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. There exist relatively few general results on the relationship between country characteristics and trade bloc formation. Here, new light is shed on this issue by systematically simulating bloc formation and by explicitly analysing the blocking behaviour of coalitions. A general equilibrium model of world trade is implemented with equilibrium coalition formation being modelled using the equilibrium concept of the core. It is found that global free trade is observed when all countries are similar. Customs unions tend to form between countries with 'adjacent' consumer preferences or with 'adjacent' endowments of their export commodity. 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 consumer preferences differ sufficiently.

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1 Introduction

Since the beginning of the 1980s, preferential trading arrangements have become increasingly popular. In some cases, customs unions (CUs) have been established, examples being the Andean Pact and MERCOSUR in South America. 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 are just four examples. Numerous other FTAs are in an embryonic stage of development. Preferential trading arrangements such as customs unions and free trade areas are distinguished by being (a) arrangements between the member countries to cooperate on trade policy to their mutual advantage and (b) discriminatory in their trade policies. Both customs unions and free trade areas (in their purest forms) eliminate trade barriers between partners but maintain tariffs on external trade.

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, 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. Until its recent expansion, the EU was 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.

Within this trade policy context, the purpose of the present paper is to examine the issue of trade bloc formation in a general equilibrium framework. Our primary concern is with the identification of the circumstances under which different coalition structures - combinations of coalitions such as free trade areas and customs unions and stand alone countries - are observed. Specifically, what type of trading arrangements are likely to be observed in equilibrium? And, how are these equilibrium choices related to the primitive characteristics, such as consumer preferences and commodity endowments, of the trading nations?

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 as a model of trade bloc formation since allocations in the core are likely to be observed - no country has an incentive to defect from coalitions in a core structure. This approach has been also been adopted by Kennan and Riezman (1990) and Riezman (1999) among others, but such analyses are typically confined to special cases, usually particular endowment distributions. In our view, this approach has yet to be fully exploited.

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. Haveman (1996) addresses the question of whether successive customs union formations lead to global free trade, while Syropoulos (1999) analyses the effects of different types of customs unions on inter-bloc tariffs and welfare. In these papers, the focus

is upon customs unions; free trade areas are not considered. Moreover, in the models of both Kennan and Riezman (1990) and Syropoulos (1999) all countries in the customs union are assumed to be symmetrically identical, in which case there is no disagreement among union members over common external tariff choice. Our model explicitly deals with asymmetric countries and with common external tariff choice by customs unions.

Abrego, Riezman and Whalley (2006) also concentrate on customs unions when discussing the possible establishment of regional agreements. While they systematically 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 how often certain broad types of regional agreements are likely to be observed. In contrast, our paper is concerned, not just with the type of regional agreement observed (if any), but also with its membership.

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, their focus is on comparing the welfare effects of large and small countries under different coalition structures and country characteristics (endowments) and not with how country characteristics influence 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 (determined unilaterally by the large country), which may or may not yield an outcome that is Pareto optimal for the members. Third, they do not consider variations in preferences over countries.

In the present paper, we develop a model of world trade, policy settings and coalition formation to address the question of how the international distribution of preferences and endowments impact upon the equilibrium structures of trading arrangements. Within our three-nation, three product model, these equilibrium trading structures include a stand alone unilateral tariff setting Nash equilibrium, customs unions, free trade areas and global free trade (the grand coalition).

There are several distinguishing features of the model and analysis. First, coalition formation is modelled using cooperative game theory. While a number of solution concepts are available,

the core is judged to be the most suitable and we therefore follow the path set by Riezman (1985). Second, in contrast to most of the literature, customs unions are assumed to set their common external tariffs endogenously rather than exogenously. Accordingly, asymmetric countries forming a customs union can choose how to share authority over the choice of common external tariff amongst themselves. Following Melatos and Woodland (2006a), we assume that customs unions choose common external tariffs to yield a Pareto optimal outcome from the viewpoint of club members. Third, we undertake a numerical simulation of the model under a systematic and broad range of assumptions regarding the international distribution of preferences and endowments to determine the impact of these distributions upon equilibrium coalition structures. Fourth, we undertake a separate investigation of the blocking behaviour of coalitions. 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 particular, this sheds new light on a number of unresolved issues in the regionalism literature, including whether preferential trade agreements help or hinder the move to global free trade and the apparent inconsistency between the observed popularity of free trade areas and the theoretical primacy of customs unions.

Our simulations strongly suggest that when all countries are sufficiently similar global free trade is observed. Customs unions tend to form between countries with adjacent consumer preferences or adjacent export endowments. Put another way, in our three country framework, customs unions do not form between countries that have elasticities of substitution (for example) at either end of the observed range of elasticities. 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, consistent with observed coalition formation behaviour, free trade areas have been demonstrated to welfare dominate customs unions within a perfectly competitive framework.

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 (with no on-selling) and an importer of the other two goods.[1] Without loss of generality, it is assumed that country i exports good i.

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 three-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 in the third stage the trading equilibrium is determined. The game is solved backwards to obtain a subgame perfect Nash equilibrium. Consistent with this, the following sub-sections specify and discuss the three stages of the game in reverse order.

2.2 Trading Equilibrium

It is assumed that countries comprise one representative agent with preferences $U^i(c^i)$ over the consumption vector $c^i = (c^i_1, c^i_2, c^i_3)$ for country i. Each consumer chooses 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 $m_i = \sum_{j=1}^{3} p^w_j \left(1 + t^i_j\right) \omega^i_j + TR^i$ where $TR^i = \sum_{j=1}^{3} t^i_j p^w_j \left(c^i_j - \omega^i_j\right)$ is tariff revenue, p^w_j is the world price of good j, t^i_j is the tariff levied by country i on imports of good j and ω^i_j is country i's endowment of good j.[2]

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^w_j), and t^i is a 3×1 vector of tariffs. These

[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.

[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.

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 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 of i's endowments and x^i is country i's 3×1 vector of net exports.

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 $v^i = V^i\left(p^w\left(t^1, t^2, t^3\right), t^i\right),\ i = 1, 2, 3$.

2.3 Tariff Formation

2.3.1 Global Free Trade

Under global free trade (the 'grand coalition'), each country levies zero trade taxes on all goods so that all world trade is duty free ($t_j^i = 0,\ \forall i, j$). In this case, equation system (2) is sufficient to solve for the equilibrium world prices purely as functions of the parameters of the model.

2.3.2 Unilateral Tariff Setting

The Unilateral Tariff Setting (UTS) equilibrium occurs when *all* countries decide to stand alone and undertake independent trade policy settings. In this context, each country chooses trade taxes to maximize its utility, given the trade taxes of all other countries. Hence, the tariff equilibrium is obtained by solving the system of implicit tariff reaction functions given by

$$t^i = \arg\max_{t^i}\left\{V^i\left(p^w\left(t^1, t^2, t^3\right), t^i\right) :\ t^i \in T^i\right\}, \quad i = 1, 2, 3, \tag{3}$$

where $T^i = \left\{t^i : t^i_i = 0,\ t^i_j + 1 > 0,\ j = 1, 2, 3\right\}$ is the set of feasible trade tax rates for country i. Given zero trade taxes on exports (and hence ignoring these)[3], the above system comprises six implicit tariff reaction functions - two for each country - for the six tariff rates $(t^1_2, t^1_3, t^2_1, t^2_3, t^3_1, t^3_2)$. System (3) yields solutions 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.

