

**Working Paper
459**

**DELEGATION IN CUSTOMS
UNION FORMATION**

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December 2014

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ABSTRACT

This paper deals with the issue of delegation between potential member countries while forming a Customs Union (CU) under a vertically differentiated monopoly in a three country world. Under universal market coverage, CU formation can be sustained with both the member countries preferring CU over setting tariff unilaterally and non-cooperatively but differing in the choice of the member being delegated the tariff-setting power. However, if the country with smaller relative taste diversity is smaller in size, then CU formation can't be sustained as a unique NE since both will prefer to set tariffs unilaterally and non-cooperatively over delegating the tariff-setting power and form a CU.

Keywords: Customs Union, Delegation, Vertically Differentiated Monopoly, Endogenous Quality, Taste Diversity.

JEL Classification: F12, F15, L12.

1 Introduction

Regional trading blocs have proliferated in recent times regardless of the geographical proximity or neighbourhood effect among member countries. However, customs unions (CUs) are less in number than free trade areas (FTAs) given the requirement of greater degrees of commitment and policy coordination among the member countries¹. This requirement emanates from the fact that CUs unify and align trade policies of the union members vis-à-vis the rest-of-the-world in the best interest of the union members as a whole. Such a policy commitment, say in terms of common external tariff (CET), may be advantageous for smaller member countries, which may have very little market power in trade to influence the terms of trade in their favour by imposing unilateral tariffs.

Such requirement of unified policy decision on part of all the members of a CU regarding the joint tariff setting exercise (or any other trade policy decision) raises the crucial question of who sets the CET – whether such decision should be delegated to a supra-national agent who maximizes joint welfare or to an aggressive potential member who maximizes her own welfare. In absence of a supra-national agent, and more importantly, when side-payments

¹ There are 17 CUs and 232 FTAs in force as reported to the WTO till 15th June, 2014. A detailed list of all trade blocs is provided in the WTO RTA Database. <http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx>

among potential CU members are not feasible, delegation issue becomes a crucial element in the formation of a CU.

In the earlier literature on CU formation, this issue had been bypassed through the assumption that the members are symmetric or identical [Krugman (1991), Bond and Syropoulos (1996)]. In Riezman (1985), Kennan and Riezman (1990) and Kose and Riezman (2002), one of the partners is ex-ante assigned the role of policy maker (PM) to choose the common external tariff for the union.

Gatsios and Karp (1991), on the other hand, demonstrated that in a strategically competitive environment, it may be in the best interest of a member country to delegate the tariff-setting power to the more aggressive member. In a homogeneous-good setting with Cournot-firms belonging to the member countries and producing only for the export markets in the rest of the world, the aggressive country emerges to be the one having the more cost-efficient (and hence, technologically advanced) firm. In an extension of this analysis to a general equilibrium setting, Gatsios and Karp (1995) used the framework of an exchange economy to show that the delegation decision depends on the endowment of the export good of the countries and whether tariffs are strategic substitutes or compliments. Syropoulos (2002) further extended the analysis to a Heckscher-Ohlin-Samuelson (HOS) framework with production and showed that welfare ranking of CETs, and consequently the optimal PM, is related to the compensated price elasticities of import demand functions. The least aggressive union member would be the one with the largest compensated price elasticity of import demand. Melatos and Woodland (2007) construct a mechanism for the choice of common external tariff using the Pareto principle and the assumption of unanimity. They construct complete utility possibility frontiers accommodating both “partial” and “super” delegation in addition to “complete” delegation *a la* Gatsios and Karp (1991)². They show that

² Under “partial” delegation the member countries will partially delegate the tariff

“super” delegation may Pareto dominate “complete” delegation. Melatos and Woodland (2009) compare welfare levels of countries under CU and FTA regime and establish that the country with relatively higher endowment of the export good or that with relatively inelastic preferences will take the lead role in setting the CET.

Thus, it is evident that the existing literature focused on either cost (and hence, technology) asymmetry among firms across member countries [Gatsios and Karp (1991)] or on relative differences in endowments [Gatsios and Karp (1995), Syropoulos (2002), Melatos and Woodland (2009)]. However, we believe that technology transfer is quite commonplace nowadays, not only because of the presence of multi-national corporations (MNCs) doing business across the globe, but also due to institutional regulations³ as well. Moreover, in a world that is predominantly converging towards modular production pattern⁴, coupled with ever increasing international mobility of financial capital, the decisive role of endowments⁵ has also been somewhat reduced. However, diversity in consumers’ tastes and preferences still remain an important factor deciding both volume and pattern of trade. This demand side of the story has not been explicitly addressed in the existing literature on delegation in customs union.

This paper makes an attempt to incorporate this demand side of the problem. In the context of delegation in CU formation, we try to analyze the crucial role that diversity of consumer tastes might play in differentiating potential union members. There are several points of

setting power to one of them while under “super” delegation even negative weights may be assigned to some of the members while the CET is chosen. However, the concept of “super” delegation is feasible as Melatos and Woodland (2007) do not rule out the option of side-payments across union members.

³ For example, the Intra-EU Transfer Directive 2009/43/EC, which enables technology transfer across EU member states, has already been implemented since June 30, 2012.

⁴ See Krugman (2008).

⁵ International mobility of labour (particularly) in the high-skill cohort is increasing rapidly. Net international migration to developed regions has increased from 2.5 million per year in 1990-2000 to 3.5 million per year in 2000-2010 (International Migration Report, 2013).

departure from the existing literature in this paper that are intended to examine the robustness of the results obtained so far. The analyses are made using a model of vertically differentiated monopoly in a three-country world economy.

