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 core. It is found that global free trade is observed when all countries are similar. Customs unions tend to form between countries with 'similar' consumer preferences or with 'similar' endowments 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 consumer preferences differ sufficiently.

(This paper is still in preparation. Please do not quote without the consent of the authors.)

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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 have also formed or 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 in their trade policies 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, for example.

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.

Within this trade policy context, the purpose of the present paper is to examine the issue of trading bloc formation in a general equilibrium framework. Specifically, we address the questions of what type of trading arrangements are likely to be observed in equilibrium and of how these equilibrium choices are related to the primitive characteristics, such as consumer preferences and commodity endowments, of the trading nations. In other words, we are concerned with trying to identify the circumstances under which different coalition structures - combinations of coalitions such as free trade areas and customs unions and stand alone countries - are likely to form.

The preferential trading arrangements (or 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 (1992) 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 and 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, thus abstracting from issues of disagreement among union members over common external tariff choice. Our model explicitly deals with asymmetric countries and with common external tariff choice by customs union.

Abrego, Riezman and Whalley (2004) 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 the likelihood that certain propositions in the regional trade agreements literature actually hold. For example, they report that a customs union Pareto dominates (from the point of view of its members) global free trade 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 over a wide range of endowments and preferences, our interest is in predicting the conditions (that is, the pattern of endowment and preference distribution) 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, 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.

One of the important issues in the specification of models of customs unions is that of how the union determines its common external tariffs. Gatsios and Karp's (1991, 1995) analyses of delegation in customs unions show that the ad hoc choice of common external tariffs is a potentially hazardous practice. They show that it may be in one member's interest to delegate complete authority for the common external tariff choice to the other member. 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 or complements. Melatos and Woodland (2004) 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 dominated union that is, therefore, unlikely to be observed. An implication of this strand of literature is that customs union's common external tariffs are best determined endogenously.

In the present paper, we formulate a model of world trade, policy settings and coalition formation and use this model 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). The model is structured as a three stage game. In the first stage, coalitions are formed; in the second, trade taxes (tariffs) are determined; and in the third stage world markets clear to determine commodity prices. The game is solved backwards for the subgame-perfect equilibrium.

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 the specification of the model, customs unions are assumed to set their common external tariffs endogenously rather than exogenously as has been the custom with most of the literature. Accordingly, asymmetric countries forming a customs union can also choose how to share authority over the choice of common external tariff amongst themselves. Following Melatos and Woodland (2004), we assume that customs unions choose common external tariffs to yield a Pareto optimal outcome from the viewpoint of club members, taking account of the final stage of the tariff game. 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, in addition to examining the impacts of preferences and endowments upon equilibrium coalition structures, we undertake an 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.

In the following section, the international trade model is described and the three stages of the tariff game - coalition formation, trade policy formation and market equilibrium - are discussed. Section 3 reports the results of simulations when preferences and commodity endowments are varied. Section 4 deals with the blocking behaviour of coalitions and section 5 investigates the relative importance of customs union members in the determination of the unions common external tariff rate. Section 6 provides some concluding remarks.

Our simulations strongly suggest that when all countries are sufficiently similar global free trade is observed. Customs unions tend to form between countries with similar consumer preferences or 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 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.

[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.

The game is solved backwards to obtain a subgame-perfect Nash equilibrium. The following sub-section outlines the model and specifies the trading equilibrium conditions given tariff settings (third stage). The subsequent sub-section details the determination of tariffs in each of the various coalition structures (second stage), given the coalition structure formed at the first stage of the game. The final sub-section then deals with coalition formation in the model.

2.2 Trading Equilibrium

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 on imports of good j and ω_j^i 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_j^w), and t^i is a 3×1 vector of tariffs. 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 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 (also called 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

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

[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.

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 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 $t^k_l = t^l_k = 0$, allowing the members to independently set tariffs on trade with non-member countries. By ruling out on-selling, we are assuming that rules of origin are completely effective in deterring trade deflection.

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 ROW 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 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 the common external tariff $t^C_n = t^k_n = t^l_n$ is on imports of good n from non-member country n. Accordingly, the CET

[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.

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 it is recalled that $t_n^k = t_n^l = t_n^C$ 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.[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 $CU(k,l;\theta)$. 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

Before defining the core, an important distinction must be made between a *coalition* and a *coalition structure*. 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, 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 members of the trade agreement. Thus, 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) 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 is needed to obtain predictions of likely outcomes.

[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. 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.

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

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.[5]

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 $\omega_i^j = 0.005$ for all $j \neq i$.

Table 1 presents the equilibrium utilities for each of 8 possible coalition structures.[6] 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.[7] Countries may only belong to one coalition at any one time, so overlapping trade agreements 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. First, it is clear from the table that both members of any customs union are worse off than under global free trade. Second, in $FTA(1,2)$ and $FTA(1,3)$ at least one member is worse off and in $FTA(2,3)$ both members 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.[8]

- 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

[5] The second step is detailed in the Appendix, available upon request.

