Pareto Optimal Delegation in Customs Unions

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Abstract. Customs unions constitute agreements to engage in free intra-union trade and to levy common external tariffs on trade with non-members. Existing theoretical models do not agree on how the common external tariffs are chosen; different, somewhat ad hoc choice rules have been employed. In this paper, a model of customs union formation is developed in which the Pareto principle and the assumption of unanimity are used to construct a mechanism for the choice of common external tariffs. The model is structured as a three-stage game in which union members select common external tariffs that yield utility outcomes that are Pareto optimal and dominate the stand-alone alternative. Numerical examples are use to demonstrate the wide range in the nature of these outcomes. Our results are discussed in relation to the delegation principle developed by Gatsios and Karp and to modeling approaches reported in the customs unions literature. The paper emphasizes the importance of modeling the formation of the customs union agreement.

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1. Introduction

A customs union (CU) represents a commitment by members to coordinate their national policies for mutual advantage. Members of a customs union agree to engage in intra-union trade free of trade taxes and to impose a set of common external tariffs (more generally, trade taxes) on trade between union members and the rest of the world. The latter condition effectively makes the union one country from the point of view of its trade policy. How the customs union decides upon the levels of the common external tariffs is an important issue, particularly when members are likely to disagree over the rates.

Despite the importance of the determination of common external tariffs by customs unions, the literature has, more often than not, skirted the issue. There have been several approaches taken in the literature. First, some authors, such as Bond and Syropoulos (1996) and Krugman (1991), have assumed that the customs union members are symmetrically identical, in which case the members will always agree upon the rates for the common external tariffs. When countries are not symmetrically identical, however, they will generally have different opinions on the levels at which the common external tariff rates should be set. Second, for situations in which disagreement is inevitable, the issue of common external tariff choice has been avoided by the selection of one of the union members as the policy maker. For example, Riezman (1985), Kennan and Riezman (1990) and Kose and Riezman (2003) select one member who then chooses the common external tariffs unilaterally. A variation on this approach has been used by Riezman (1999). In his approach, the utilities of both member countries are calculated for the two extreme situations in which first one partner and then the other unilaterally chooses the external tariff. The common external tariff agreed to is that which yields, for each partner, their average utility from the two extreme cases.

A third approach to modelling the choice of the common external tariff rates involves the customs union choosing these tariff rates by maximizing a social welfare function with non-negative weights. For example, Perroni and Whalley (2000) and Abrego, Riezman and Whalley

(2003) specify social welfare functions that depend on the utility of both members, implying that union members share responsibility for selecting the common external tariffs. In these studies, the common external tariffs are chosen to maximize a linear combination of member utilities. Perroni and Whalley calibrate the weights to the observed GNP levels of each member. In Abrego, Riezman and Whalley, the weights are given by the share of the value of each country's endowment in the value of the world endowment.

The somewhat ad hoc nature of these implied models of common external tariff choice is highlighted by the results of Gatsios and Karp (1991, 1995). Gatsios and Karp (1995) demonstrate that, provided non-members behave strategically, it may be in the best interests of one member of the customs union to delegate authority over the choice of external tariff entirely to its partner.[1] That is, the member who has been delegated authority chooses the common external tariffs unilaterally to maximize its own welfare, taking into account the fact that the tariff rates chosen will apply to all union members. The resulting common external tariff rates make the passive partner better off than if it had full control over the choice of the external tariffs. This result holds whether intra-union transfers are allowed or not. The importance of the delegation principle, in the present context, is that an arbitrary choice of a customs union member to take responsibility for setting the common external tariffs may yield outcomes that are Pareto inefficient from the point of view of the customs union.

Gatsios and Karp's delegation results, within the context of the above-mentioned literature on customs union modeling, provide a compelling argument in favour of a more thorough investigation of the determination of common external tariffs by customs unions. The purpose of the present paper is to undertake such an investigation. To achieve this objective, we provide a model of customs union formation that pays particular attention to the contractual arrangements that define the customs union and to the decision process that members employ. The axiomatic bases for the model are that unanimity is required to reach agreement, that a country will only agree to join a union if it yields higher utility than the alternatives available to it, and that the prospective members will wish to consider all possible Pareto optimal (from the point of view of the union) utility outcomes from the proposed union. By considering all possible Pareto optimal outcomes, countries choose whether to join the union and, if so, choose among the set of outcomes by a bargaining process. The consideration of all possible Pareto optimal outcomes for union members avoids the potential difficulties with the arbitrary choice of social welfare function weights implicit in the literature.

The specific model is expressed as a multi-stage game. The final stage of the game establishes the competitive equilibrium for the world economy, given the countries' tariff policy choices. The preceding stage of the game is the formation of tariff policies of the union and other countries, these policies being determined via a Nash equilibrium. For the customs union and, hence, for the outcome of the tariff game, the common external tariffs are chosen to be Pareto optimal from the point of view of the union by utilizing a social welfare function with a particular choice of weights given to union members' utility functions.[2] The initial stage of the game is the determination of the weight vector for the union's social welfare function from the set of *acceptable* weights, defined as the set of weights yielding utility outcomes that are Pareto optimal and Pareto dominate the stand-alone alternative to the formation of the customs union.

[1] Syropoulos (2002) builds on the work of Gatsios and Karp (1995), identifying a relationship between factor endowments and delegation within a Heckscher-Ohlin framework.

[2] The use of a union social welfare function, with a set of weights indicating the importance of each country, facilitates the construction of the set of Pareto optimal outcomes available to the union. Corresponding to each weight vector is a particular social welfare function that, when maximized, yields the optimal common external tariffs for given tariffs in the rest of the world.

Thus, at this first stage, countries decide whether to join the union and, if in the affirmative, the weights to be used in the social welfare function employed to determine the common external tariffs. That is, they are deciding upon the nature of the union contract.

The approach taken in the present paper has several advantages. First, it provides a framework for customs union formation that avoids the arbitrariness of particular choices of a social welfare function that has characterized the literature. Considering zero-one weights or exogenously chosen intermediate weights may yield Pareto inefficient outcomes. By considering all Pareto optimal outcomes as potential choices for the union, this difficulty is avoided. Second, it demonstrates that a customs union is an agreement or contract involving more than simply an arrangement to set internal tariffs at zero and common external tariffs. To operate effectively, the union contract must involve an agreement about the decision-making process. In the present case, this includes the identification of all possible Pareto optimal outcomes and the choice therein.[3]

In addition, our framework provides for a generalization of the delegation principle developed by Gatsios and Karp (1991, 1995). In particular, while the Gatsios and Karp delegation concept is one of complete delegation, our focus on the complete utility possibilities frontier allows for the concepts of partial delegation and super delegation. Under the partial delegation concept, countries would partially delegate tariff-setting authority to another in the sense that they would be prepared to consider tariffs being chosen to maximize a social welfare function with positive weights for each member country.[4] On the other hand, under super delegation, one or more countries may be prepared to accept tariffs being chosen to maximize a social welfare function with negative weights for this subset of member countries. The resulting outcome may be Pareto superior for the union compared to complete delegation outcomes.[5] More generally, our framework argues for the concept of Pareto optimal delegation as the over-riding concept to be used by union members to achieve desirable outcomes.

Section 2 provides the details of our model of a customs union as a multi-stage game. The model is discussed in section 3. This section provides a range of illustrative numerical examples that demonstrate the importance of properly specifying the first stage of the tariff game and the process by which the customs union contract is determined. It is shown that there is a wide range of shapes and positions of the Pareto optimal segments of the utility possibilities frontiers facing union members, depending upon the nature of preferences. This section also discusses the connections of our results with Gatsios and Karp's delegation principle within the context of these examples. It also relates the implications for our approach to the existing literature. Section 4 provides some concluding remarks.