2.3.3 Free Trade Areas

The FTA equilibrium arises whenever any two countries, say k and l, establish a free trade area, $FTA(k, l)$. Given the assumed pattern of trade, whereby country i exports good i and imports the other goods, trade between the $FTA(k, l)$ members is only in goods k and l. Accordingly, this FTA represents an agreement by members to (i) levy zero trade tax rates on trade in these two goods, that is, they set $t^k_l = t^l_k = 0$, and (ii) independently set tariffs on trade with non-member countries.

We assume that rules of origin are completely effectively enforced and, moreover, that there is no trade deflection through domestic production. The enforcement of rules of origin implies that if the high tariff member of a free trade area wishes to consume goods originating from a non-member country, it must obtain these goods directly from that non-member country. That is, these goods cannot first be imported into the low tariff FTA member country and then on-sold to the high tariff member duty free. In addition, by assuming no trade deflection through domestic production, we prevent the low tariff member importing its requirements and selling its domestic endowment to the high tariff member duty free.[4]

[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.

[4] Richardson (1995) showed that legal internal free trade in domestically produced goods may result in a deflection of trade, whereby the high tariff member country gets its imports of a commodity from the low tariff FTA member's domestic production rather than directly as imports from the non-member, even when rules of origin are enforced. He shows that this type of trade deflection (substitution of domestic production for imports) ensures that prices received by producers are equated within a free trade area and results in tariff revenue competition in the setting of external tariffs.

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

$$\begin{aligned} t^i &= \arg\max_{t^i} \left\{ V^i \left(p^w \left(t^1, t^2, t^3 \right), t^i \right) : \ t^i \in T^i, \ t^i_j = 0, \ j \neq i, n \right\}, \quad i = k, l, \\ t^n &= \arg\max_{t^n} \left\{ V^i \left(p^w \left(t^1, t^2, t^3 \right), t^n \right) : \ t^n \in T^n \right\}, \quad n \neq k, l. \end{aligned} \tag{4}$$

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 optimality conditions for the two optimal tariffs (one directed at each FTA member) imposed by the non-member. For example, under the free trade area $FTA(1,2)$, the first set of conditions determine tariff rates t^1_3 and t^2_3 while the second set of conditions determine country 3's tariff rates t^3_1 and t^3_2. 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.

2.3.4 Customs Unions

The CU equilibrium arises whenever any two countries, say k and l, establish a customs union, $CU(k,l)$. Consistent with the trade pattern described above, member k (l) exports good k (l) to its partner and the rest of the world and both members import the other product from outside the union. Accordingly, in forming a customs union $CU(k,l)$ both nations agree to set $t^k_l = t^l_k = 0$ (free internal trade) and to set a common external tariff rate on imports of the remaining good j from the non-member, i.e., $t^k_j = t^l_j = t^C_j$ 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 and extend the model specified and analyzed by Melatos and Woodland (2006a), who argue that members of a customs union will choose the common external tariff rates, as part of the union contract, to ensure that the utility outcome is Pareto optimal from the point of view of the members.[5] According to this specification, the customs union chooses its common external

[5] Melatos and Woodland (2006) have also shown that, by choosing the union's common external tariff rate exogenously, one may neglect consideration of Pareto optimal customs unions or, alternatively, consider a Pareto

tariff to maximize a social welfare function for the union, which is expressed as a linear function of members' utility functions and given by

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

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

The common external tariff (CET) of the customs union is chosen to maximize the union's social welfare function defined above. Accordingly, the CET t_n^C is chosen to maximize $W^{kl}\left(p^w\left(t^1,t^2,t^3\right),t^k,t^l\right)$, where $t_n^k=t_n^l=t_n^C$ 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 equation system:

$$\begin{aligned} t^C &= \arg\max_{t^C}\left\{W^{kl}\left(p^w\left(t^1,t^2,t^3\right),t^k,t^l\right):\ t^k\in T^k,\ t^l\in T^l,\ t^C=t^k=t^l,\ t_l^k=0,\ t_k^l=0\right\},\\ t^n &= \arg\max_{t^n}\left\{V^i\left(p^w\left(t^1,t^2,t^3\right),t^n\right):\ t^n\in T^n\right\},\quad n\neq k,l. \end{aligned} \tag{6}$$

The first equation (implicit reaction function) specifies the optimal CET condition for the union, the common external tariff (CET) vector t^C comprising only one non-zero element corresponding to the common external tariff on imports from the non-member country n. The second equation determines the non-member's two optimal tariffs on imports from the two union members. Given the model parameters and the 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. 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, which lies on the unit sphere.[6] Customs unions will then be distinguished

dominated union that is, therefore, unlikely to be observed.

[6] While the use of θ provides no substantive gain over the weight vector d, it provides an easily interpreted scalar measure of delegation. 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. The weights are restricted by the requirement that $\theta\in(0,180)\cup(270,360)$, meaning that at least one of the weights is positive.

by the member countries and by the weights (measured by the angle) in the social welfare function as in $CU(k, l; \theta)$. The definition of the core as the set of equilibrium coalition structures (provided below) ensures that only those customs unions with weights yielding a Pareto optimal outcome for the union members can be elements of the core and, hence, observed.

2.4 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.

2.4.1 The Core

A coalition structure resides in the *core* if it is not blocked by any coalition.[7] 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 members of the trade agreement. Thus, elements of the core represent stable outcomes in the sense that players cannot regroup in any way to improve their payoffs.

While the core assigns a set of outcomes (coalition structures) 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 on likely equilibrium coalition structures. In this case, appeal to a finer cooperative solution concept

When θ lies outside the (0,90) range and so one of the weights is negative, the objective function for the customs union may no longer be concave and this may exacerbate the problem of obtaining optimal tariffs. However, as indicated further below, we check our computed equilibria to ensure that they correspond to utility maximization. All our results satisfy this check and so this issue does not arise in our simulations reported below.

[7] A *coalition* is a description of a set of countries that agree to behave cooperatively, such as a customs union or free trade area. 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. Hence, for example, 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.

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	$CU(1,2)$	0.0815	0.0904	0.0875
7	$CU(1,3)$	0.0912	0.0815	0.1026
8	$CU(2,3)$	0.0432	0.1308	0.1326

Table 1: Equilibrium utilities for the example parameter distribution

is needed to obtain predictions of likely outcomes.

2.4.2 Implementing the Core

The general approach for identifying the contents of the core consists of two steps: (1) solve for the equilibrium utilities associated with each coalition structure and (2) apply the core definition. Sub-section 2.2 above dealt with the first step of this process, explaining how the various coalition structure equilibria are calculated. A numerical example will help explain the second step and enhance understanding of the results of the next section.

In this illustrative example, all countries are assumed to have constant elasticity of substitution (CES) preferences that approximate the Cobb-Douglas form, each country having a substitution elasticity $\sigma^i = 0.99$. The assumed endowment distribution is $\omega_1^1 = 0.1, \omega_2^2 = 0.5, \omega_3^3 = 1.0$ and $\omega_j^i = 0.005$ for all $j \neq i$.