[6] Since there are just three countries, a coalition structure may be described by the dominant coalition.

[7] 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.

[8] Its worst prospect (which is what we assume in our core algorithm) is if the other countries form 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.

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.
- The coalition structure featuring $FTA(1,3)$ is similarly blocked by $CU(1,3)$, since countries 1 and 3 are both 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. This happy outcome is for the world described by our model and our choice of numerical values for the parameters of the utility functions and for the endowments. Alternative choices of the numerical values for parameters 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 relating the nature of the international distribution of endowments and of preference parameters to the coalition structures that are in the core of the trade policy game. For example, our interest is 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 general in Table 2. According to this specification, the world supply for each good is unity. Given a country's endowment of its export commodity, the remaining quantity of the good is divided evenly between the importing countries.

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

Two sets 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. In particular, σ_1 and σ_2, the elasticities of substitution of countries 1 and 2 respectively, 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 this simulation, 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.[9]

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. Country 1 and 2's endowments of their export goods are varied in the range $\left(\omega_1^1, \omega_2^2\right) \in (0.47, 0.97)$, 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 $\sigma_1 = \sigma_2 = \sigma_3 = 0.999$.

We consider 413 possible coalition structures, which are listed in Table 3.[10] These include global free trade, unilateral tariff setting with each country standing alone, three free trade areas and three families of customs unions. For customs unions 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.

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	$CU(1, 2; \theta = -15$ to $120)$	$\{CU(1, 2; \theta), \{3\}\}$
142-277	$CU(1, 3; \theta = -15$ to $120)$	$\{CU(1, 3; \theta), \{2\}\}$
278-413	$CU(2, 3; \theta = -15$ to $120)$	$\{CU(2, 3; \theta), \{1\}\}$

Table 3: Possible Coalition Structures

For each world (defined by a particular choice of elasticity of substitution parameters for countries 1 and 2 in the first set of simulations or a particular choice of endowment distribution in the second set of simulations), the trading equilibria were calculated for all 413 possible coalition structures specified in Table 3 and the core of the tariff game was computed. The core results for the two sets of simulations are summarized in Figures 1 and 2. The shaded regions in the figures identify the predominant coalition structure belonging to the core for each cell.[11] Also shown are the regions in which the trade pattern becomes inconsistent with that assumed in the underlying theoretical model.

(Insert Figures 1 and 2 about here)

[9] 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.

[10] Note that, with only three countries in the trading world, each coalition implies a unique coalition structure. Thus, for example, the coalition $FTA(1, 2)$ implies one and only one coalition structure, namely $\{FTA(1, 2), \{3\}\}$.

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

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, 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 which all three countries are identically symmetric - that 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 elasticity of substitution. 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 (with country 3's endowment of its export good being fixed at $\omega_3^3 = 0.97$). The highlighted (bolded 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 (respectively, endowments of their export good).*

As support for this proposition, we first observe that 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 the bolded border cell at $\left(\omega_1^1, \omega_2^2\right) = (0.97, 0.97)$ in Figure 2 as indicated by the blue shaded region of cells. These cells correspond to situations where all three countries have identical preferences and are symmetrically identical in their endowments. Second, we observe from Figure 2 that, as country preferences diverge, global free trade is no longer the sole element of the core but shares the core with other coalition structures. 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. However, unlike in the preferences case, Figure 2 reveals that global free trade never shares the core with any other coalition structure as national endowments diverge from equality. If free trade is in the core, it is there alone. Third, we observe that if preferences or endowments diverge further from equality, global free trade no longer figures in the core. For example, at $(\sigma_1, \sigma_2) = (0.8, 1.5)$ in Figure 1 global free trade is not in the core with the customs union $CU(1,3;\theta = -15)$ being the sole surviving coalition structure. In Figure 2 a similar pattern is evident. As endowments move 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.

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 (respectively 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).

Importantly, these results show that it is similarity of preferences that matter and not the values of the elasticities. Moving along the diagonal countries 1 and 2 have high substitution elasticities and country 3 has a relatively low elasticity, whereas moving horizontally country 2's substitution elasticity is higher than the other countries. In the first case the union $CU(1,2;\theta)$ is between countries with high elasticities, whereas in the second case the union $CU(1,3;\theta)$ is between countries with low elasticities.

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 different (in terms of export endowment only) from both countries 1 and 2, which remain symmetrically identical. Eventually, one or more $CU(1,2;\theta)$s replace global free trade in the core.[12]

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 $FTA(1,2)$ 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 a customs union. 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 $(\sigma_1, \sigma_2) = (1.5, 2.4)$ 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. This is somewhat of a puzzle.

Of particular interest in the simulation results summarized in Figure 1 is that sometimes free trade areas exist in the core while customs unions do not. This is true, for example, when $(\sigma_1, \sigma_2) = (0.6, 0.8)$; $FTA(1,2)$ and $FTA(1,3)$ is 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.

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 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 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

[12] However, moving vertically from the bolded cell country 1's endowment of its export good falls and so it might be expected that a union between countries 2 and 3 would develop. However, this does not happen and, indeed, the core becomes empty.