2. Customs Union Formation

2.1. The Customs Union Contract. A customs union agreement prescribes that members levy preferential (usually zero) tariff rates on intra-union trade and that each union member adopt the same rates of tax on trade between member and non-member countries - the so-called common external tariffs.

While zero tariffs on intra-union trade and common external tariffs rates on trade with non-members constitute the two most obvious essential aspects of a customs union between two or

[3] Syropoulos (2003) makes a similar point by noting that an essential part of a customs union agreement involves the distribution of the common external tariff revenue amongst the union members. In the present paper, this issue is also addressed as part of the customs union model.

[4] Like Gatsios and Karp, Syropoulos (2002) only explicitly considers complete delegation.

[5] The literature invariably rules out the possibility of negative weights, as illustrated by the following quote from Syropoulos (2002: p.631): "As usual, we suppose this function [the customs union's social welfare function] is strictly increasing in the welfare levels of the individual members".

more countries, the customs union agreement involves other important aspects.[6] One additional aspect, which has received recent attention by Syropolous (2003), concerns the allocation of the tariff revenue of the customs union amongst the member countries. A second additional aspect concerns the mechanism by which the union members choose the levels of the common external tariffs. Each of these two additional aspects constitutes an important part of the customs union contract and must be dealt with in any model of customs union behaviour. In short, a customs union constitutes a pure trade agreement or contract in which members commit to: (i) zero tariffs on intra-union trade, (ii) common external tariffs rates on trade with non-members, (iii) a formula for distributing common external tariffs revenue amongst members and (iv) a criterion for the determination of the common external tariffs.

The primary concern of the present paper is with the criterion chosen for the determination of the common external tariffs. To facilitate the analysis, the model developed below is of a customs union that has the standard features of internal free trade and a common external tariff and that, in addition, deals with the allocation of the tariff revenue amongst union members. The model, therefore covers all four essential aspects specified above.

2.2. Customs Union Model and Assumptions. Starting with an initial Nash equilibrium based upon unilateral tariff setting behaviour by all countries, it is assumed that two or more countries contemplate the formation of a customs union. Within this context, we argue that the prospective customs union members will be interested in identifying the complete set of utility outcomes that are Pareto efficient for the union and that are Pareto superior to the stand alone utility levels. The union will choose amongst these Pareto optimal utility points and no others. If the customs union does not Pareto dominate the initial unilateral tariff setting (UTS) Nash equilibrium, the customs union will not eventuate; the equilibrium reverts to the UTS equilibrium.

The model of the decision process involves a three stage game. In the first stage, union members determine the design of the customs union contract by choosing the weights, d, in the union's social welfare function (SWF). In the second stage, given the weights chosen for the union's social welfare function, tariffs are set optimally. In the third stage, markets clear and equilibrium world prices are determined. The game is solved backwards to yield a subgame perfect Nash equilibrium. The literature on customs unions has concentrated upon stages 2 and 3 of this game and has paid little attention to stage 1. The role of the present paper is, primarily, to model the first stage of the game and to draw out its implications.

World trade is modelled within a general equilibrium framework. It is assumed that the world economy comprises many countries trading in many goods. Let I denote the set of all countries and let I^U and I^N (where $I^U \cup I^N = I$) represent, respectively, the subset of countries that are union members and the subset of countries that are non-members. The set of traded goods is denoted by J. Each nation is comprised of a production sector, consumption sector and a government. The world price vector for traded goods is denoted p^w (elements p^w_j), while t^i is the vector of ad valorem tariff rates (elements t^i_j) levied by country i.[7] Domestic price vectors are denoted as p^i. The relationship between world and domestic prices and the ad valorem tariff vector may be expressed as $p^i = \rho(p^w, t^i)$, where element j of vector $\rho(p, t^i)$ is

[6] A customs union agreement may specify cooperation between members on many levels, including, for example, the coordination of domestic taxation, labour market and competition policies. However, in the present paper we focus on those parts of an agreement that relate directly to international trade and the union's tariff policies.

[7] In general, taxes on trade may involve import duties or subsidies and export taxes or subsidies. We follow the convenient convention of using the term 'tariffs' to refer to all of these cases. Throughout this paper, the terms 'trade tax' and 'tariff' will be used interchangeably.

$\rho_j(p, t^i) = p_j(1 + t^i_j)$.[8]

Each nation has a production possibilities set described by the transformation function $G^i(y^i) \geq 0$, which defines the set of net output vectors y^i that can be produced. The net outputs are chosen to solve the revenue maximization problem $\max\left\{p^{i\intercal}y^i : G^i(y^i) \geq 0\right\}$, where the operator $\intercal$ denotes transposition, yielding the net revenue function $R(p^i)$ and the net supply functions $Y^i(p^i)$.

Consumption sectors comprise one representative agent whose preferences are defined, for country i, as $u^i = U^i\left(c^i\right)$, where u^i is the utility of country i and c^i is i's consumption vector (elements c^i_j). Each consumer chooses a consumption vector to maximize utility subject to the budget constraint, taking domestic prices and income as given, yielding the consumer demand functions $c^i = \varphi^i(p^i, m^i)$. National income, m^i, takes the form

$$m^i = p^{i\intercal}y^i + T^i, \quad i \in I, \tag{1}$$

where T^i is tariff revenue. There are two crucial assumptions concerning transfers implied by the definition of national income. The first is that all tax revenue is redistributed to domestic consumers in a lump sum manner.[9] The second is that there are no international transfers between countries.

The specification of tariff revenue depends upon whether the country is a member of the customs union. For countries that are not members of the customs union, tariff revenue is given by

$$T^i = (p^i - p^w)^\intercal(c^i - y^i) = \sum_{j \in I} t^i_j p^w_j \left(c^i_j - y^i_j\right), \quad i \in I^N. \tag{2}$$

For countries that are members of the customs union, tariff revenue depends upon the tariff revenue collected by the union and upon the rule established by the union for its allocation amongst union members. The tariff revenue collected by the union depends upon the vector of union trade with the rest of the world and the common external tariff chosen by the union and may be expressed as $T^U = (p^U - p^w)^\intercal \sum_{i \in I^U}(c^i - y^i)$, where $p^U = \rho(p^w, t^U)$ is the internal union price vector common to all member countries. The union allocates its tariff revenue to union members according to the rule $T^i = \alpha^i(p^w, t^U)T^U$, where α^i is a non-negative proportion that depends on endogenous variables within the union and so, ultimately, upon the world price and the chosen tariffs.[10] Thus, tariff revenue for a union member may be expressed as

$$T^i = \alpha^i(p^w, t^U)\left[(p^U - p^w)^\intercal \sum_{k \in I^U}(c^k - y^k)\right], \quad i \in I^U. \tag{3}$$

For the customs union, the equilibrium and tariff revenue allocation conditions may be combined as

$$c^i = \varphi^i(p^U, R^i(p^U) + T^i), \quad i \in I^U \tag{4}$$

$$T^i = \alpha^i(p^w, t^U)\left[(p^U - p^w)^\intercal \sum_{k \in I^U}(c^k - Y^k(p^U))\right], \quad i \in I^U, \tag{5}$$

[8] The ad valorem tariff rates are assumed to be greater than minus unity to ensure positive domestic prices. This follows since $p^i_j = p^w_j(1 + t^i_j)$.

[9] Domestic taxes and subsidies are not allowed. For a discussion of the impact of domestic taxes and subsidies on customs union formation, see Richardson (1994).

[10] Various rules (the population, consumption and import absorption rules) have been discussed by Syropoulos (2003).

where $p^U = \rho(p^w, t^U)$. These equations may be solved for the members' consumption vectors c^i and tariff revenue allocations T^i as functions of the world price vector p^w and the customs union's common external tariff vector t^U. The other endogenous variables within the customs union can then be expressed in terms of p^w and t^U.