Table 1 presents the equilibrium utilities for each of 8 possible coalition structures.[8] These include the global free trade (GFT) and unilateral tariff setting (UTS) structures, three possible free trade agreement structures and three possible customs union structures. It is assumed that the first member of each customs union is delegated responsibility for setting the common external tariff.[9] Countries may only belong to one coalition at any one time, so overlapping trade agreements

[8] Since there are just three countries, a coalition structure may be uniquely described by its dominant coalition. For example, the coalition $FTA(1,2)$ implies one and only one coalition structure, namely $\{FTA(1,2), \{3\}\}$.

[9] Delegation of the responsibility for choosing the CET to just one member is assumed to keep the illustrative example simple. In the simulations further below each of the three customs unions constitutes a family of many possible contracts.

are not considered.

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:

- None of the free trade, customs union or singleton coalitions block global free trade and, hence, global free trade is in the core. Indeed, it is clear from the table that both members of any customs union or free trade area are worse off than under global free trade. Similarly, we see that no singleton coalition blocks global free trade. For example, if country 1 chooses to opt out of global free trade and stand alone it will be worse off irrespective of what the other two countries choose to do.[10]

- Every other coalition structure is blocked by some coalition.

  - 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 $U(UTS) = (0.0530, 0.0808, 0.0938)$ so that the UTS coalition structure is blocked by GFT. However, comparing the utility vector $U(GFT)$ with the vector $U(FTA(1,2)) = (0.075, 0.0822, 0.137)$, it is clear that $U^3(GFT) < U^3(FTA(1,2))$ and, hence, $FTA(1,2)$ is not blocked by global free trade. Similarly, $FTA(1,3)$ is not blocked by global free trade.

  - The coalition structure that features $FTA(1,2)$ is blocked by $CU(1,2)$, since countries 1 and 2 are both better off under the customs union than the free trade area.

  - Similarly, the coalition structure featuring $FTA(1,3)$ is blocked by $CU(1,3)$. Both countries 1 and 3 are better off under the customs union than the free trade area.

Thus, in this numerical example the outcome of the tariff game in which coalition formation is endogenous is one of global free trade. Alternative choices of the numerical values for parameters

[10] If country 1 stands alone, the other countries may also stand alone, form a free trade area or from a customs union. Their rational choice is to form a customs union $CU(2,3)$, in which case country 1 only gets $U^1(\{1\}) = 0.043$ compared to $U^1(GFT) = 0.1184$ under global free trade.

and endowments lead to the possibilities of different coalition structures and of multiple coalition structures residing in the core or of an empty core, as is demonstrated below.

3 Effects of Preferences and Endowments on Equilibrium Coalition Structures

In the remainder of the paper, we examine how international differences in endowments and preferences influence coalition formation. The objective is to derive propositions on the relationship of the international distribution of endowments and preference parameters with the coalition structures that are in the core of the trade policy game. For example, our interest lies in answering questions such as "under what distribution of endowments and preferences are we likely to observe customs unions?".

To achieve this objective, the theoretical framework introduced above is used to simulate endogenous trade bloc formation in a world of asymmetric countries. The theoretical model is made operational by specifying functional forms for preferences and by choosing parameter values for their parameters and endowments. We then undertake a comprehensive simulation by computing the core for every point on a grid of endowments and on a grid of substitution elasticities to shed light on how the distributions of endowments and of preferences influence coalition formation.

3.1 Simulation Design

Consumer preferences are represented by constant elasticity of substitution (CES) utility functions of the form

$$U^i = \left[\sum_{j=1}^{3} \gamma_j^i \left(c_j^i \right)^{\frac{\sigma_i - 1}{\sigma_i}} \right]^{\frac{\sigma_i}{\sigma_i - 1}}, \quad i = 1, 2, 3, \tag{7}$$

where $\gamma_j^i = \frac{1}{3}$ for all i, j are the consumption distribution parameters and $\sigma_i \neq 1$ is the elasticity of substitution. The distribution of endowments is given in Table 2. According to this specification,

the world supply for each good is unity and, given a country's endowment of its export commodity, the remaining quantity of the good is divided evenly between the importing countries. By varying the endowments of each country's export good ω_i^i $(i = 1, 2, 3)$, the world endowment matrix in Table 2 is altered accordingly.

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

Table 2: Endowment Distribution

A number of simulations are undertaken. First, to isolate the role of country preferences in trade bloc formation, national elasticities of substitution are varied over a grid holding fixed the endowment distribution. Two sets of simulations of this kind are reported on here. In the first case, σ_1 and σ_2, the elasticities of substitution of countries 1 and 2 respectively, are varied in the range $[0.9, 4]$, while country 3's elasticity of substitution is fixed at $\sigma_3 = 1.5$. In the second case, σ_1 and σ_2 are varied 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 in both simulations, 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 2 implying that countries are allocated 0.99 units of their exportable good and 0.005 units of each importable good. The fact that countries are endowed with relatively small amounts of their importable goods ensures that, more often than not, they will import these goods in equilibrium - consistent with the trade pattern assumption implicit in the simulation model.

Second, to determine the influence of the endowment distribution upon the formation of trade agreements, endowments are varied over a grid holding country elasticities of substitution fixed. In the simulations reported on here, country 1 and 2's endowments of their export goods are varied in the range $\left(\omega_1^1, \omega_2^2\right) \in (0.49, 0.99)$, while country 3's endowment of its export good is set at $\omega_3^3 = 0.97$. To neutralize to role played by preferences in this set of simulations, all three countries are assumed to have the same preferences with elasticities of substitution given by $\sigma_1 = \sigma_2 = \sigma_3 = 0.999$.

The choice of the parameter ranges for the elasticities of substitution and endowments was driven by several considerations. First, the choices of the elasticities of substitution were made to correspond roughly to those empirical estimates that have been accepted in the literature. Our elasticity of substitution range (0.6-4.0) is consistent with estimates of long run Armington elasticities for 309 manufacturing industries reported by Gallaway et al. (2003), which are in the range 0.5-4.8 (average 1.55). They are also consistent with other empirical studies. Blonigen and Wilson (1999) report an average elasticity across 146 sectors of 0.81, Reinert and Roland-Host (1992) report a range between 0.04 and 3, Sheills et al. (1986) report a range of 0.5-6.5, with an average of 2.5 and Stern et al. (1976) suggest elasticities in the range 1-2.[11] Within the structure implied by Table 2, a full range of endowment values between zero and unity is considered. By normalizing the world endowment of each good to be unity, we can think of the chosen values as percentages of world endowments. Finally, our choice of parameters was also conditioned by the need to have equilibria solutions for the pattern of trade to be consistent with the theoretical model.

We consider 413 possible coalition structures, which are listed in Table 3. These include global free trade, unilateral tariff setting with each country standing alone, three free trade areas and three families of customs unions. For each customs union there is a family of customs union coalitions corresponding to each choice of CET. These are denoted, for example, by $CU(1, 2; \theta)$ for a customs union between countries 1 and 2 with the direction of weights of members in the union's social welfare function being measured by the angle θ. Integer values of θ in the range -15 to 120 were considered to simplify the simulation exercise.[12]

For each set of elasticity of substitution parameters and endowment distribution, the trading equilibria were calculated for all 413 possible coalition structures specified in Table 3 and the core of the tariff game was computed.[13] The core results for the simulations are summarized in Figures

[11] These papers all estimate Armington elasticities (how consumers switch between imported and locally produced goods), which are relevant here since our model assumes an Armington trade pattern – each good is uniquely exported by one country.

[12] Also, for values outside this range the computation of equilibria sometimes proved sensitive to starting values and therefore was difficult.