(1985)). 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.

As a final observation, 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

Because the core comprises coalition structures that are unblocked, Figures 1 and 2 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 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.

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 3 and 4 record, for the preferences and endowments simulations, whether or not global free trade is blocked and, if it is, what type of coalition blocks it.

(Insert Figures 3 and 4 about here)

In keeping with Proposition 1, global free trade is not blocked by any coalition when countries are similar (close to the reference cell). However, as national preferences or endowments diverge from one another global free trade is blocked and the blocking coalition depends on the degree of divergence. Examination of Figures 3 and 4 in the vicinity of the reference cells suggests the following proposition:

Proposition 4 *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 preferential trade agreement.

(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 $(\sigma_1, \sigma_2) = (0.9, 0.9)$ 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 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 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 more pronounced, a free trade area between the 'similar' countries may also block global free trade.*

Proposition 5 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 $\sigma_1 = \sigma_2 = 1.6$ along the diagonal, 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. 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 3 show that global free trade is blocked by preferential trading agreements for preference distributions in the dark green, light green and yellow shaded areas. Thus, as the distribution of preferences becomes more spread the greater 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 4 - 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 preference or endowments are similar will a PTA not be a stumbling block to free trade. Overall, our results therefore come down on the side of preferential trading agreements being stumbling blocks to global free trade.

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

Figure 5 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.

(Insert Figure 5 about here)

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. These areas are shown by the red and blue coloured cells.

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. Such regions are coloured brown, orange and maroon. 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 $FTA(1, 3)$.[13]

[13] On the other hand, in the same cell, at least one $CU(1, 2; \theta)$ blocks the coalition structure characterized by $FTA(1, 2)$. This is not shown in the figure.

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 all 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.

Finally, note that 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 Delegation Authority in Customs Unions

In this subsection we investigate how customs unions that exist in the core determine their common external tariffs and relate this to the distribution of preferences and endowments. In particular, we examine the relative roles of the two customs union members in CET determination and we examine the range of CETs that are potentially observable.

Gatsios and Karp (1991, 1995) demonstrated that it may pay one member of a customs union to delegate responsibility for the determination of the union's common external tariff to the other member. Despite the fact that the second member would choose the CET to maximize its own welfare, the welfare of the first member would also increase in this case. Delegation in the sense of Gatsios and Karp is complete delegation - one member assumes complete authority to determine the CET. Recently, Melatos and Woodland (2004) generalized the concept of delegation to include partial delegation and super delegation. If it is assumed that members choose the CET by maximizing a social welfare function, complete delegation means that the weights are zero and unity, partial delegation means that the weights are both positive and super delegation means that one weight is positive and one is negative.

Melatos and Woodland showed 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. Indeed, in some circumstances a Pareto efficient customs union requires one member's utility being negatively weighted in the union's social welfare function. Their demonstration leaves open the possibility that a customs union with a negative welfare weight may itself be Pareto dominated by some other coalition structure such as global free trade or by another customs union involving only positive welfare weights. Since any customs union appearing in the core is Pareto optimal for its members, it follows that such a customs union may have negative welfare weights.

In the present paper, we interpret the delegation concepts in terms of policy aggressiveness with respect to the choice of the union's CET. We compare the CETs that would be chosen if one of the members was given complete authority with the range of CETs that are Pareto optimal for those customs unions in the core. If the Pareto optimal range is within the CETs chosen by the two members, we say that there is partial delegation. If it moves outside, then there is super delegation with one of the members taking an aggressive role.

Given that a customs union resides in the core, the following propositions refer 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. The following three propositions summarize our observations, given below, on the simulation results in this regard.

Proposition 7 *When a customs union between two members is in the core: (i) partial delegation of authority to determine the union's common external tariff may not constitute a core contract, and (ii) super delegation to one of the members may constitute a core contract.*

Proposition 8 *When a customs union is in the core, if member preferences (export endowments) differ (even 'slightly') the more inelastic (respectively, well-endowed exports-wise) member assumes greater authority in common external tariff choice.*

Proposition 9 *When a customs union is in the core, as member preferences (export endowments) diverge the range of common external tariff choice rules in the core tends to expand.*

These proposition are verified using Figures 6 and 7 for preference and endowments, respectively.
(Insert Figures 6 and 7 about here)

Figure 6 assumes that $\sigma_2 = 2.4$ and considers variations in σ_1 such that customs union $CU(1,2)$ is in the core (moving vertically from the bottom right hand cell in Figure 1). This figure contains a plot of the CETs that each of the members of customs union $CU(1,2)$ would choose individually ($cet1$ and $cet2$) and a plot of the minimum and maximum CETs that are Pareto optimal for the members (i.e., the range of customs unions $CU(1,2)$ in the core, denoted by $corelow$ and $corehigh$). In the figure, $cet2$ lies below $cet1$ except at the endpoint where $\sigma_1 = \sigma_2 = 2.4$, showing that country 1, if choosing the CET on behalf of the customs union, would always choose the higher tariff rate and is, therefore, the 'aggressive' member. It is particularly noteworthy that the range of CETs in the core and given by $corelow$ and $corehigh$ overlaps the $cet1 - cet2$ range but also contains CETs outside the $cet1 - cet2$ range.