The implication to be drawn from this model specification is that the endogenous variables in each country, whether or not it is a member of the customs union, may be expressed in terms of the world price vector and the country's tariff vector (common external tariff vector in the case of union members). In each country, the solution to the consumer's constrained utility maximization problem yields the consumer demand functions in terms of world prices and tariffs. That is, the consumption demand vector for country i may be written as $c^i = C^i\left(p^w, t^i\right), i \in I$. The consumer demands can be substituted back into the utility functions to yield indirect utility functions of the form $u^i = V^i\left(p^w, t^i\right), i \in I$.

2.3. The Trading Equilibrium (Stage 3). Stage 3 of the game is the determination of the competitive equilibrium for the world economy, given tariff choices made by countries at stage 2 and the social welfare weights decision made by members of the customs union at stage 1. Here we briefly outline the competitive equilibrium conditions.

Country i's vector of net exports may be written as

$$x^i = X^i\left(p^w, t^i\right) \equiv Y^i\left(\rho(p^w, t^i)\right) - C^i\left(p^w, t^i\right), i \in I, \tag{6}$$

where each element of x^i is denoted x^i_j and it is recalled that domestic prices may be expressed as $p^i = \rho(p^w, t^i)$. For countries not in the customs union, these net export functions satisfy the trade balance condition, $p^{w\intercal} X^i\left(p^w, t^i\right) = 0$, $i \in I^N$. For countries in the customs union, the balance of trade condition needs to distinguish between intra- and extra-union trade and take into account the distribution of the common external tariff revenue. However, in aggregate, the union's net export function $X^U\left(p^w, t^U\right) \equiv \sum_{i \in I^U} X^i\left(p^w, t^U\right)$ does satisfy the balance of trade condition $p^{w\intercal} X^U\left(p^w, t^U\right) = 0$.

In equilibrium, the market for each good clears and so, using the national net export functions in equation (6), the world market equilibrium conditions may be expressed as

$$\sum_{i \in I} X^i\left(p^w, t^i\right) = 0. \tag{7}$$

By Walras' Law, one of these market equilibrium conditions is redundant and may be ignored and, by their homogeneity in prices, one world price, p^w_M say, may be designated the numeraire and normalized to unity. Taking these features into account, the market equilibrium conditions determine solutions for world prices in terms of tariffs and the parameters of the model, i.e. $p^w = p^w\left(t^1, ..., t^M\right)$.

2.4. Tariff Setting (Stage 2). In this model, a group of countries form a customs union with a common external tariff vector while other countries stand alone and choose their own tariff vectors. In this context, it is natural to employ the concept of a Nash equilibrium in a tariff-setting game in which each nation, or customs union, determines its own trade policy to maximize its own welfare, given the trade policies of the other countries. We first consider the tariff choice problem for countries in the rest of the world and then consider the tariff choice problem for the union.

For countries that are not members of the customs union, the vector of trade taxes levied is determined as the solution to the optimization problem

$$t^i = \arg\max_{t^i} V^i\left(p^w\left(t^1, ..., t^M\right), t^i\right), \tag{8}$$

where, in choosing its vector of optimal trade taxes, country i assumes that *all* other tariffs are fixed. Equation (8) determines the tariff vector t^i as a function of all other countries' tariffs, the first-order necessary condition defining the implicit tariff reaction function for country i, $R^i\left(t^1,...,t^M\right)=0$. As is well known, each national tariff vector may be normalized without loss of generality; for example, by setting one of the tariff rates equal to zero.[11]

The determination of the common external tariff vector for the customs union is more complex, since the union has to operate on behalf of its members and these members may have different views on the choice of the common external tariff rates.[12] Given this potential range of views, a criterion for choosing the union's common external tariffs is required. It is assumed that rational union members will consider all possible common external tariff vectors that yield a utility point for union members that is on the utility possibilities frontier, given the tariff choices by all other countries. Points on the utility possibilities frontier may be obtained as a solution to the problem of maximizing a linear combination of the members' utility functions. That is, these points may be obtained by maximizing the union's social welfare function.

Accordingly, the union is assumed to choose the common external tariff vector to maximize union welfare, which is measured using an appropriately defined social welfare function. In what follows, the union's social welfare function is assumed to be a linear combination of member indirect utilities, i.e.,

$$W^U=\sum_{i\in I^U}d_iV^i\left(p^w,t^i\right), \tag{9}$$

where d_i is the weight given to country i's level of utility. Changing the weights, d_i, varies the union's social welfare function; the greater the value of d_i, the greater the importance of country i in the union's social welfare function. The weights may be normalized; without loss of generality, they are restricted to be on the unit sphere $D\equiv\left\{d:\sum_{i\in I^U}d_i^2=1\right\}$.[13]

The union chooses its common external tariff vector to maximize this social welfare function, given the tariff choices of non-members. Recalling that each union member's tariff vector is $t^i=t^U$, the common external tariff vector t^U is determined as the solution to the optimization problem

$$t^U\left(t^N;d\right)=\arg\max_{t^U}\left\{\sum_{i\in I^U}d_iV^i\left(p^w\left(t^1,...,t^M\right),t^U\right):t^i=t^U,i\in I^U\right\}, \tag{10}$$

where d is the vector of weights (elements d_i, $i\in I^U$) in the union's social welfare function and $t^N=(t^i,i\in I^N)$ is a vector of all other countries' tariffs.

Equation (10) determines the common external tariff vector t^U as a function of all foreign tariffs and the weights in the social welfare function, and defines the implicit tariff reaction function for the union given by $R^U\left(t^U,t^N;d\right)=0$. Since the common external tariff vector is a function of the weights, d, as well as the non-members' tariff vectors, changing the weights in the social welfare function alters the union's choice of the common external tariffs.

[11] See Woodland (1982, p. 301) for an explanation of why this assumption does not detract from the robustness of the model.

[12] In special cases, the union members will agree upon the choice of the CET rates. An example is where the members are symmetrically identical.

[13] This does not restrict the weights to the non-negative orthant, which may be regarded as plausible for a social welfare function. However, as will become clearer below, it is noteworthy that a restriction of the weights to be non-negative might eliminate Pareto optimal portions of the complete utility possibilities frontier. In other words, some Pareto optimal utility vectors are obtained from a social welfare function with some *negative* weights.

The Nash equilibrium for the tariff game engaged in by the customs union and countries in the rest of the world is the solution to the system of implicit reaction functions

$$\begin{aligned} R^U\left(t^U, t^N; d\right) &= 0 \\ R^i\left(t^1, ..., t^M\right) &= 0 \qquad i \in I^N, \end{aligned} \tag{11}$$

where $t^i = t^U$ for $i \in I^U$ and $t^N = (t^i, i \in I^N)$. The solution yields the equilibrium tariff vectors (the common external tariff vector t^U for the union and the vector of all non-members' tariffs t^N) as functions of the vector of welfare weights, d. Thus, the reaction functions (11) determine the tariffs as functions of the social welfare function weights chosen by the customs union, i.e., $t^U(d)$ and $t^i(d), i \in I^N$.

Stages two and three of the game thus determine all tariff rates, world prices and national utility levels as functions of the weights of the union's social welfare function.

2.5. Contract Selection by Union Members (Stage 1). Having obtained equilibrium tariffs and world prices, attention can now turn to the first stage of the game in which union members determine the design of the customs union contract by choosing the weights, d, in the union's social welfare function. Notice that equilibrium tariffs and prices are all functions of the union social welfare function weights, d. Hence, the welfare of every country, whether or not it is a member of the customs union, is also a function of d, i.e. $u^i = U^i(d)$, $i \in I$.

Let the union's social welfare function weights vary over the unit sphere D (defined above). For all possible $d \in D$, the equilibrium utilities of each member can be plotted to trace out the union's utility possibilities frontier, $F(D)$. Not all choices of $d \in D$ will yield utility vectors that are Pareto optimal for the union, but a subset of weights will yield utility vectors for union members that are Pareto optimal. This set of weights is denoted by D^O. The resulting Pareto optimal utility possibilities frontier is denoted by $F^O = F(D^O)$.

