically upwards reveals a similar trend.

In the simulations carried out in this paper it turns out that global free trade and customs unions are not the only coalition structures that can be observed - although they are easily the most common coalition structure predicted by our simulations. Proposition 5 argues that free trade areas and the unilateral tariff setting equilibrium may also be Pareto efficient, although these coalition structures are only ever observed when country preferences differ substantially.

Proposition 5 *Free trade areas and the unilateral tariff setting equilibrium may exist in the core although never as the unique elements.*

To see Proposition 5 in Figure 1 note that $FTA(1,2)$ and $FTA(1,3)$, coalition structures 3 and 4 respectively, arise above and to the left of the 'benchmark' case. In each of these cases, the free trade areas share the core with global free trade and, sometimes, another free trade area or, in one case, with customs unions. The unilateral tariff setting outcome, coalition structure 2, lies in the core when $\sigma_1 = 1.2$ and $\sigma_2 = (2.2, 2.3, 2.4)$ but $CU(1,2;\theta)$ is also a member of the core in these cases.

Figure 1 also reveals the potential for coalition structures characterized by free trade areas and customs unions to coexist in the core. For example, at $(\sigma_1, \sigma_2) = (1.5, 2.1)$ in Figure 1, the structure $\{FTA(1,3), \{2\}\}$ shares the core with $\{CU(1,2), \{3\}\}$. This is especially interesting because these coalitions involve different members. While country 1 is willing to form a customs union with the most elastic nation, it will only agree to a free trade area with the least elastic country.

Of particular interest in the simulation results summarized in Figure 1 is that sometimes, free trade areas may exist in the core while customs unions do not. This is true, for example, when $(\sigma_1, \sigma_2) = (0.6, 0.8)$; $FTA(1,2)$ is in the core but $CU(1,2;\theta)$ is not. To the best of the authors' knowledge, this outcome has not been previously observed within a perfectly competitive framework. In fact, as will be shown section 4, it is often the case that free trade areas block (that is, Pareto dominate) customs unions involving the same countries. Again, to the best of the authors' knowledge, this is a novel finding - the first time free trade areas have been shown to be Pareto superior to customs unions in a perfectly competitive trading world.

These are comforting results. In reality, after all, free trade areas are more commonly observed than customs unions. Nevertheless, in much of the regional trade agreements literature customs unions Pareto dominate free trade areas from the point of view of members. Indeed, even the model used in this paper finds that customs unions dominate most of the time. The reason for this is that in perfectly competitive general equilibrium frameworks such as those popularized by Riezman (1985), the monopoly power or 'tariff externality' benefits accruing to customs union members through their choice of common external tariffs tend to swamp all other welfare considerations. Other authors, such as Krueger (1996), relate the inferiority of free trade agreements (compared to customs unions) to the significant costs associated with implementing rules of origin.

It is clear from Figures 1 and 2 that when preferences (or export endowments) differ, even slightly, across nations, unique core solutions are the exception rather than the rule. Hence, the core solution concept does not provide unambiguous predictions very often. Nevertheless, the type (or family) of coalition observed is usually identified, even if its exact characteristics (choice of weight parameter θ) are not. The differently coloured regions of Figures 1 and 2 indicate clear broad patterns of coalition structures that are generated endogenously as members of the core. The general overall principle that arises from these results is that global free trade occurs only when all countries are similar and, when they are not, customs unions between the most similar countries are most likely to be formed. Free trade areas and stand-alone, unilateral tariff setting structures are, in our example, seldom observed in the core and then only along with other structures.

4 Coalition Blocking Behaviour

Figures 1 and 2 are useful for identifying which coalition structures have been blocked and, therefore, which are most likely to be observed. However, they yield little information regarding the blocking behaviour of particular coalitions. This is because the core is merely a summary of all blocking behaviour. Nevertheless, information on coalition blocking behaviour is important in its own right. Not only does this information help to motivate predictions on core composition, but it also shows how the relative merits of particular coalitions (from the point of view of prospective members) vary with country characteristics. Hence, explicit information on blocking behaviour can be used to determine under what conditions global free trade is likely to Pareto dominate a preferential trade agreement such as a customs union or free trade area. Alternatively, what country characteristics are most likely to result in trading partners preferring a customs union over a free trade area or vice versa?