The first point to note from an examination of Figure 6 is that partial delegation, whereby the chosen CET is a weighted average of the compete delegation CETs (equivalently, the union chooses positive weights for both members in its welfare function, in the present context), may not be Pareto optimal for the members and, hence, such a union contract may not be in the core. This is the case for all $\sigma_1 \in [1.4, 2.3]$, indicated by the CET range $op2 - cet2$. Customs union contracts giving a large weight (role) to country 2 in the determination of the union's CET will be Pareto dominated by unions giving a lesser role to country 2 and, hence, will not appear in the core.

Second, the core consists of customs unions $CU(1,2)$ that yield CETs in the range $corelow - cet1$. This is the case for all $\sigma_1 \in [1.3, 2.3]$ in the figure. In these cases, the union's CET is larger than even the aggressive member would have chosen if given complete authority to determine the CET. This is a case of 'super delegation' - country 1 gets a positive weight in the social welfare function, while country 2 gets a negative weight. This weight choice translates into a very high CET choice, which distorts the union's offer surface to the non-member in favour of the union members.

These two observations verify Proposition 7 in the case of preferences - partial delegation may not be part of an appropriate union contract and super delegation may be.

Proposition 7 (i) seems in the spirit of Syropoulos' (2002) Proposition 2. This proposition states that "If ROW's tariff is a strategic complement (strategic substitute) to the union's CET, then CU members should delegate authority over CET choice to the member with the smallest (largest) relative endowment of the factor employed intensively in the CUs export sector." For every case that we have tested in our simulation model, the relationship between union and non-member tariffs has been one of strategic substitution.

The intuition for Proposition 7 (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.

Third, a customs union $CU(1,2)$ that gives a strong role (large weight) to the aggressive country 1 will appear in the core. Such unions are represented by contracts yielding CETs in the range $cet1 - corehigh$. In these cases, the aggressive member is given greater authority than country 1 in the upper section of the CET range.

Finally, it is noted that the aggressive member, country 1, is characterized by having the lower elasticity of substitution since $\sigma_1 < \sigma_2 = 2.4$, except at the endpoint. Thus, the country with the lowest elasticity of substitution assumes greater authority in CET determination in the customs union.

These latter two observations on variations in preferences in Figure 6 are formalized in Proposition 8 - the country with the low elasticity of substitution will be given the dominant role in CET selection in a core customs union.

To verify Proposition 9 in the case of preferences, we again refer to Figure 6. At low levels of σ_1, where the divergence of preferences is greatest, the range of Pareto optimal (core) CETs is largest. This range of Pareto optimal CETs gradually diminishes in size and vanishes once the elasticity of substitutions in the two countries converge to equality at $\sigma_1 = \sigma_2 = 2.4$. Thus, the greater the divergence of preferences of the two customs union members, the greater the range of common external tariff rates that reside in the core.

The above three propositions may also be verified for variations in endowments using Figure 7, again for the case of a customs union between countries 1 and 2. This union is in the core, for example, when $\omega_{22} = 0.94$ and $\omega_{11} \in [0.49, 0.82]$. Figure 7 plots the same information as plotted in Figure 6, but this time for variations in endowments. Notice that in the endowments case country 2 is now the aggressive CET setter. Proposition 7 is verified for endowments by the observation that, for all values of ω_{11}, there are many customs union contracts of partial delegation with country 1 getting high weight that are not Pareto optimal and hence not in the core (CETs between $cet1$ and $corelow$), and also (part (ii)) by the observation that many contracts of super delegation with country 2 getting strong weight and country 1 getting negative weight are Pareto optimal and hence reside in the core. In the latter cases, the CET is higher than country 2 would have chosen had it been complete delegation of tariff setting authority.

Proposition 7 is verified for endowments by noting that the Pareto optimal range $corehigh - corelow$ is higher on average than the partial delegation range $cet2 - cet1$ and observing that country 2, the aggressive member, has a greater endowment of its export good than does the other member country.

Finally, Proposition 8 is verified for endowments in Figure 7 by noting that the Pareto optimal range of CETs is widest when ω_{11} is smallest and becomes generally smaller as ω_{11} increases towards the value of $\omega_{22} = 0.94$ (as does the partial delegation range $cet2 - cet1$). Thus, the set of potential CETs for the union is larger the greater the divergence in endowments of the union members.

The propositions were verified by reference to just one customs union and for particular ranges of preferences and endowments. However, other choices for illustration could have been made and the same conclusions would have been obtained. Figures 8 and 9 provide more complete detail on the Pareto optimal and partial delegation ranges of CETs for all customs unions in the core corresponding to Figures 1 and 2. For example, above the main diagonal in Figure 8 (where $\sigma_1 < \sigma_2$), country 1 tends to shoulder more responsibility for setting the union's common external tariff rate. In Figure 9 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.