The customs union model specified here is based upon several behavioural assumptions or axioms. These are:

Axiom 1. *Unanimity is required to form a customs union.*

Axiom 2. *Given that a customs union is to be formed, union members will choose among utility outcomes that are Pareto optimal for the union, i.e., F^O is the choice set.*

Axiom 3. *A country will not join a customs union that yields a utility outcome that is Pareto inferior to the unilateral tariff setting (stand-alone) utility outcome, u^{UTS}.*

In interpreting these axioms, it is important to note that the issue is whether a particular customs union is to be formed and, if so, how the common external tariff is to be set. It is implicitly assumed that the rest of the world is passive and that no other customs unions is an option. With this context in mind, the axioms provide the basis for identifying the set of feasible outcomes.

Axiom 2 states that the appropriate choice set for the members of a customs union is the Pareto optimal set of utilities F^O. This has implications for the choice of the weights in the social welfare function, which is our device for computing the utility possibilities frontier. The set of weights D^O yielding Pareto optimal utility points for the members of the customs union is the relevant set of weights for the union members. Only these will be seriously considered as weights for the union's social welfare function, since other weights yield utility outcomes that are Pareto dominated by points in $F(D^O)$. Given that the union is to be formed, the set of weights D^O

defines the range of social welfare functions that are consistent with the Pareto principle and that constitute the feasible opportunity set of weights for union members. Moreover, *all* weight vectors $d \in D^O$ and the corresponding Pareto optimal utility points F^O constitute rational choices for the members of the customs union.

Axiom 3 relates to the decision of whether to form a particular customs union. Under the Pareto principle embodied in Axiom 1, a customs union will be established only if all prospective members are unanimous in their acceptance of the terms of the agreement. Accordingly, a customs union will eventuate if, and only if, it represents a Pareto improvement over the alternative situation from the point of view of union members. In the present paper, we assume that this alternative or fallback situation is the situation of the member prior to the formation of the customs union.[14] In particular, we assume that the initial situation is that of the unilateral tariff setting Nash equilibrium, which yields u^{UTS} as the utility vector for union members. This yields the *acceptable* utility possibilities set for the union given by $F^A \equiv \{u : u \in F^O, u \geq u^{UTS}\}$. Prospective members will only join the customs union if the set F^A is non-empty; if empty, the customs union will not be formed.

The decision rule for prospective members of the customs union should now be clear. (a) Prospective members of the customs union will form the union if, and only if, the Pareto efficient set, F^O, contains points that are Pareto superior to the unilateral (stand alone) tariff setting equilibrium levels of utility for these two countries. That is, they will join if, and only if, the acceptable utility possibilities set for the union, $F^A = F(D^A)$, is non-empty. (b) If the set F^A is non-empty, there exist utility points for union members that are Pareto superior (at least not inferior) to the stand-alone situation and that are Pareto optimal from the point of view of the union. Within this choice set of utility points (and corresponding set of weight vectors D^A), the union member may bargain according to some bargaining mechanism.

In summary, the utility possibility set for the union members indicates the set of all utility points that a customs union can deliver, each point in the set corresponding to a particular choice of a union social welfare function. Only Pareto efficient points on the utility possibilities frontier will be considered by a union that requires unanimity of choice and so this Pareto efficient set defines the set of efficient contracts for the union. This Pareto efficient set then has to be compared to the Pareto efficient sets from alternative trading arrangements to determine whether the union will occur.

3. Discussion

3.1. Illustrative Examples. Some examples based upon a numerical simulation model will help to illustrate the nature of the utility possibilities frontier and the common external tariff choice arising from the formation of a customs union within the context of the general model introduced above. In this simulation model, it is assumed that there are three countries trading in three goods and that countries 1 and 2 wish to form a customs union $CU(1, 2)$, while country 3 is the sole non-member.

Structure of Simulation Model. It is further assumed that countries comprise one representative agent whose preferences are defined, for country i, by the constant elasticity of

[14] In a more general context, different combinations of countries might be permitted to form a customs union and, indeed, other arrangements such as free trade agreements and global free trade might be allowed. Whatever the alternative trading arrangements being compared, the concept of the Pareto efficient set forms a crucial tool.

substitution (CES) utility function

$$U^i = \left[\sum_{j=1}^{3} \gamma_j^i \left(c_j^i \right)^{\frac{\sigma_i - 1}{\sigma_i}} \right]^{\frac{\sigma_i}{\sigma_i - 1}} \tag{12}$$

where U^i is the utility of country i, c_j^i denotes i's consumption of good j and σ_i is the elasticity of substitution with $\sigma_i > 0$ and $\sigma_i \neq 1$.[15] The parameters chosen for this example are such that countries 2 and 3 have approximately Cobb-Douglas preferences ($\sigma_2 = \sigma_3 = 0.99$), while the distribution parameters are the same in each country and are product neutral, taking values $\gamma_j^i = 1/3, \forall\, i, j$. The examples will be distinguished by different values for the elasticity of substitution in country 1. There is no production in the simulation model, each country having a fixed endowment of each of the three goods. The endowment distribution, presented in Table 3.1, is symmetric in that each country is endowed with 1 unit of its export good and 0.1 units of the commodities it imports. Thus, in this example, endowments are symmetrically distributed over countries thus effectively neutralizing endowment effects.

	good 1	**good 2**	**good 3**
country 1	1.0	0.1	0.1
country 2	0.1	1.0	0.1
country 3	0.1	0.1	1.0

Table 1: Endowment distribution

Within this model specification, it is assumed that the Meade trade pattern, in which only country i exports good i, applies. Country 3 sets tariffs on the imports of goods 1 and 2 from the union members but does not tax its exports. The union members, countries 1 and 2, impose zero tariffs on imports of goods 1 and 2 from each other so that there is free trade within the customs union. The customs union imposes a common external tariff on imports of good 3 from country 3 and does not impose taxes on exports of goods 2 and 3 to country 3. Customs revenue is distributed according to the imports of good 3 by the union members.

In accordance with the theoretical model specified above, the customs union chooses the common external tariff that maximizes the union's social welfare function, which is a linear function of the member country's utility functions. The vector of weights, which constitutes a point on the unit circle, is denoted as $(d_1, d_2) = (\cos\theta, \sin\theta)$ with $\theta \in [0, 360]$ being the angle between the vector of weights and the utility axis for country 1. The parameter θ constitutes a convenient measure of the degree of influence exercised by each customs union partner in common external tariff choice. At $\theta = 0$ the weight vector is $(d_1, d_2) = (1, 0)$ and so only country 1's utility has any value to the union and country 1 exerts total control over the CET choice; at $\theta = 90$ the weight vector is $(d_1, d_2) = (0, 1)$ and so country 2 chooses the common external tariff to maximize its own utility function. For values of θ between 0 and 90, union welfare depends on the utility of both members and is a convex combination of the utility functions. For values of θ outside the $[0, 90]$ range, union welfare is no longer a convex combination of members' utility functions.

In the following, the utility possibilities curves for the members of $CU(1, 2)$ are generated and plotted for several values of σ_1 by computing the equilibrium for the tariff game for a

[15] The limiting case as $\sigma_i \to 1$ is the Cobb-Douglas utility function, which has been used extensively in simulation models of customs unions. The limiting case as $\sigma_i \to 0$ is the Leontief utility function.

sufficiently large range of values of θ. The chosen values for the elasticity of substitution are $\sigma_1 = 0.5, 0.8,\ 0.99, 1.1, 1.5$ and 4.6.