The literature has so far failed to exploit information on the blocking behaviour of coalitions. In particular, there has been no attempt to describe how blocking behaviour varies with the characteristics of trading nations. Studies such as Riezman (1999), among others, only detail the blocking behaviour of coalitions for one or two example endowment distributions. Furthermore, this is treated simply as a necessary, intermediate step towards determining the composition core. In fact, as argued below, the blocking behaviour of coalitions provides useful insights into the mechanics of coalition formation.

4.1 When is Global Free Trade Blocked?

For different national preferences and endowment distributions, Figures 3 and 4 analyse the blocking behaviour of all coalitions with respect to global free trade. That is, they reveal whether or not global free trade is blocked and, if it is, what type of coalition blocks it.

In keeping with Proposition 1, the following proposition is also valid:

Proposition 6 ***(Blocking Behaviour)*** *When all countries have 'similar' preferences (or are endowed with similar quantities of their export commodity):*

(i) Global free trade is not blocked by any regional trade agreement.

(ii) Global free trade blocks all coalition structures except some which involve a free trade area.

This proposition is easily verified by inspecting cells in the vicinity of $(\sigma_1, \sigma_2) = (0.9, 0.9)$ in Figure 3 and cells around $\left(\omega_1^1, \omega_2^2\right) = (0.97, 0.97)$ in Figure 4. Comparing Figures 3 and 4 with their core composition counterparts, it is clear that when global free trade survives in the core, it usually blocks all other customs unions at the very least.

On the other hand, in those regions where a customs union survives in the core, this union tends to block global free trade. Moreover, global free trade is often also blocked by a free trade area involving the same two countries. Hence, consistent with Proposition 2, the following proposition holds:

Proposition 7 ***(Blocking Behaviour)*** *Global free trade is blocked by a customs union between countries with 'similar' preferences (export endowments) when the excluded country's preferences (export endowments) are 'sufficiently different'. As this difference in elasticities becomes even more pronounced, a free trade area between the 'similar' countries may also block global free trade.*

Proposition 7 can be demonstrated in Figure 3 by starting at the highlighted cell at $(\sigma_1, \sigma_2) = (0.9, 0.9)$ and moving south-east along the main diagonal of the matrix. Eventually, (at $\sigma_1 = \sigma_2 = 1.2$, in fact) global free trade is blocked by some $CU(1, 2; \theta)$. At and beyond $\sigma_1 = \sigma_2 = 1.6$, however, global free trade is blocked both by some $CU(1, 2; \theta)$ and the $FTA(1, 2)$ agreements. A similar pattern can be observed in Figure 4 when export endowments are varied. However, note that because of trade pattern restrictions we are unable to confirm whether or not free trade areas block global free trade when endowment differences become substantial.

As a final observation, note that singleton coalitions can often play a pivotal blocking role - usually blocking global free trade from inclusion in the core. For example, consider cell $(\sigma_1, \sigma_2) = (0.8, 1.5)$ in Figure 3 where country 2 gains from disrupting the grand coalition regardless what its rivals do in response. Thus, the assumption in Section 2 of a pessimistic algorithm for calculating the value of standing alone is far from innocuous. On the other hand, singleton coalitions are not as pivotal in the endowment simulations.

4.2 When Will Customs Unions be Preferred to Free Trade Areas?

Consider Figure 5 which focuses on the blocking behaviour of customs unions and free trade areas with respect to each other. Around the bolded border cell at $(\sigma_1, \sigma_2) = (0.9, 0.9)$, customs unions Pareto dominate free trade areas involving the same countries. In the spirit of proposition 1 and blocking proposition 6, this suggests the following proposition:

Proposition 8 ***(Blocking Behaviour)*** *A customs union between two countries blocks a free trade area between the same two countries when <u>all</u> trading nations have 'similar' preferences.*