(Insert Figures 8 and 9 about here)

6 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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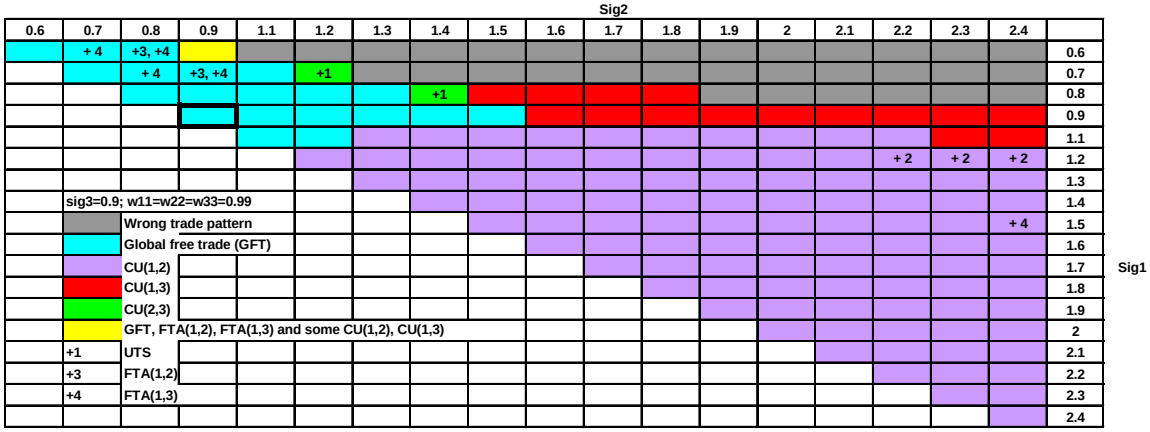