In each figure below, the segment labelled CD constitutes the Pareto efficient set, F^O, of utility points for the customs union. Points C and D identify the extremities of this set, where the utilities of country 1 and 2 reach their respective maxima. The second segment, labeled AB in each figure below, corresponds to utility outcomes when the social welfare function is restricted to have non-negative weights (i.e. $\theta \in [0, 90]$). Points A and B, at the extremities of this latter segment, denote utility pairs (u^1, u^2) that correspond to social welfare functions in which $\theta = 0$ and $\theta = 90$ respectively. Values of θ are shown in parenthesis.

Example 1: $\sigma_1 = 0.5$. Figure 1 illustrates the utilities possibilities curve. Two observations are of particular interest in this example. First, the segments AB and CD overlap with segment AD being common to both. Points on the segment BD (corresponding to $\theta \in [53, 90]$) are Pareto inefficient, being Pareto dominated by the utility point D. Thus, A is Pareto optimal, while B is Pareto inefficient. The second important observation is that the Pareto optimal segment CD corresponds to welfare angles in the range $\theta \in [-27, 53]$. This range includes angles in the range$[-27, 0]$, which implies *negative* weights, d_2, for country 2 in the union's social welfare function. Example 1, therefore, illustrates that (i) the Pareto optimal portion of the utility possibilities frontier may correspond to negative weights in the social welfare function and (ii) non-negative weights in the social welfare function may generate Pareto inefficient utility outcomes.

Example 2: $\sigma_1 = 0.8$. Figure 2 illustrates the utility possibilities curve when $\sigma_1 = 0.8$. In contrast with Example 1, the segments AB and CD do not overlap. In this case, the entire segment AB (corresponding to $\theta \in [0, 90]$) contains utility points that are Pareto inefficient, being Pareto dominated by the utility point D at which $\theta = -25$. The Pareto optimal segment CD corresponds to angles $\theta \in [-35, -25]$ that are all negative, implying that the weight for country 2 in the social welfare function, d_2, is negative. Example 2, therefore, illustrates the extreme situation in which (i) the entire Pareto optimal portion of the utility possibilities frontier corresponds to negative weights in the social welfare function and (ii) all possible non-negative weights in the social welfare function generate Pareto inefficient utility outcomes.

Example 3: $\sigma_1 = 0.99$. Figure 3 shows that the utility possibilities curve collapses to a single utility point when $\sigma_1 = 0.99$. The reason is that, when $\sigma_1 = 0.99$, the customs union members (countries 1 and 2) are identically symmetric. Hence, the same common external tariff rate is chosen regardless of the social function weights. In this very special example, the points A, B, C and D all coincide. The choice of social welfare function weights is, therefore, immaterial in this case.

Example 4: $\sigma_1 = 1.1$. Figure 4 illustrates the utilities possibilities curve when $\sigma_1 = 1.1$. As in Example 2, the segments AB and CD do not overlap. Again, the entire segment AB is Pareto inefficient, although this time it is Pareto dominated by the utility point C at which $\theta = 125$. The Pareto optimal segment CD corresponds to angles $\theta \in [125, 128]$, once again implying that, in this example, negative social welfare function weights d are required to ensure a Pareto optimal customs union; here the weight for country 1 in the social welfare function is negative. Note that, unlike in Examples 1-3, country 1 has a larger elasticity of substitution than its partner, country 2.

Example 5: $\sigma_1 = 1.5$. Figure 5 illustrates the utility possibilities curve when $\sigma_1 = 1.5$. As in Example 1, the segments AB and CD do overlap in this case, with segment BC common

to both. The segment AC (along which $\theta \in [0, 55]$) contains utility points that are Pareto inefficient, being Pareto dominated by utility point C. Once again, there are Pareto optimal utility points BD, corresponding to the welfare angles $\theta \in [90, 113]$, that lie outside the range associated with non-negative weights d; here the weight for country 1 is negative. This example is similar in spirit to Example 1. However, it differs in terms of the positioning of segment AB. The result is that, contrary to Example 1, B is Pareto optimal while A is Pareto inefficient.

Example 6: $\sigma_1 = 4.6$. Figure 6 illustrates the utility possibilities curve when $\sigma_1 = 4.6$. In this example, with an even larger elasticity of substitution for country 1, the Pareto optimal segment CD corresponding to weight parameter $\theta \in [1, 89]$ is a subset of the segment AB corresponding to weight parameter $\theta \in [0, 90]$. This observation has two salient implications. First, all Pareto optimal utility points may be obtained from the maximization of a social welfare function with non-negative d weights since $CD \subset AB$. Second, the use of a social welfare function with very low non-negative d weights for one of the members ($\theta \in [0, 1]$ or $\theta \in [89, 90]$) will generate utility outcomes that are Pareto inefficient.

Summary and Implications of the Examples. Several important points emerge from these examples.

1. The utility possibilities frontier AB, based on the assumption that $\theta \in [0, 90]$, is not necessarily downward sloping. In every example except Example 3 the segment AB of the utility possibilities frontier contains upward sloping portions (AB in Examples 2 and 4, BD in Example 1, AC in Example 5, as well as AC and BD in Example 6). In Example 3 the segment AB is a single point.

2. The turning points, C and D, may or may not be in the segment AB of the utility possibilities frontier. In Examples 2 and 4 neither C nor D is contained in the segment AB, while in Examples 1 and 5, points C and D respectively are not on AB. Only in Example 6 is it the case that CD lies within AB.

3. There may be Pareto efficient utility points that are not captured by a social welfare function that restricts the weighting parameter to the range $[0, 90]$. Only Examples 3 and 6 above have the property that all Pareto optimal points CD are contained in the segment AB of the utility possibilities frontier. Example 3, in which all members are identically symmetric, satisfies this property trivially. In each of the other examples, restricting attention to social welfare functions that have non-negative weights leads to Pareto optimal points on the frontier being ignored. Pareto optimal segments thus ignored are AC in Example 1, CD in Examples 2 and 4 as well as BD in Example 5.

4. The properties of the utility possibilities frontier (position, shape and placement of points A, B, C and D) vary considerably from one example to another. It should be evident that these properties will depend crucially upon the shapes of the indifference curves, and these shapes depend upon the nature of the utility functions and the countries' endowments.[16]

Some important implications follow from the model specification of the previous section and the illustrative examples discussed above. First, if two or more countries are contemplating the formation of a customs union the set of potential customs union outcomes that is relevant to these countries is the set of Pareto optimal utility points F^O denoted by the segment CD in

[16] Elsewhere, the sensitivity of the frontiers to changes in preferences and endowments is analysed further in the context of numerical simulations. See Melatos and Woodland (2003).

the figures above. Every utility point in this set is relevant and a potential outcome. No other utility point on the utility possibilities frontier F is relevant. Second, a convenient algorithm for computing the point on the utility possibilities frontier is to compute the solution to the tariff game, assuming that the customs union chooses its common external tariff by maximizing a social welfare function, for every feasible choice of weights in that function (given by d or by θ in the examples). By varying the weights, points on the efficiency frontier are obtained. Third, as demonstrated vividly by the examples, Pareto optimal points on the frontier may correspond to social welfare functions that have negative weights, d (θ outside the range $[0, 90]$). If attention is restricted to non-negative weights, Pareto efficient contacts for the customs union may be completely ignored. Ignoring such outcomes might lead to the unnecessary rejection of a customs union.

3.2. Delegation of Authority to Set the CET. The idea of focusing upon the Pareto optimal (from the union's point of view) utilities possibilities frontier in the modeling of customs unions, as developed above, is closely related to Gatsios and Karp's (1991, 1995) concept of delegation of authority in setting the common external tariff rates. Their primary contribution was to point out that one member of the customs union may voluntarily relinquish any role in the setting of the common external tariff rate and delegate complete authority for this role to its partner member. By doing so, the union member achieves a higher level of welfare by delegating authority to the partner member than it would attain if it had complete authority. While this may appear paradoxical at first sight, the possibility arises as a result of taking into account the tariff response of the rest of the world.