[13] The equilibrium conditions are solved as a set of simultaneous equations and the solutions are checked to ensure

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	$CU(1,2;\theta)$	$\{CU(1,2;\theta),\{3\}\}$
142-277	$CU(1,3;\theta)$	$\{CU(1,3;\theta),\{2\}\}$
278-413	$CU(2,3;\theta)$	$\{CU(2,3;\theta),\{1\}\}$

Table 3: Possible Coalition Structures

1, 2 and 3. Each cell in the figures is shaded according to whether a customs union or global free trade belongs in the core for that cell.[14] Where both a customs union and global free trade reside in the core, that cell's shading is determined by the membership of the customs union observed while global free trade is identified by its coalition structure identifier (+1).[15] Also shown are the regions in which the equilibrium trade pattern is inconsistent with that assumed in the underlying theoretical model.

(Insert Figures 1, 2 and 3 about here)

3.2 Preferences, Endowments and the Core

Figure 1 provides a summary of how the composition of the core varies with country preferences. 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, country 3's elasticity of substitution being fixed at $\sigma_3 = 1.5$ throughout. The dashed border cell at $(\sigma_1, \sigma_2) = (1.5, 1.5)$ represents the situation in which all three countries are identically symmetric - that is, where all three countries have identical preferences and are symmetrically identical in their endowments. This is the 'benchmark' case for our preference analysis. The further away is a cell from this benchmark case the greater the international differences in preferences, as measured by the elasticities of substitution.

that tariff choices by the customs union and the excluded country are global constrained utility maxima. In every equilibria, this was indeed the case.

[14] Only the upper half of the figure is shown, since the lower half will be symmetric due to the symmetry of the model specification.

[15] For those cells in which the core comprises coalition structures in addition to those characterized by a customs union or global free trade, the additional structures are also identified by their coalition structure identifier. Thus, +2 denotes UTS, +3 denotes $FTA(1,2)$, +4 denotes $FTA(1,3)$ and +5 denotes $FTA(2,3)$.

The results for the simulations in which the preferences are held fixed and the endowments of the three countries are altered are presented in Figure 2. In this figure, each cell represents the results for a particular combination of export endowments for countries 1 and 2, ω_1^1 and ω_2^2, country 3's endowment of its export good being fixed at $\omega_3^3 = 0.97$. The dashed border cell at $\left(\omega_1^1, \omega_2^2\right) = (0.97, 0.97)$ represents the situation in which all three countries are identically symmetric - the 'benchmark' case for our endowment analysis. Analogously with Figure 1, the further away is a cell from this benchmark case the greater the international differences in endowments.

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 (GFT) is an element of the core when <u>all</u> countries have 'similar' preferences and 'similar' endowments of their export good.*

In support of this proposition, we first observe that when all countries have 'sufficiently similar' preferences and export endowments, global free trade is the sole element of the core. This is indicated by the shaded region of cells in the vicinity of the benchmark cells at $(\sigma_1, \sigma_2) = (1.5, 1.5)$ in Figure 1 and $\left(\omega_1^1, \omega_2^2\right) = (0.97, 0.97)$ in Figure 2, where all three countries have identical preferences and are symmetrically identical in their endowments.

Second, we observe from Figure 1 that, as country preferences diverge from equality, global free trade is no longer the sole element of the core but shares the core with other coalition structures. The sharing regions are shown by shaded cells that have a '+1' label. For example, at $(\sigma_1, \sigma_2) = (1.1, 1.2)$ and $(\sigma_1, \sigma_2) = (1.3, 1.7)$ in Figure 1, free trade (coalition structure 1) cohabits the core with a range of possible $CU(2, 3; \theta)$ agreements. At $(\sigma_1, \sigma_2) = (1.6, 1.9)$, free trade coexists in the core with a range of possible $CU(1, 2; \theta)$ agreements.

Third, we observe that if preferences or endowments diverge sufficiently from equality, global free trade no longer features in the core. Areas where global free trade is not in the core are indicated by those cells beyond the GFT region without the '+1' label. In these regions, customs

unions and, possibly, other coalition structures are the elements of the core. For example, at $(\sigma_1, \sigma_2) = (0.9, 2.1)$ in Figure 1, the core comprises a range of possible $CU(2,3;\theta)$ agreements and $FTA(1,3)$ (coalition structure 4). At $(\sigma_1, \sigma_2) = (1.1, 3.2)$ the core consists of a range of $CU(2,3;\theta)$ agreements and the unilateral tariff setting outcome in which all countries stand alone (coalition structure 2). In neither case is free trade an element of the core. In Figure 2 a similar pattern is evident. For cells in the $CU(2,3)$ shaded region, for example at $\left(\omega_1^1, \omega_2^2\right) = (0.49, 0.94)$, a range of $CU(2,3;\theta)$ customs union agreements are the only surviving coalition structures. In short, therefore, as endowments and preferences move further away from the benchmark cases in Figures 1 and 2, global free trade is displaced from the core by a customs union and, possibly, other coalition structures.

The following proposition identifies when customs unions will form and who their members will be when countries differ in their preferences.

Proposition 2 *Customs unions are in the core (and often the only elements of the core) if country preferences or endowments are 'sufficiently different'. If a customs union is in the core, the membership comprises countries with 'adjacent' preferences or endowments. In other words, customs unions of two countries with 'non-adjacent' preferences or endowments are never in the core.*

To verify the validity of Proposition 2 in the case of differences in preferences, refer to Figure 1. Starting at the benchmark (dashed 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 $(\sigma_1, \sigma_2) = (1.5, 1.5)$ 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. Finally, as one moves vertically from the benchmark case in Figure 1, country 1's preferences become increasingly different from its rivals. Eventually, only $CU(2,3;\theta)$ agreements survive in the core. In each of these three cases, the core consists of customs unions in shaded regions surrounding the GFT

region of 'similar' preferences in which global free trade is the element of the core. Differences in preferences provide a basis for the existence of sustainable customs unions.

The second part of Proposition 2 provides a prediction as to which countries will form a customs union and which will be excluded. To verify this part of the proposition in the case of preferences, we consider each of the core customs union regions in Figure 1. First, it is observed that every cell in the $CU(1,2)$ shaded region, in which $CU(1,2;\theta)$ is in the core, has the property that $\sigma_3 < \sigma_1 \leq \sigma_2$. Accordingly, it is confirmed that the core customs union $CU(1,2;\theta)$ is between countries with adjacent elasticities of substitution. Second, in the $CU(2,3)$ shaded region the elasticities of substitution are related by $\sigma_1 < \sigma_3, \sigma_2$. In this case, the core comprises a structure with customs union $CU(2,3;\theta)$, whose members also have adjacent elasticities of substitution. Finally, the $CU(1,3)$ shaded area has the property that $\sigma_1, \sigma_3 < \sigma_2$ and the core comprises a structure with a customs union $CU(1,3;\theta)$ of members that have adjacent elasticities of substitution. In no cell is it the case that a customs union between countries with non-adjacent elasticities of substitution is in the core. Thus, in each case considered, the proposition has been confirmed.

Proposition 2 strongly suggests that core customs unions involve countries that have 'similar' preferences, as measured by elasticities of substitution in the present context. Intuitively, this similarity of preferences engenders market power to the union to be able to exploit the different shape of the excluded country's offer functions.