As one moves far enough away from the $(0.9, 0.9)$ cell, free trade areas begin to Pareto dominate their customs union counterparts. Thus, at $(\sigma_1, \sigma_2) = (0.8, 1.4)$ for example, **all** coalition structures characterized by $CU(1, 2; \theta)$ are blocked by the coalition $FTA(1, 2)$. Similarly, at $(\sigma_1, \sigma_2) = (1.7, 1.7)$, all coalition structures characterized by $CU(1, 3; \theta)$ are blocked by $FTA(1, 3)$. On the other hand, in the same cell, at least one $CU(1, 2; \theta)$ blocks the coalition structure characterized by $FTA(1, 2)$. Finally, note that in simulating differences in export endowments among countries, we found that customs unions block their free trade area counterparts everywhere.

The Pareto superiority of free trade areas with respect to customs unions is a novel result in the regionalism literature, particularly in the context of perfect competition. It suggests that even in a simple framework like that employed here, the benefits to members from joining a free trade area may outweigh the membership benefits that accrue to participants in a customs union. This is in spite of the fact that the latter type of trade agreement entails an exploitable positive tariff externality and the former does not.

5 Conclusion

In this paper, coalition formation has been modelled endogenously. The core solution concept, from cooperative game theory, has been employed to predict which coalition structures are most likely to eventuate given country characteristics. While the core has been used previously in the literature, it has only been applied to isolated special cases. Hence, the main contribution of this paper has been to show how the composition of the core changes with the nature of the trading world.

The simulations undertaken, have yielded a number of interesting results regarding the formation of trade blocs. Global free trade is most likely to arise when all countries are similar in terms of their endowments and preferences. Furthermore, all countries may choose to stand alone only if national preferences differ substantially. Customs unions tend to form between relatively well-endowed countries or between nations with similar preferences. When a customs union forms, the relatively well-endowed or relatively inelastic member, assumes responsibility for external tariff choice. Finally, FTAs may only be observed if countries possess different preferences. Similarly, customs unions usually dominate free trade areas in a welfare sense, except where preferences differ markedly.

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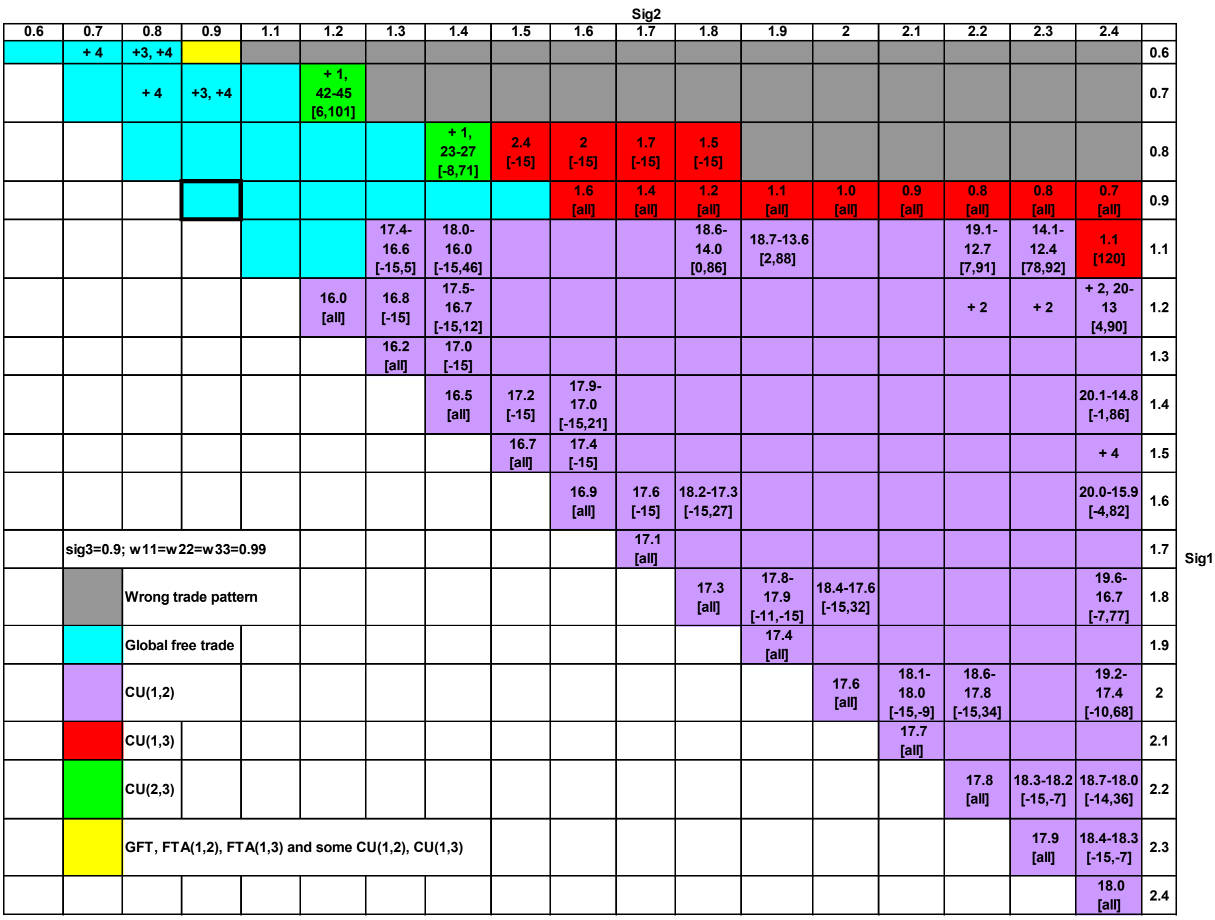