The Gatsios and Karp principle of delegation of authority is illustrated in Figure 2. In this case, country 2 would gladly relinquish authority to country 1. If it does so, the utility point achieved at A ($\theta = 0$) yields higher utility than country 2 would get at point B ($\theta = 90$).

The delegation of authority does not necessarily apply in every particular case. For example, the delegation principle does not apply in Figures 1 and 6 since point B is north-west of point A; neither point Pareto dominates the other.

While the Gatsios and Karp delegation principle refers to *complete delegation* of authority from one country to another, one can generalize the principle to that of *partial delegation* of authority. In Figure 5, for example, while country 1 is willing to provide complete delegation of tariff-setting authority to country 2 and so move from A to B, country 1 would prefer to option of moving partially along the frontier to point C. At that point, both countries are better off than at A (though country 2 is worse off than at B) and the point is Pareto optimal for the union. Point C corresponds to a weight parameter $\theta = 55$, which implies a weight vector $d = (0.57, 0.82)$. The social welfare function yielding point C is therefore a convex combination of the utility functions of the two union members. Thus, this utility point corresponds to a case of partial delegation of tariff-setting authority.[17]

In Figure 6, neither country would delegate complete authority to the other. Nevertheless, it is in the interest of country 1 to move from the point A to the Pareto superior point C and it can do this by providing a partial delegation of authority to country 2 in the setting of the common external tariff rate. It can do this by volunteering a weighting parameter $\theta = 1 \in (0, 90)$ that gives weight to country 2's utility in the union's social welfare function. This sharing of responsibility for setting the tariff rate is better for country 1 than either country having full control. Similarly, there is a clear advantage to partial delegation from country 2 to country 1, thus moving from B to D, where $\theta = 89 \in (0, 90)$.

[17] Of course, in this example, country 2 has no such incentive to share control.

It is also possible to generalize the concept of delegation by allowing for weights that are negative. In Figure 2, both countries would increase their utility levels if country 2 were to delegate some tariff-setting authority to country 1 by moving from point B to the Pareto efficient utility point E, since point E is Pareto superior to B. At point E the weight parameter is $\theta = -30$, implying a weight vector of $d = (0.866, -0.5)$ that gives negative weight to country 2. This might be termed *super delegation*.

From our current perspective, what is important about Gatsios and Karp's concept of delegation is that it starkly demonstrates that some points on the utility possibilities frontier may be Pareto dominated by other points on the frontier. Delegation moves the union from inefficient utility points to Pareto efficient points on the frontier. Our modeling of the customs union takes this idea further by arguing that it is the set of Pareto efficient points on the frontier that constitutes the set of outcomes that is relevant to the union. In terms of the social welfare function (adopted as a computational device), the attainment of a particular point on that efficient frontier may involve complete delegation ($\theta = 0$ or $\theta = 90$), partial delegation ($0 < \theta < 90$) or super delegation ($\theta < 0$ or $\theta > 90$).

3.3. Comparison with the Existing Literature. As has already been noted, the customs union literature has dealt with the issue of common external tariff choice largely by imposing exogenous choice rules based on intuitive, but seemingly ad hoc, criteria. In Figures 1-6, the main choice rules employed in the literature are implemented and their implied utility points plotted. The social welfare function weights that most closely approximate these rules are also identified. In this way, it is possible to compare the welfare outcome of each rule in terms of their positions vis-à-vis the utility possibilities frontier defined above.

The common external tariff choice rules plotted include:

1. Riezman's (1999) "average" (AVE) rule. According to this rule, the utilities of both member countries are calculated for the two extreme situations in which first one partner and then the other unilaterally chooses the external tariff. The common external tariff agreed to is that which yields, for each partner, their average utility from the two extreme cases.

2. The "complete delegation" (DEL) rule introduced by Gatsios and Karp (1991, 1995) and employed recently by Syropoulos (2002). In this case, the common external tariff is chosen unilaterally by the member assigned authority. That member is the one for which the resulting vector of members' utility is highest.

3. The "proportional GNP" (GNP) rule, variations of which have been used by Perroni and Whalley (2000) and Abrego, Riezman and Whalley (2003). While the former select weights proportional to member GNP, in the latter weights are determined as the share (by value) of each country's endowment in the world endowment. Since both versions of the GNP rule yield similar welfare outcomes in the examples above, only the Perroni and Whalley version is illustrated in Figures 1-6.

4. The "big country" (BIG) rule. The member with the larger GNP chooses the union's tariff rate unilaterally. This rule is used by Kose and Riezman (2003).

Each of these rules for the setting of the common external tariff rate for the union imply non-negative weights in the union's social welfare function and, accordingly, each yields a welfare

outcome between points A and B in Figures 1-6.[18]

From Figures 1-6, the following observations can be made:

1. These rules do not necessarily yield welfare outcomes that are Pareto optimal from the point of view of the customs union. In Figures 2 and 4, none of the rules tested yield utility points on the Pareto efficient segment CD. The GNP rule may select a point on CD (Figures 1 and 6), but it is not always so successful (as in Figure 5). The delegation rule is successful in selecting a Pareto efficient outcome in Figure 5 only. Finally, the AVE rule does not yield a Pareto efficient outcome in any of the examples simulated.

2. The GNP rule always yields a welfare outcome on the interior of the segment AB, since it always implies positive welfare weights for each union member.

3. The AVE rule can yield utility points off the utility possibilities frontier if the segment AB is curved (Figures 4 and 5).

4. The DEL rule is not always applicable. In Figures 1 and 6, complete delegation provides no assistance whatsoever in selecting the union's preferred social welfare function weights.

5. The BIG and DEL rules imply significantly different welfare outcomes in the examples considered. This can be seen in Figure 2, for example. While the delegation rule suggests that country 1 be allocated complete control over the choice of common external tariff, the "big country" rule would insist on Country 2 making the decision unilaterally.

3.4. Implications. As mentioned in the introduction, the common approach to the modeling and computation of equilibrium solutions to tariff games involving customs unions is to assume that (a) one or other of the members has authority to set tariffs or that (b) the union maximizes a social welfare function with arbitrarily chosen, non-negative weights. Our examples and the above discussion raises questions about the wisdom of such approaches. The demonstration by Gatsios and Karp that one country might wish to provide complete delegation of tariff-setting authority to another partner implies that an arbitrary choice of member to set tariffs is problematic. Our results go further and imply that (a) partial delegation might be Pareto optimal and (b) that partial delegation (non-negative weights) may not yield utility points that are Pareto optimal. This suggests that approaches such as the averaging method of Riezman (1999) or the use of GNP share weights by Perroni and Whalley (2000) or the use of endowment share weights by Abrego, Riezman and Whalley (2003) are also potentially problematic.

4. Conclusions

The issue of how customs union members design their trade agreement had not attracted much attention in the literature. Moreover, existing models used in research on customs unions provide several different mechanisms for the determination of a customs union's common external tariffs. This paper has focussed on this issue and, in particular, upon the modeling of a customs union agreement as a trade policy contract that specifies how its signatories interact with each other and the rest of the world.

In this paper, it has been argued that prospective customs union members are confronted by a menu of possible contracts each of which is associated with a particular common external tariff vector and a particular utility vector for the union. Prospective members will only agree to join the union if they will be better off than at the initial stand-alone situation and, if a union

[18] In Figures 1-6, the GNP and BIG rules are implemented by measuring country GNP at world prices at the unilateral tariff setting equilibrium.

is formed, members will choose a contract that yields a utility vector that is Pareto optimal from the point of view of the union. Any such Pareto optimal point is an acceptable outcome. Bargaining over all Pareto optimal outcomes can yield a unique solution.