Beyond adjacency, however, Proposition 2 is somewhat limited in its ability to predict the nature (that is, elasticity values) of the preferences of the members of the customs union in the core. In particular, adjacency of preferences is not, of itself, sufficient to determine whether customs unions will form between countries with the highest or the lowest pair of elasticities of substitution. To see this, note that moving downwards along the diagonal from the benchmark cell in Figure 1, countries 1 and 2 have high substitution elasticities and country 3 has a relatively low elasticity. In this case, the union $CU(1,2;\theta)$ is between countries with high elasticities. Similarly, moving vertically from the benchmark cell, the customs union $CU(2,3;\theta)$ involves those nations with relatively elastic preferences. On the other hand, moving horizontally from $(\sigma_1, \sigma_2) = (1.5, 1.5)$, country

2's substitution elasticity is higher than the other countries. In this case the union $CU(1,3;\theta)$ is between countries with low elasticities.

The discussion above has assumed that all countries are endowed with identical amounts of their unique export good and has focused on international differences in preferences. Proposition 2 may also be verified in the case of differences in endowments by a similar examination of Figure 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 vertically upwards results in countries 2 and 3, while remaining symmetrically identical, becoming increasingly large in terms of their export endowments relative to country 1. Eventually, a coalition structure containing a customs union $CU(2,3;\theta)$ replaces global free trade in the core. Clearly, the members of this customs union (countries 2 and 3) have adjacent endowments, being symmetrically identical.[16] More generally, throughout the $CU(2,3)$ shaded region the endowments are such that $\omega_1^1 < \omega_2^2, \omega_3^3$ and the core comprises a structure with a customs union $CU(2,3;\theta)$. Thus, it is verified that the customs union in the core coalition comprises members with adjacent endowments.

In the simulations undertaken it turns out that global free trade and customs unions are not the only coalition structures that can be observed in the core - although they are easily the most common coalition structure predicted by our simulations. Proposition 3 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 3 *Free trade areas and the unilateral tariff setting equilibrium may exist in the core although never as the unique elements. Moreover, free trade areas may exist in the core without customs unions.*

To see Proposition 3 in Figure 1, note that the unilateral tariff setting outcome and $FTA(1,3)$ (coalition structures 2 and 4 respectively) arise above and to the right of the 'benchmark' case. In

[16] Moving diagonally upwards to the left from the benchmark cell in Figure 2 the core eventually becomes empty. This occurs because along this axis countries 1 and 2 are identically symmetric. As a result, the coalition $CU(1,3;\theta)$ blocks (i.e. Pareto dominates) coalition structures characterised by $CU(2,3;\theta)$. Similarly, the coalition $CU(2,3;\theta)$ blocks coalition structures involving $CU(1,3;\theta)$. Therefore, for those cases in which global free trade is dominated by one or more customs unions (i.e. where $\omega_1^1, \omega_2^2 < 0.85$), the core is empty.

each of these cases, labeled by '+2' and '+4' respectively, the free trade area and UTS outcome share the core with a customs union involving countries 2 and 3.

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 $(\sigma_1, \sigma_2) = (0.9, 2.1)$, the structure $\{FTA(1,3), \{2\}\}$ shares the core with $\{CU(2,3), \{1\}\}$. This is especially interesting because these coalitions involve different members. While country 3 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. This is somewhat of an unresolved puzzle.

A particularly interesting result arising from our simulations is that sometimes free trade areas exist in the core while customs unions do not. This can be seen in Figure 3, which is similar to Figure 1 except that now $\sigma_3 = 0.9$ (rather than 1.5) everywhere. When $(\sigma_1, \sigma_2) = (0.6, 0.8)$ in Figure 3, $FTA(1,2)$ and $FTA(1,3)$ are in the core but the corresponding customs unions $CU(1,2;\theta)$ and $CU(1,3;\theta)$ are not. 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. These results - that free trade areas can be Pareto superior to customs unions in a perfectly competitive framework - are somewhat surprising and, to the best of the authors' knowledge, appear to be novel. Finally, note that the patterns of core composition observed in Figure 3 are consistent with Propositions 1 and 2 above.

These are comforting results given that in reality free trade areas are more commonly observed than customs unions. Nevertheless, in much of the regional trade agreements literature customs unions are shown to 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 in most simulations. The reason for this is that 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 (Riezman, 1985). Other authors, such as Krueger (1997), relate the inferiority of free trade agreements (compared to customs unions) to the significant costs associated with implementing rules of origin - costs that are assumed to be zero in the present paper.

Before leaving this subsection, we make some general remarks about the results obtained thus far. First, the results obtained in Proposition 2 are consistent with the notion of intermediate characteristics discussed by Demange and Guesnerie (1997), Demange (1994) and Demange and Henriet (1991).[17] They demonstrate that it is generally easier to form a coalition between agents whose characteristics belong to some interval. In terms of preferences, agents willing to form a coalition would also like agents with preferences between theirs to join them. These additional members, while reinforcing the power of the coalition, do not introduce a new 'conflict of tastes'. Thus, in Figure 1, while a customs union may involve the relatively elastic or inelastic countries, the preferences of member countries are always adjacent. That is, given $\sigma_i > \sigma_j > \sigma_k$, either $CU(i, j; \theta)$ or $CU(j, k; \theta)$ is observed, but never $CU(i, k; \theta)$.[18] A similar relationship holds for our results with international differences in endowments. While these results are strongly suggestive, it remains to determine whether our results, quite clear in the case of a model with just three countries, apply in a model with many countries. For example, in the context of many countries, if a coalition (customs union) between members with different preferences (or endowments) is in the core, will it be the case that this customs union also includes countries with 'intermediate' preferences (or endowments)?

As a final observation, it is clear from Figures 1, 2 and 3 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 (membership and choice of weight parameter θ) are not. The differently shaded regions of Figures 1, 2 and 3 indicate clear broad patterns of coalition structures that are generated endogenously as members of the core.[19] The general overall principle that arises from

[17] We are indebted to Murali Agastya for pointing out this literature and suggesting that our simulations could be interpreted within the context of intermediate preferences. See, also, Agastya (1994).

[18] Note, however, that this does not necessarily hold for free trade areas. As pointed out above, $CU(2, 3; \theta)$ coexists in the core with $FTA(1, 3)$ at $(\sigma_1, \sigma_2) = (0.9, 2.1)$ in Figure 3, where $\sigma_2 > \sigma_3 > \sigma_1$ thus confirming the adjacency relationship. However, at $(\sigma_1, \sigma_2) = (0.7, 0.8)$ in Figure 1, where $\sigma_3 > \sigma_2 > \sigma_1$, the free trade agreement $FTA(1, 3)$ between non-adjacent members is in the core.

[19] In reporting our simulation results, we do not record the θ values for the customs unions observed in the core, purely in the interest of avoiding clutter in the figures. Figures containing these θ value ranges, and the implied

these results is that global free trade occurs only when all countries are similar and, when they are not, customs unions between countries with adjacent preferences or endowments are most likely to be formed. Free trade areas and stand-alone, unilateral tariff setting structures are, in our simulations, seldom observed in the core and then only along with other structures.

4 Coalition Blocking Behaviour

Because the core comprises coalition structures that are unblocked, Figures 1, 2 and 3 yield little direct information regarding the blocking behaviour of particular coalitions. 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 (PTA) such as a customs union or free trade area. Alternatively, it can help to answer the question of 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. However, as argued below, an examination of the blocking behaviour of coalitions provides useful insights into the mechanics of coalition formation.

common external tariff ranges, are available from the authors upon request (Melatos and Woodland, 2006b).