Figure 1: Composition of the core when σ_1 and σ_2 vary, given $\sigma_3 = 0.9$.

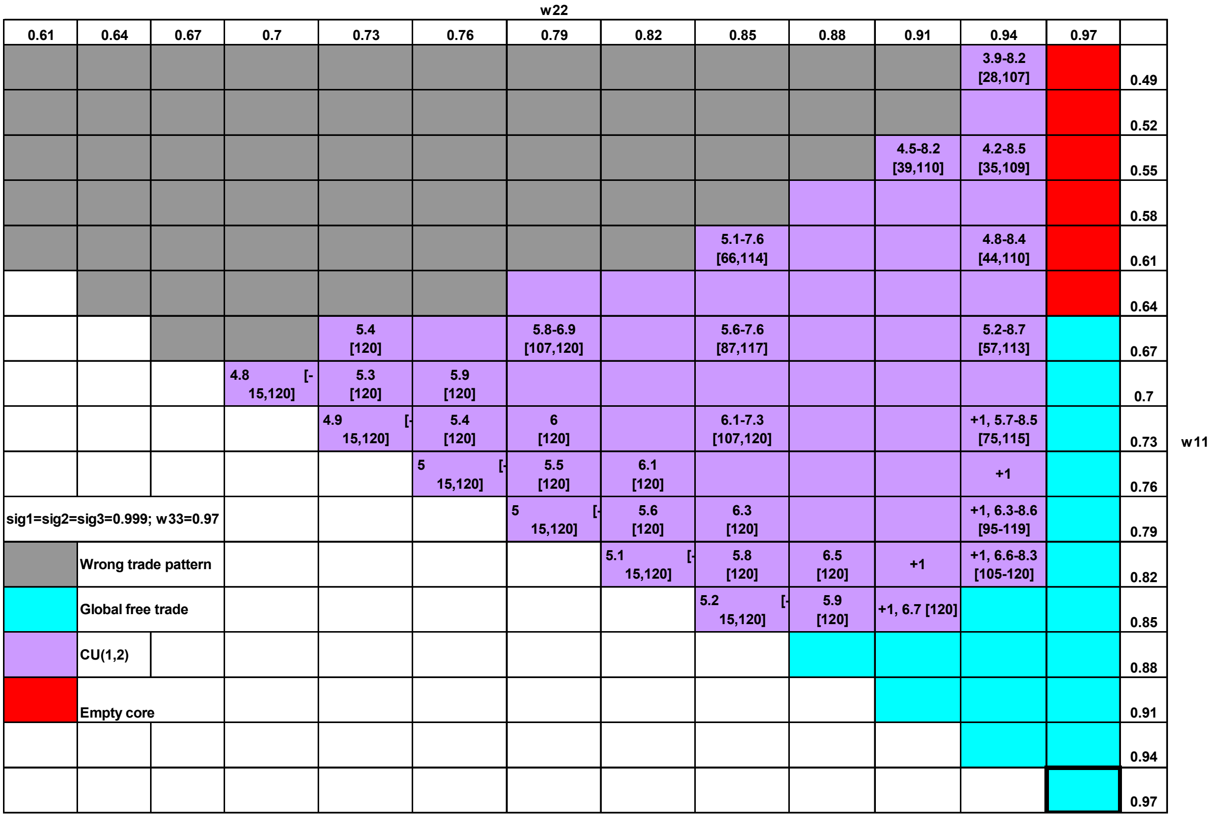

Figure 2: Composition of the core as ω_1^1 and ω_2^2 vary, given $\omega_3^3 = 0.97$ and $\sigma_1 = \sigma_2 = \sigma_3 = 0.999$.