This approach yields some surprising results. Recently, it has become more common to assume that the common external tariff vector is chosen to maximize a social welfare function. Here we use the concept of a social welfare function as a computational device to generate the utility possibilities frontier for the union by systematically varying the national weights. It turns out that non-negative weights are neither necessary nor sufficient for the resulting utility point to be Pareto optimal for the customs union. Accordingly, models that employ arbitrarily chosen non-negative weights may yield Pareto inefficient outcomes and ignore Pareto optimal outcomes. In doing so, they may accept customs union that members would not choose on our more general context or, conversely, ignore others that would be acceptable in our framework.

The simulation examples have shown how variations in member preferences (via the elasticity of substitution) can have a marked effect on the position and shape of the utility possibilities frontier in the context of a simple endowments model. In a more general framework, in which endowments and production technologies were varied, it would be expected that the relationship between preferences, technologies and endowments on the one hand and the utility possibilities frontier on the other hand would become very complex.

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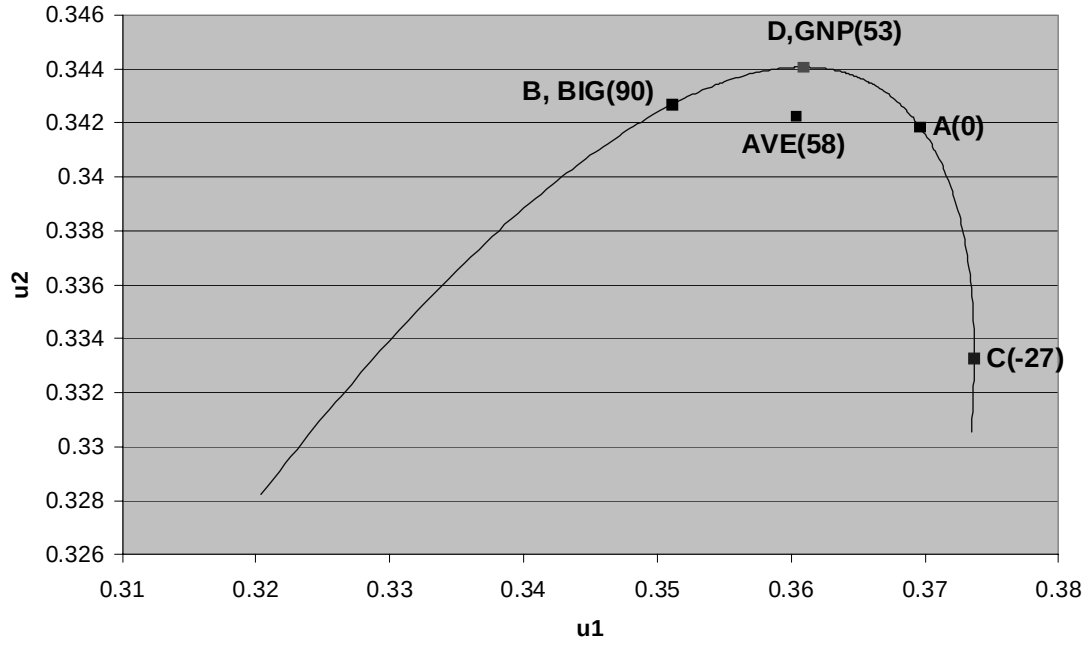

Figure 1: Utility Possibilities Frontier for Customs Union $CU(1,2)$, $\sigma_1 = 0.5$

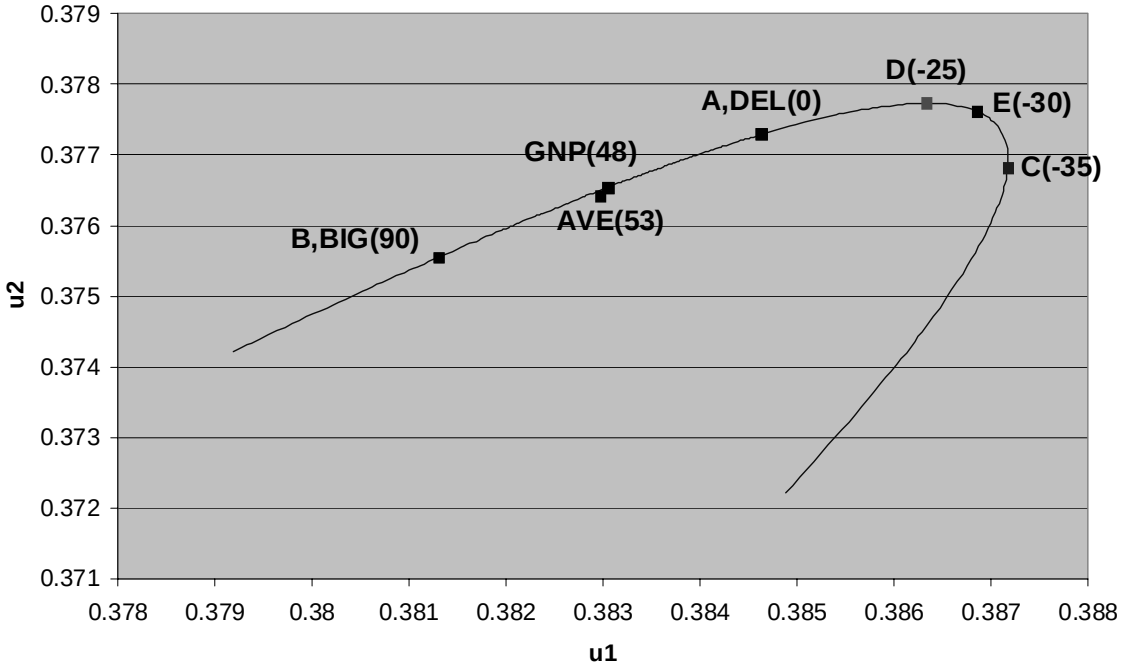

Figure 2: Utility Possibilities Frontier for Customs Union $CU(1,2)$, $\sigma_1 = 0.8$

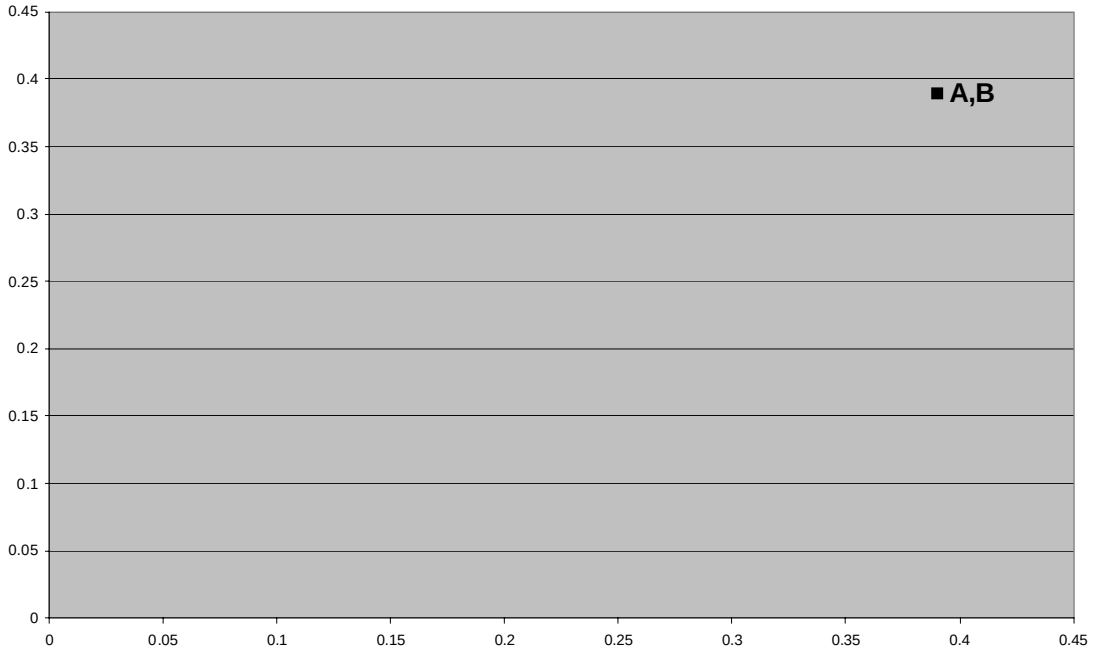

Figure 3: Utility Possibilities Frontier for Customs Union $CU(1,2)$, $\sigma_1 = 0.99$