Figure 1: Composition of the core as preferences vary

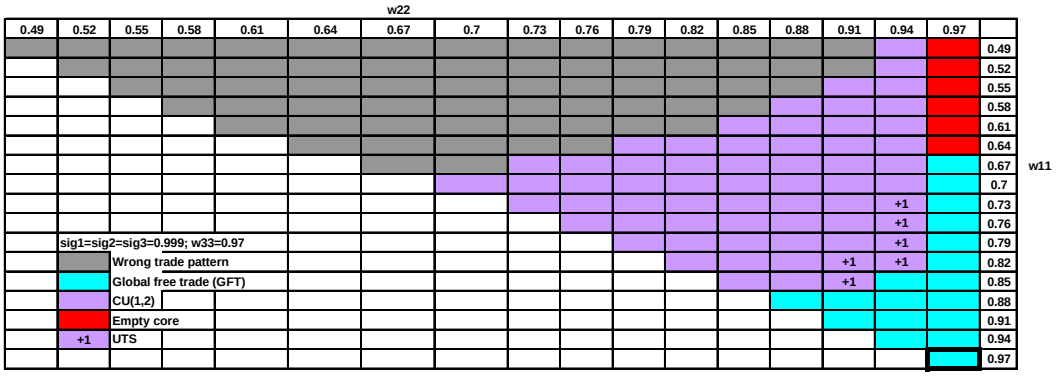

Figure 2: Composition of core as endowments vary

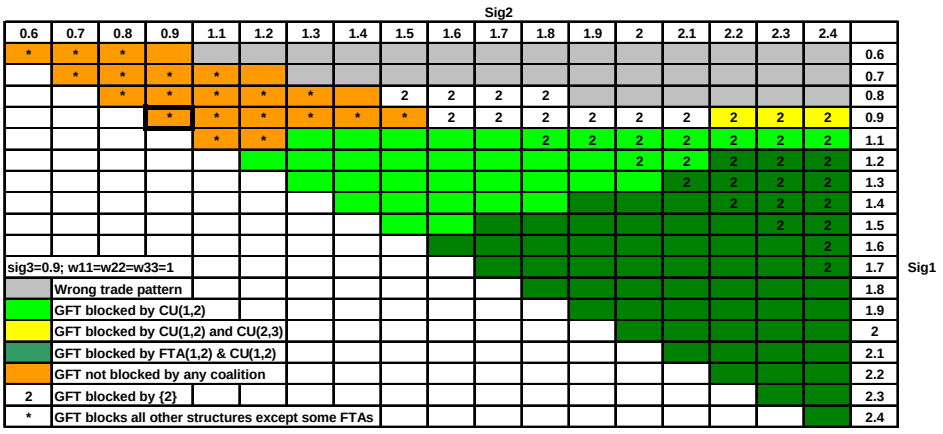

Figure 3: Blocking by, and of, global free trade as preferences vary

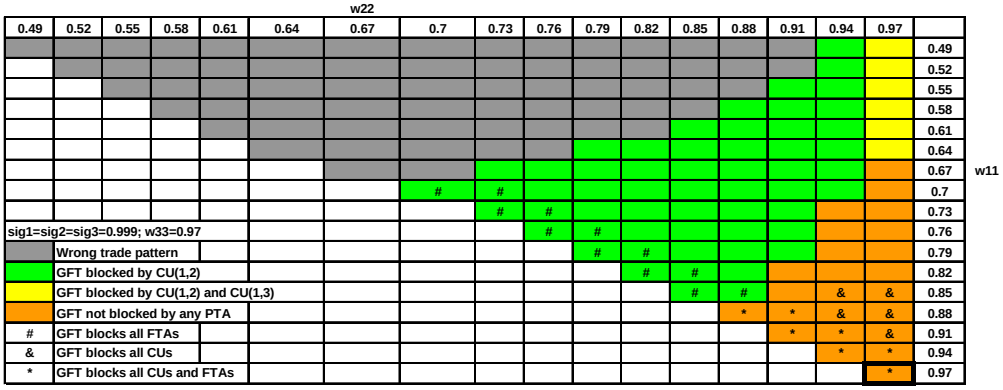

Figure 4: Blocking by, and of, global free trade as endowments vary

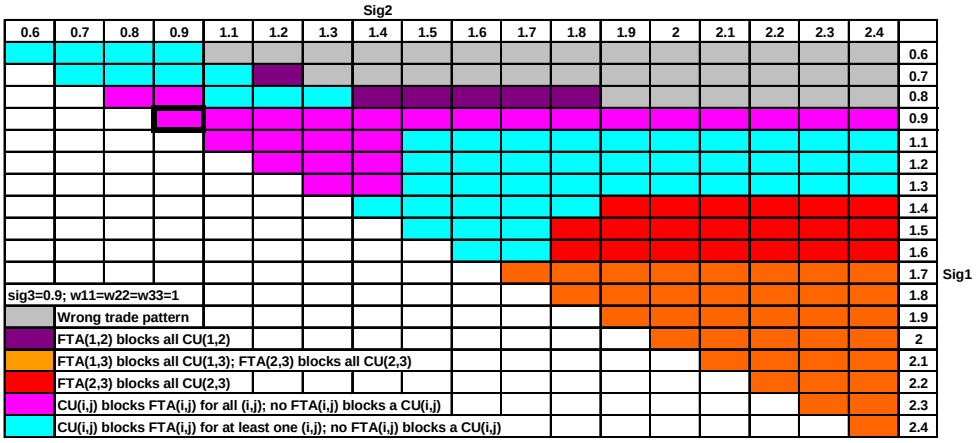

Figure 5: Blocking behaviour of customs unions and free trade areas as preferences vary