It is generally the case that a particular customs union $CU(i, j; \theta)$ with member countries i and j is in the core for a range of θ values. This range often include values of θ in a subset of $(0, 90)$, which corresponds to partial delegation of common external tariff setting authority in the terminology of Melatos and Woodland (2006). In addition, this core-consistent range often involves values of θ outside of $[0, 90]$, which corresponds to super delegation of tariff setting authority in their terminology. See Syropoulos (2002) for an excellent theoretical discussion of the relationship between the characteristics of customs union members and their delegation decision over the choice of the common external tariff.

The values of θ are not of direct interest except in so far as they determine a Pareto optimal common external tariff choice for the customs union members. When there is partial delegation the common external tariff is between the common external tariffs that each member would choose if given complete tariff setting authority. On the other hand, when there is super delegation the common external tariff is higher than the common external tariff that the member with $\theta > 90$ would choose if given complete tariff setting authority.

4.1 When is Global Free Trade Blocked?

Our first task is to identify coalitions that block global free trade and to relate these coalitions to the international distributions of consumer preferences and endowments. Figures 4 and 5 record, for the preferences and endowments simulations presented in Figures 1 and 2, whether or not global free trade is blocked and, if it is, what type of coalition blocks it.

(Insert Figures 4 and 5 about here)

In keeping with Proposition 1, global free trade is not blocked by any coalition when countries are similar (close to the benchmark cell). However, as national preferences or endowments diverge global free trade is blocked and the blocking coalition depends on the degree of divergence. Examination of Figures 4 and 5 in the vicinity of the benchmark cells suggests the following proposition.

Proposition 4 *When all countries have 'similar' preferences and are endowed with 'similar' quantities of their export commodity: (i) global free trade is not blocked by any preferential trade agreement, and (ii) global free trade blocks all coalition structures except some that involve a free trade area.*

This proposition is easily verified by inspecting cells in the vicinity of $(\sigma_1, \sigma_2) = (1.5, 1.5)$ in Figure 4 and cells around $\left(\omega_1^1, \omega_2^2\right) = (0.97, 0.97)$ in Figure 5. Comparing Figures 4 and 5 with their core composition counterparts, Figures 1 and 2, 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 customs 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, the following proposition holds.

Proposition 5 *Global free trade is blocked by one or more customs unions if preferences or export endowments are 'sufficiently different' internationally. As this difference in elasticities or endowments becomes more pronounced, free trade areas and singleton coalitions (countries standing alone) may also block global free trade.*

Proposition 5 can be demonstrated in Figure 4 by starting at the dashed border benchmark cell at $(\sigma_1, \sigma_2) = (1.5, 1.5)$ and moving south-east along the main diagonal of the matrix. Eventually, (at $\sigma_1 = \sigma_2 = 1.8$, in fact) global free trade is blocked by some $CU(1, 2; \theta)$. At and beyond $\sigma_1 = \sigma_2 = 2.5$ along the diagonal, however, global free trade is blocked both by some $CU(1, 2; \theta)$ and $FTA(1, 2)$ agreements. Moving in other directions from the benchmark cell, we also observe that global free trade eventually gets blocked by some customs union. In short, the shaded region in Figure 4 in which GFT is unblocked by any PTA is completely surrounded by regions in which some customs union, usually the customs union that is in the core, blocks global free trade.

A similar pattern can be observed in Figure 5 when export endowments are varied. Moving vertically from the reference cell at $(0.97, 0.97)$, global free trade is blocked first by a $CU(2, 3; \theta)$ (the lighter shaded region) and then both by $CU(2, 3; \theta)$ and $FTA(2, 3)$ agreements (the diagonally shaded region).

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 $(\sigma_1, \sigma_2) = (1.4, 3.6)$ in Figure 4 where country 2 gains from disrupting the grand coalition regardless what its rivals do in response. On the other hand, singleton coalitions are not as pivotal in the endowment simulations.

Our results on blocking behaviour may be interpreted in the light of the continuing debate on whether preferential trading agreements such as customs unions and free trade areas are a 'stepping stone' or a 'stumbling block' to global free trade. Within the present context we can shed some light on this issue by asking whether, given that a customs union or a free trade area has been established for whatever reason, the existence of such a preferential trading agreement will allow or prevent global free trade from occurring. Figure 4 shows that global free trade is blocked by preferential trading agreements for preference distributions in the areas further from the benchmark cell. Thus, as the distribution of preferences becomes more spread the greater is the chance that a preferential trading agreement will constitute a stumbling block to global free trade. A similar conclusion arises from an examination of Figure 5 - the greater the divergence of

endowments, the greater the possibility of free trade being blocked by some customs union or free trade area. Only when preferences or endowments are similar will a preferential trade agreement not be a stumbling block to free trade. Overall, our results therefore come down on the side of preferential trading agreements acting as stumbling blocks to global free trade.

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

Figure 6 focuses on the blocking behaviour of customs unions and free trade areas with respect to each other. It shows when customs unions block free trade areas and vice versa for the simulations undertaken in Figure 3.

(Insert Figure 6 about here)

In the shaded regions around the benchmark cell at $(\sigma_1, \sigma_2) = (0.9, 0.9)$, customs unions Pareto dominate free trade areas involving the same countries. However, as one moves far enough away from the $(0.9, 0.9)$ cell, free trade areas begin to Pareto dominate their customs union counterparts. These three regions have lighter shading. Thus, at $(\sigma_1, \sigma_2) = (0.8, 1.4)$ for example, all coalition structures characterized by the customs union $CU(1, 2; \theta)$ are blocked by the free trade area coalition $FTA(1, 2)$. Similarly, at $(\sigma_1, \sigma_2) = (1.7, 1.7)$, all coalition structures characterized by customs union $CU(1, 3; \theta)$ are blocked by the corresponding free trade area $FTA(1, 3)$. In fact, in the same cell, all coalition structures characterized by the customs union $CU(2, 3; \theta)$ are also blocked by the corresponding free trade area $FTA(2, 3)$.

In the spirit of proposition 1 and blocking proposition 4, these observations suggest the following proposition.

Proposition 6 *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 preferences diverge between members, free trade areas tend to block their customs union counterparts.*

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. Presumably, the tariff externality is weak compared to the terms of trade power of a member independently setting its own external tariff when preferences diverge.

Finally, in simulating differences in export endowments among countries, we found that customs unions block their free trade area counterparts everywhere. This outcome is at odds with the results for variations in preferences and may be due to the significant area generating the wrong trading pattern and, hence, our inability to properly check outcomes over a wide range of endowment spreads.

5 Conclusion

In this paper, coalition formation has been modelled endogenously. The core solution concept, from cooperative game theory, has been employed to predict the coalition structures that 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. The general, over-riding feature of the simulation results is that international differences in the distributions of preferences and endowments are important determinants of the coalition structures that reside in the core. One of our main results is that global free trade is the only element of the core when all countries are symmetrically identical and that it remains as the unique member of the core while countries are sufficiently similar in terms of their endowments and preferences. However, as international differences in preferences and endowments diverge further, other coalition structures share the core with global free trade and then replace it in the core. In

particular, customs unions are often the dominant coalition when countries become more dissimilar. Only where international differences become more extreme do coalition structures involving free trade areas and singleton coalitions (countries standing alone) feature in the core.