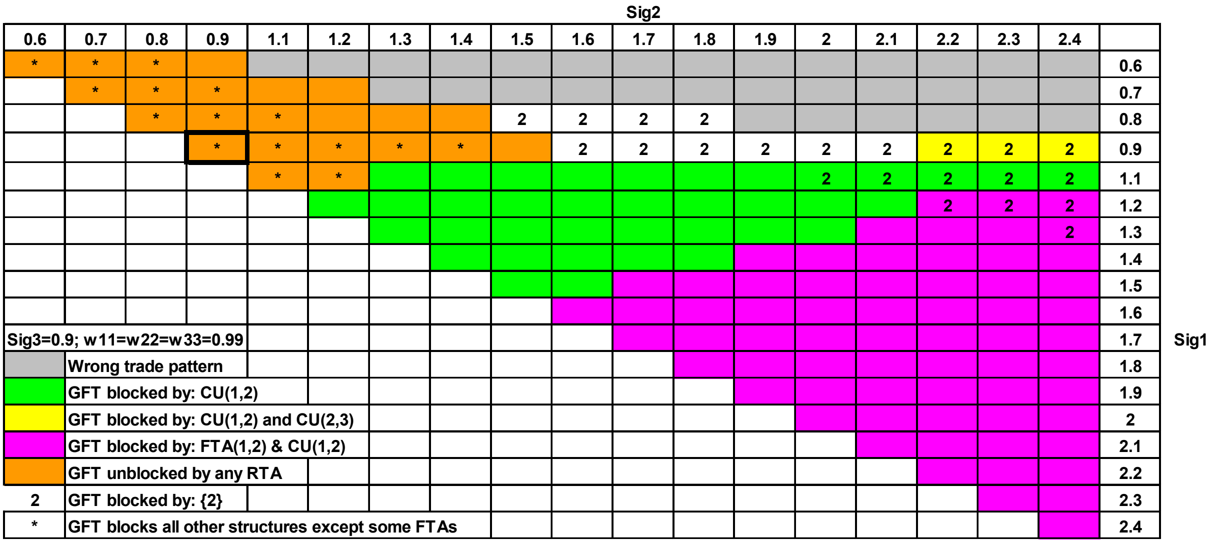

Figure 3: Blocking behaviour of regional trade agreements with respect to global free trade as σ_1 and σ_2 vary, given $\sigma_3 = 0.9$ and $\omega_1^1 = \omega_2^2 = 0.97$.