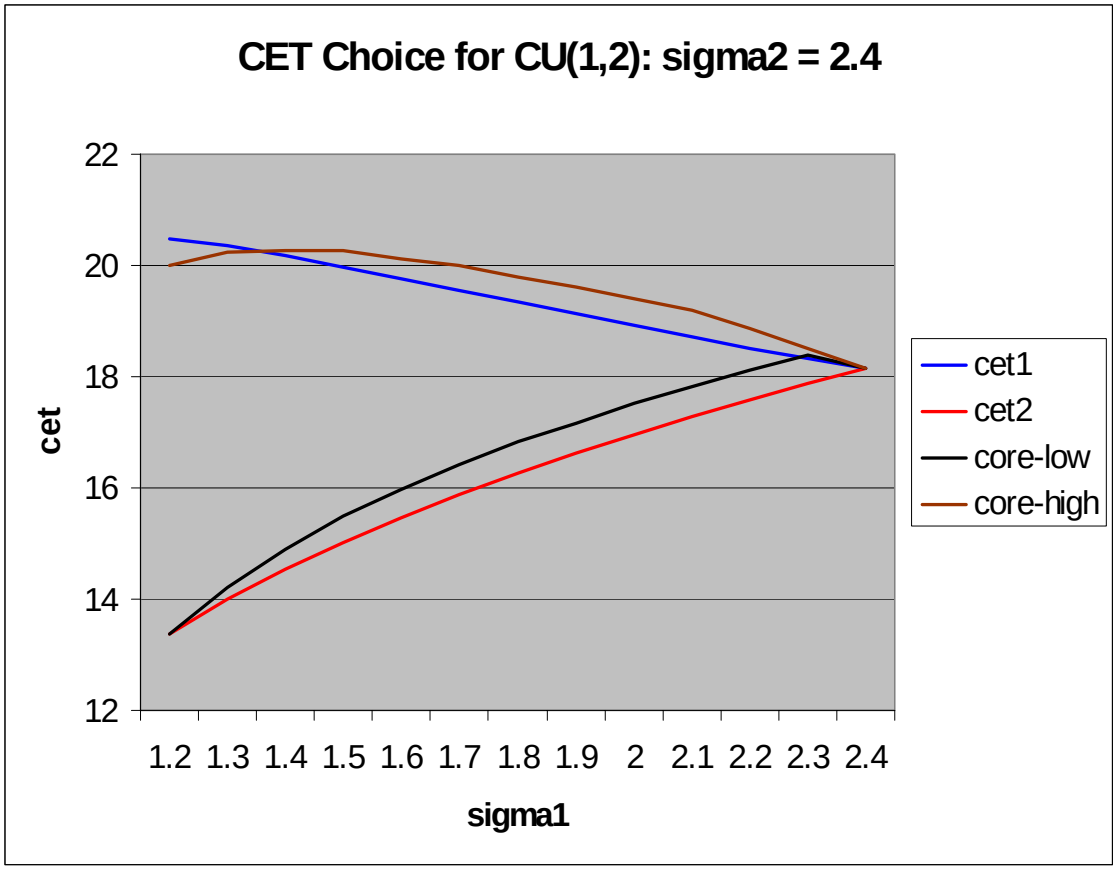

Figure 6: Delegation of CET choice as preferences vary

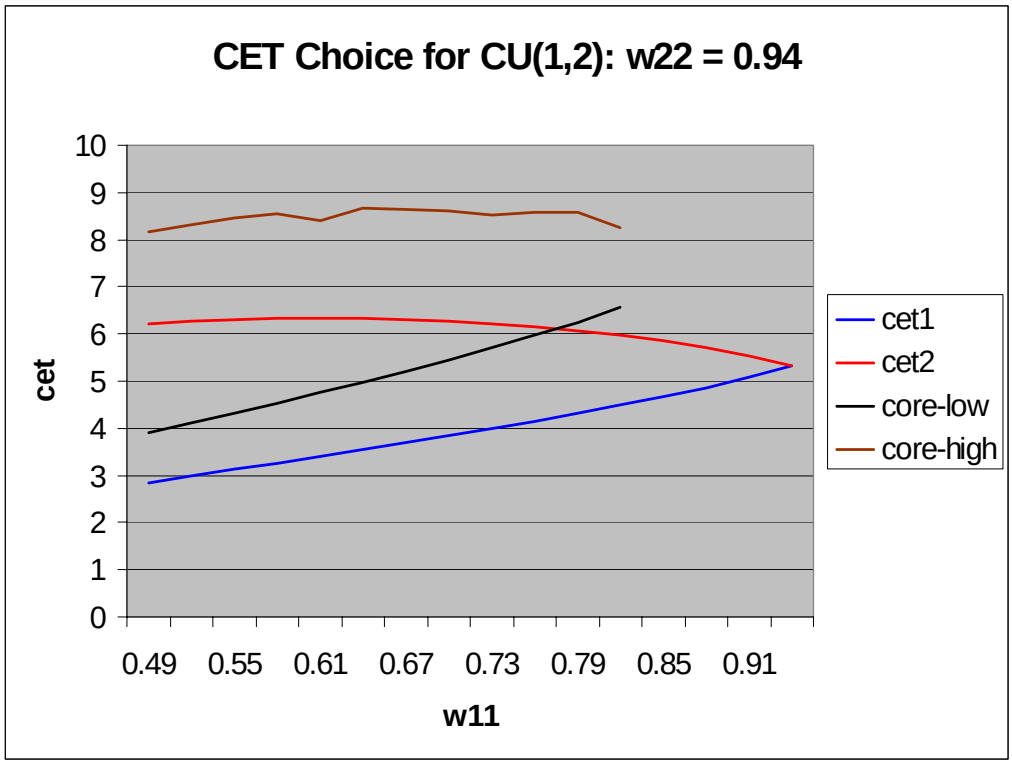

Figure 7: Delegation of CET choice as endowments vary