Another important result arising from the simulations concerns the membership of core customs unions. These results show that customs unions that appear in the core are always unions of countries with adjacent elasticities of substitutions or adjacent endowments of their export goods. Customs unions between countries with non-adjacent elasticities or endowments never form. These results are consistent with the results obtained in different contexts by Demange (1994) and others. If they extend to models in which there are many countries that allow the formation of customs unions with more than two members (apart from the grand coalition), the prediction of customs union membership would be quite powerful - customs unions between two members would also include all countries with 'intermediate' preferences or endowments.

The paper has also provided information on the blocking behaviour of various coalitions. When preferences or endowments diverge internationally, customs unions tend to block global free trade, a result suggesting that customs unions are a 'stumbling block' on the path to free trade rather than a 'building block'. In terms of the relative power of different preferential trade agreements, our results also show that customs unions successfully block free trade agreements when international differences in preferences or endowments are small but that free trade areas can block customs unions when these differences become sufficiently large. Differences in preferences and endowments tend to dissipate the terms of trade externalities that constitute the welfare creating power of customs unions.

While our results and interpretations are fairly clear and suggestive in our chosen context, there are many extensions that are needed to confirm their validity more generally. First, it would be desirable to extend our study to models with many countries. Having more countries than three is not only more realistic, but raises the possibilities of coalitions of more than two members and of several such coalitions in some of the permissible coalition structures. In particular, it would be very interesting to see whether core customs unions of more than two members continued to exhibit

membership between those with adjacent preferences. Second, it would be desirable to undertake simulations over more of the preference and endowment parameters and to allow for production in the model. Third, coalition concepts other then the core might be usefully investigated. Finally, since simulation methods cannot hope to provide proofs of general propositions, there is a need for further theoretical work on the formation of equilibrium coalition structures within the context of international trading arrangements.

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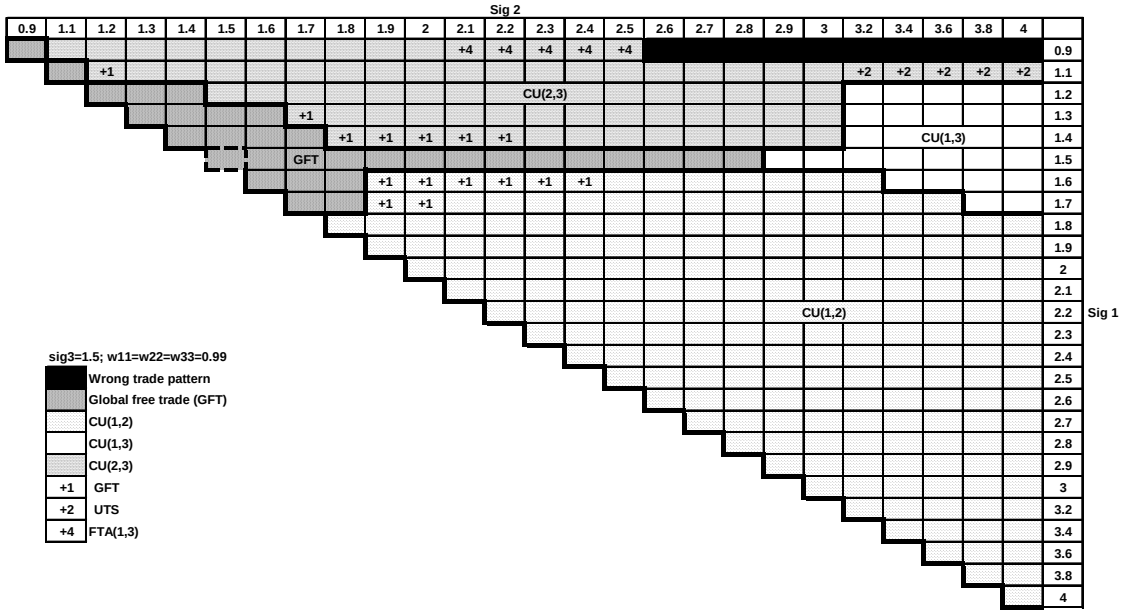