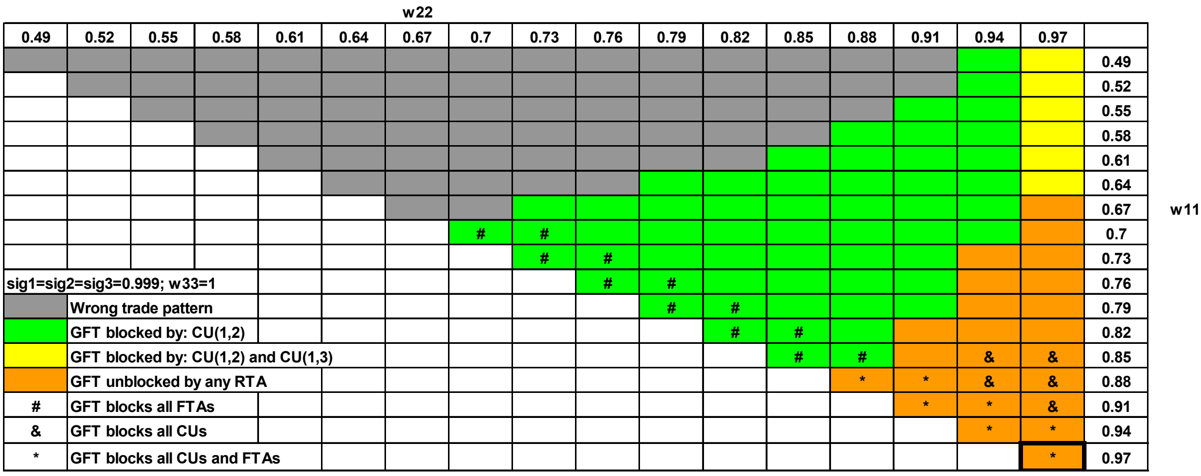

Figure 4: Blocking behaviour of regional trade agreements as ω_1^1 and ω_2^2 vary, given $\omega_3^3 = 1$, $\sigma_1 = \sigma_2 = \sigma_3 = 0.999$.

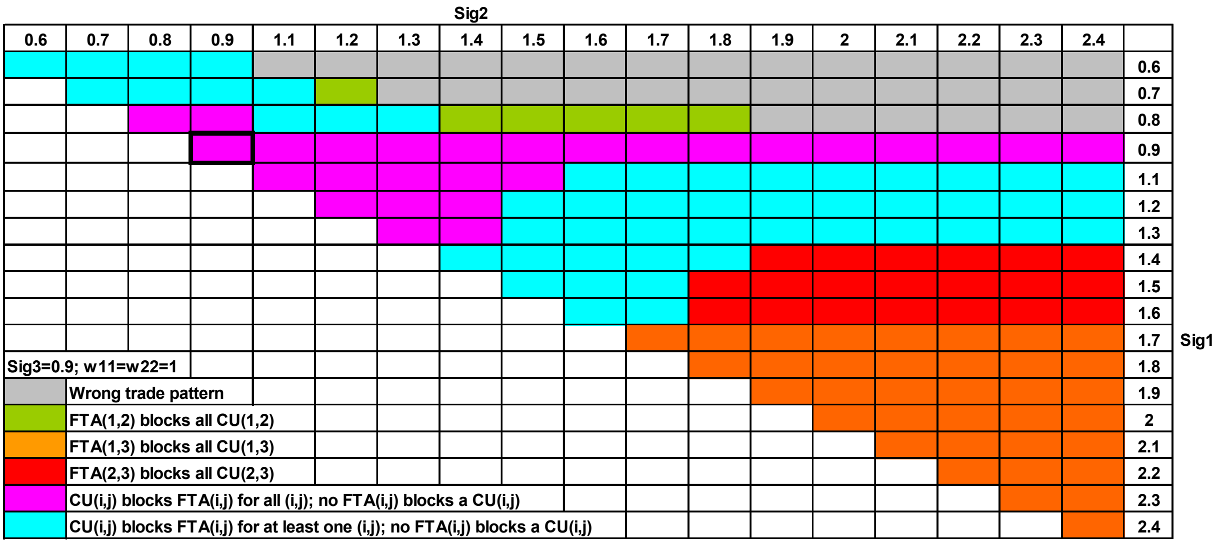

Figure 5: Blocking behaviour of customs unions and free trade areas with respect to each other as σ_1 and σ_2 vary, given $\sigma_3 = 0.9$ and $\omega_1^1 = \omega_2^2 = 0.97$.