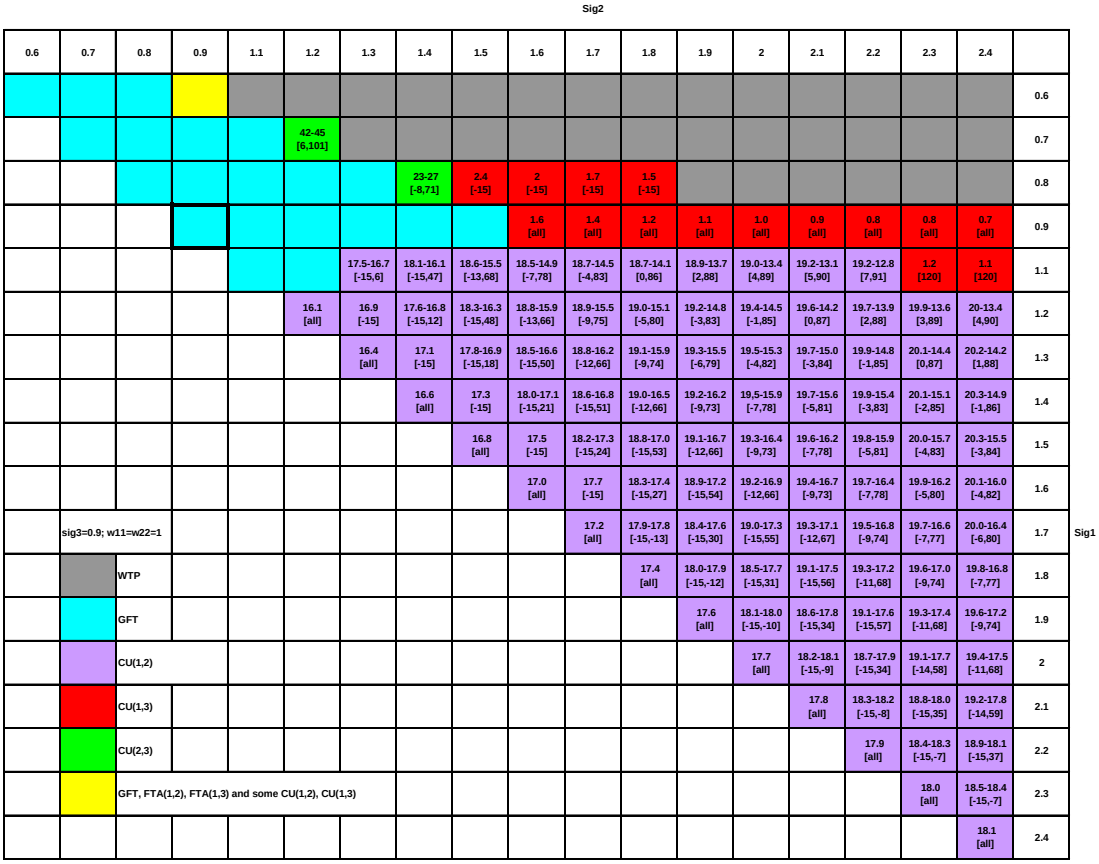

Figure 8: Delegation of CET choice as preferences vary: complete results

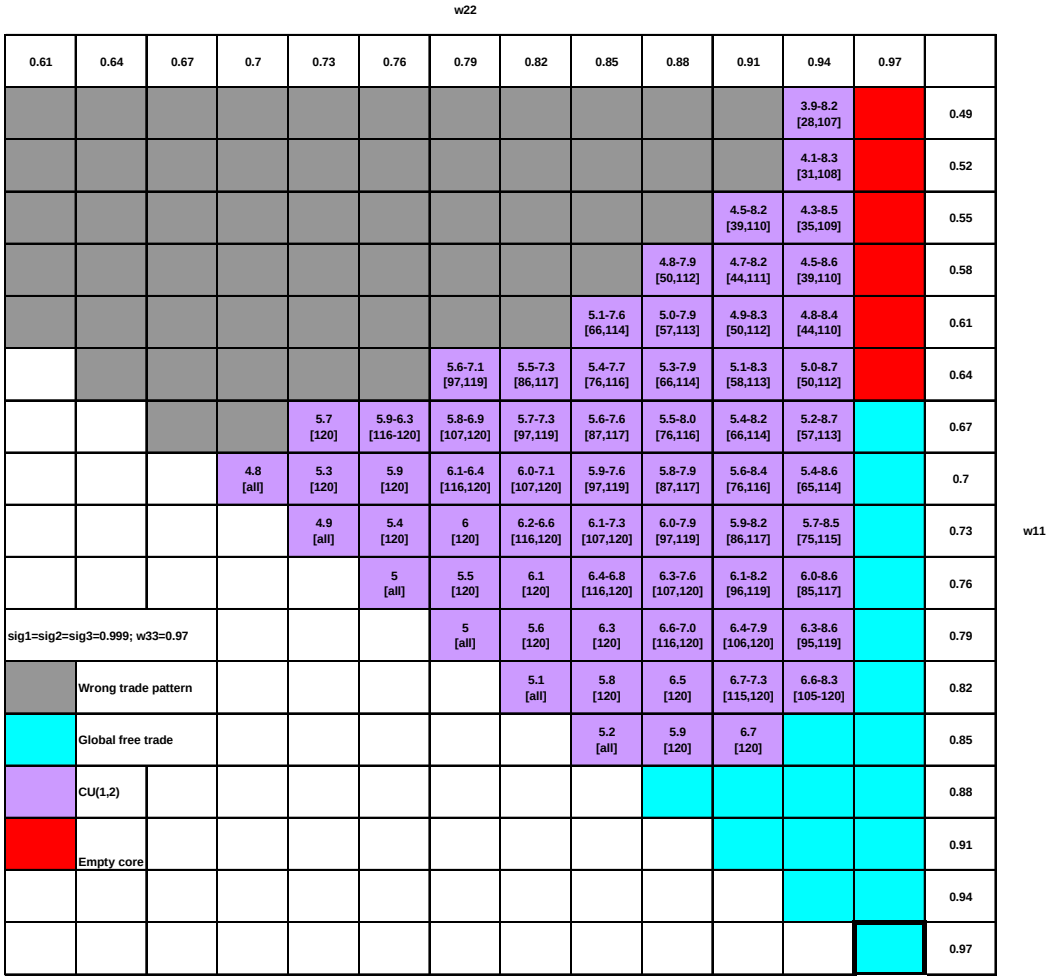

Figure 9: Delegation of CET choice as endowments vary: complete results