Figure 1: Composition of the core as preferences vary; $\sigma_3 = 1.5$

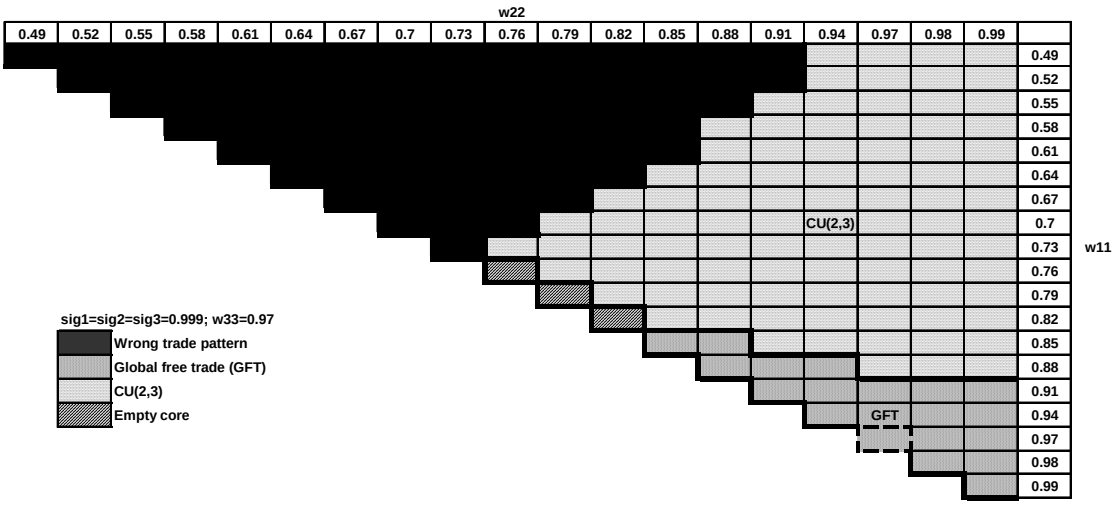

Figure 2: Composition of core as endowments vary; $\omega_3^3 = 0.97$

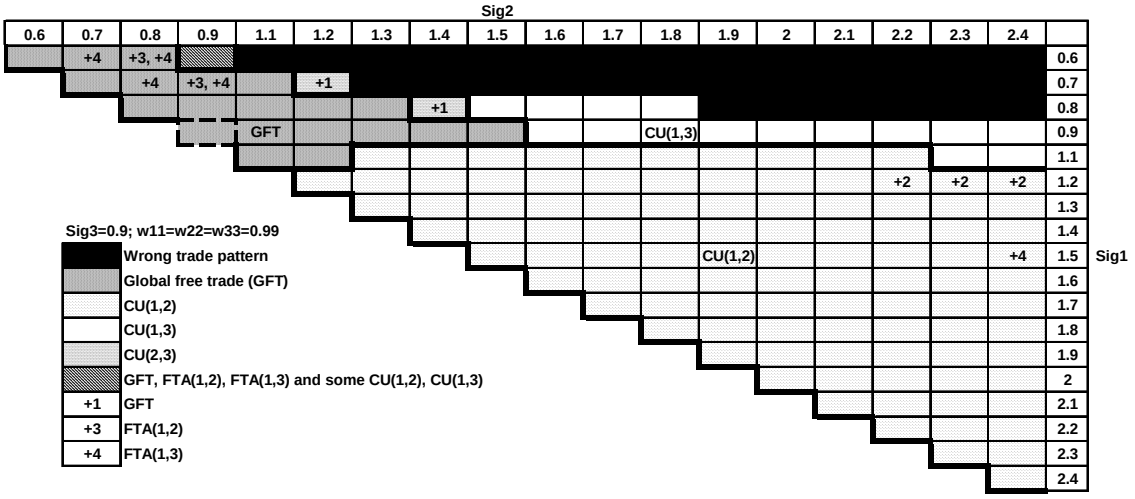

Figure 3: Composition of the core as preferences vary; $\sigma_3 = 0.9$

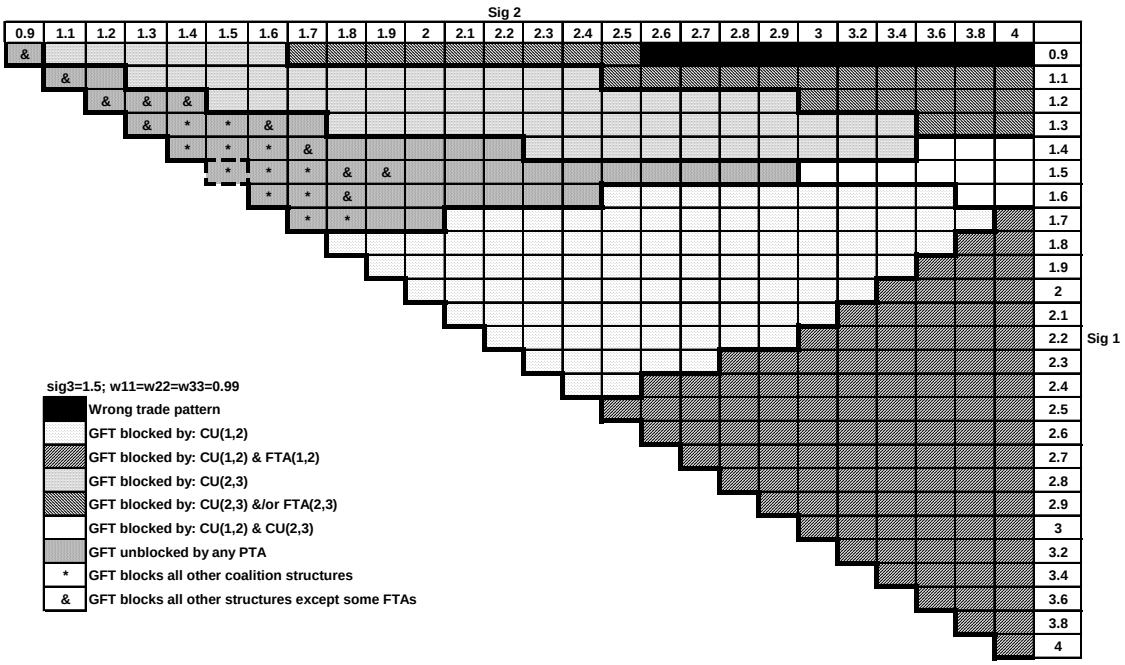

Figure 4: Blocking by, and of, global free trade as preferences vary; $\sigma_3 = 1.5$

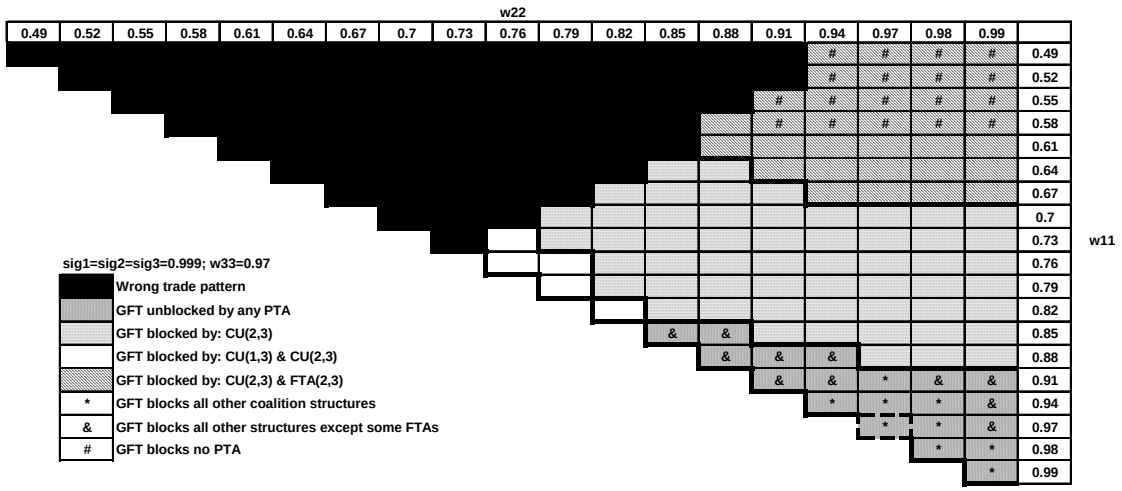

Figure 5: Blocking by, and of, global free trade as endowments vary; $\omega_3^3 = 0.97$

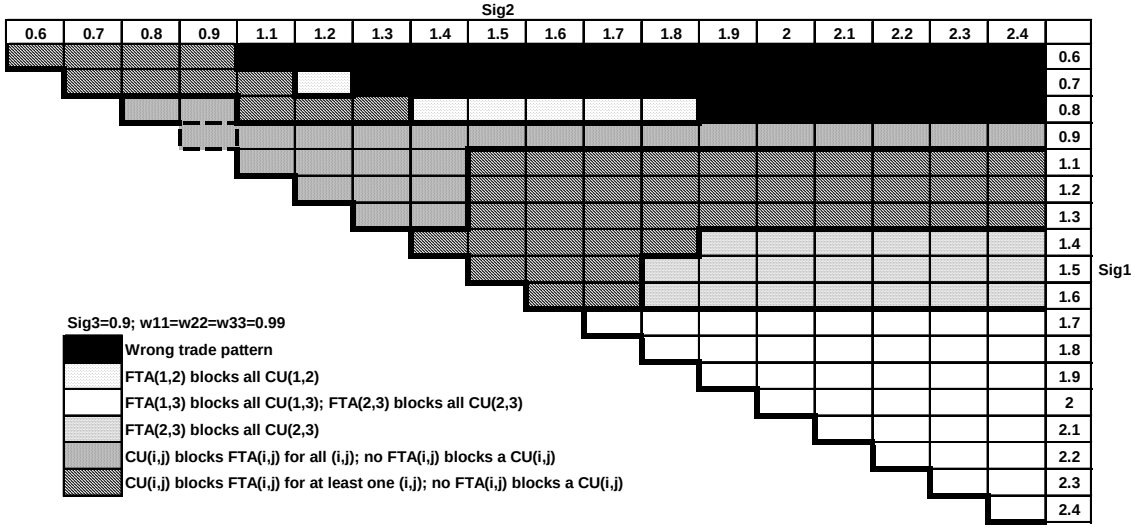

Figure 6: Blocking behaviour of customs unions and free trade areas as preferences vary; $\sigma_3 = 0.9$