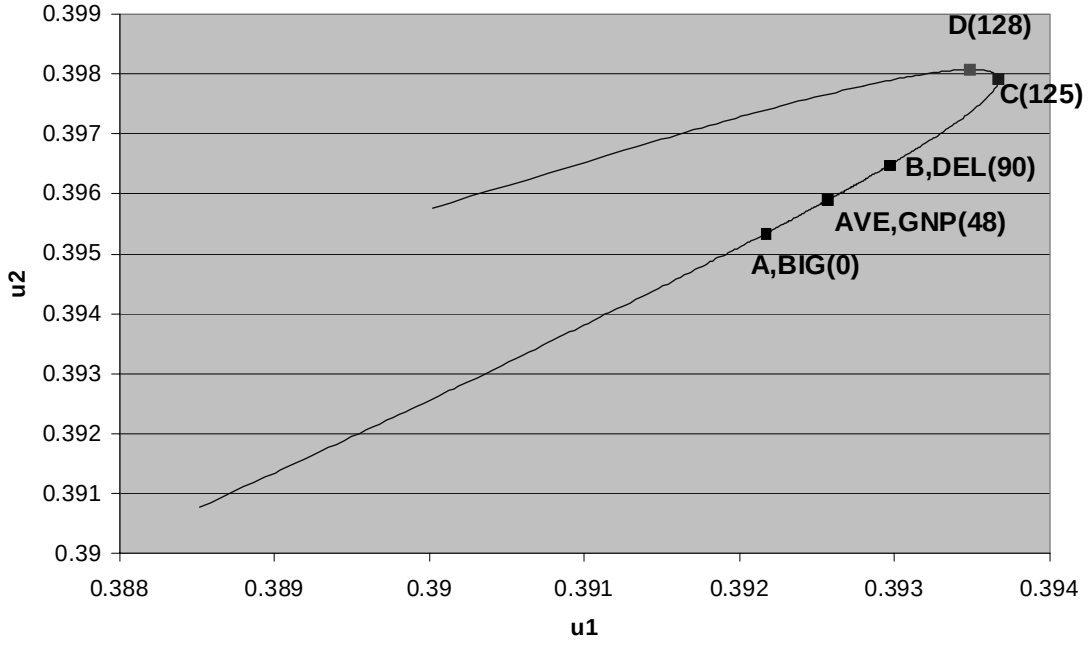

Figure 4: Utility Possibilities Frontier for Customs Union $CU(1,2)$, $\sigma_1 = 1.1$

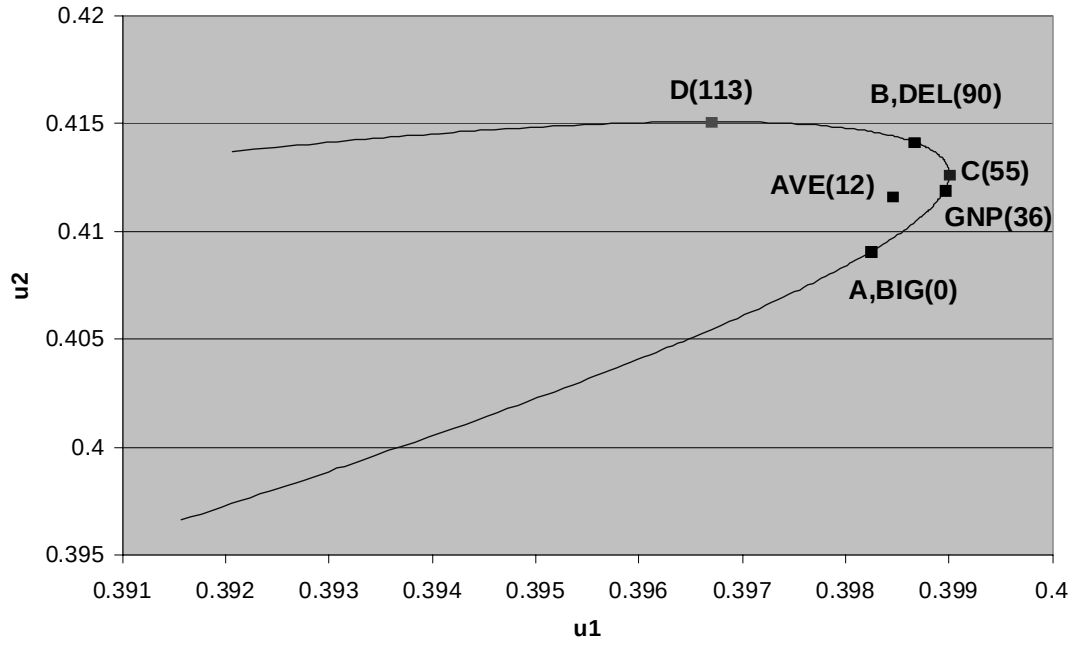

Figure 5: Utility Possibilities Frontier for Customs Union $CU(1,2)$, $\sigma_1 = 1.5$

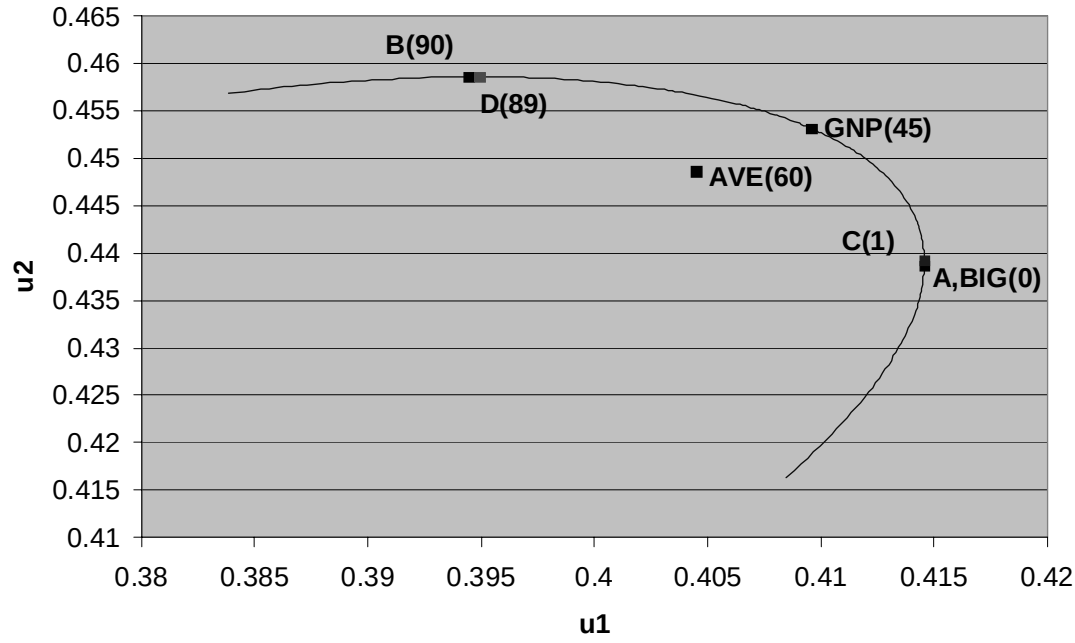

Figure 6: Utility Possibilities Frontier for Customs Union $CU(1,2)$, $\sigma_1 = 4.6$