First, we focus on home market characteristics in terms of taste diversity among consumers both within and across members. To do so, we assume that population in each country is distributed over two discrete types of consumers. Allowing for consumer heterogeneity in all the markets helps us to identify and quantify the welfare differences that a potential member of the union might face under CU vis-à-vis the situation where they impose tariffs unilaterally. In fact, the delegation decision of a potential union member would directly affect the CET that the union might impose on their imports from the ROW and hence, the surplus accruing to the consumers located in the member countries and in turn the respective national welfare levels. Thus, asymmetry in taste arising from marginal willingness-to-pay differentiates the potential union members in their respective levels of aggression while setting the CET. This is in contrast to the cost (and hence, technology) asymmetry among firms across member countries and export market focus of Gatsios and Karp (1991) or relative differences in endowment of Gatsios and Karp (1995), Syropoulos (2002) and Melatos and Woodland (2009).

Moreover, the presence of heterogeneous consumers allows the monopolist firm to choose the degree of coverage in its export markets. Such a decision on the part of the monopolist firm has far reaching implications for the issue of delegation. For example, when a member country's market is partially covered, it can emerge as a more aggressive tariff-setter because it is no longer concerned with the fact that higher rates of tariff might be detrimental to the quality of the commodity it imports (and, that will be binding on the other union members as well). It could not have ignored such a possibility had its market been fully covered.

Second, the model considers a quality differentiated good being produced in the rest-of-the-world (ROW) which is imported under a CET by the union members. The level of quality is endogenously chosen by the producer of that vertically differentiated good (the monopolist located in the ROW). A higher tariff set by the union acts as a disincentive to higher quality levels and, hence, creates a tension between tariff setting power of an aggressive member and welfare of the union members.

Finally, the paper examines the delegation issue in the context of deciding whether to form a CU or not. The outside option for potential member countries considered here is unilateral and non-cooperative tariffs imposed by them on the import of the quality differentiated good [similar to the stand-alone situation of Melatos and Woodland (2007)].

The welfare levels attained thereby constitute the reservation payoffs for countries in the delegation game in formation of the CU. These issues are examined in a non-cooperative delegation game between two potential member countries. Each country has two policy options: setting its own welfare maximizing tariff or delegating the tariff-setting power to the other member. The point of concern is, once the CET is set, it is binding on all union members, irrespective of who sets it. Optimal strategies are chosen simultaneously. Hence, we look for the Nash Equilibrium of the delegation game. Here, I have used the results of Ghosh and Acharyya (2012) who examined the feasibility of forming a CU when a supra-national agent maximizes the union's welfare to set the common external tariff.

The main results that are derived here are as follows. Under universal market coverage, CU formation can be sustained depending on relative sizes of the potential union members. If the size of the country with smaller intra-country taste diversity is larger or equal to that of the country with relatively higher intra-country taste diversity then, both the member countries will prefer CU over setting tariff unilaterally and non-cooperatively. However, they will differ in the

choice of the member being delegated the tariff-setting power. Otherwise no CU formation can be sustained as a unique NE since both will prefer setting tariffs unilaterally and non-cooperatively to delegating the tariff-setting power and form a CU. Under partial market coverage, formation of a CU by delegating the tariff-setting power to any union member cannot be sustained.

The rest of the paper is organized as follows. In section 2 we describe the model and pre-union non-cooperative global equilibrium in section 3. Section 4 considers the delegation issue and derives the main results under full market coverage. In section 5 we consider the other relevant market coverages. Finally, section 6 summarizes the results followed by appendices.

2 The Model

Consider a three country world – the countries are labeled P, M and R with population sizes being N_P , N_M and N_R respectively. All the countries consume and export a homogeneous good X . This good is produced under constant returns-to-scale technology and perfectly competitive conditions. It can be treated as the numeraire good. The constant cost of producing this good is normalized to one. It is traded freely around the world with marginal utility equal to one. These countries also consume a quality differentiated good Z , produced and exported by a monopolist in country R. The quality of this good, indexed by s , is developed by the monopolist by investing an amount c in research and development (R&D). This R&D cost is sunk in nature and is convex in the level of quality being developed:

$$c = \frac{1}{2}s^2 \quad (1)$$

Population in each country is distributed over two discrete types of consumers⁶. The types are defined by the taste parameter or the

⁶ This assumption of heterogeneous consumers is the source of intra-country taste diversity [see Ghosh and Acharyya (2012)].

marginal willingness-to-pay (MWP) for the quality differentiated good. In particular, let α_{1j} and α_{2j} with $\alpha_{2j} > \alpha_{1j}$ ($j = P, M, R$) denote the two types of buyers in country- j . The number of buyers of each type is n_{ij} ($\forall i = 1, 2; j = P, M, R$), such that, $n_{1j} + n_{2j} = N_j$. Each buyer buys, if at all, only one unit of the good and derives gross utility of $u(\alpha_{ij}, s)$. Following the literature on endogenous quality choice [Tirole (1989), Mussa and Rosen (1978), Acharyya (1998, 2005)], suppose the “net” utility derived from consuming the good is additively separable in quality and price. To obtain closed form solutions we further assume a quasi-linear specification:

$$V_{ij} = \alpha_{ij}s - P_j \quad (2)$$

where, P_j is the price charged by the innovator in country- j .

We assume that taste parameters vary across countries⁷ and parallel import of the quality differentiated (one can assume that to be protected by patent) good Z is not allowed⁸. This creates scope for the monopolist belonging to country- R to price discriminate across different country markets. However, since there are no production costs whatsoever and the R&D cost is sunk, following Acharyya (1998), there is no scope for quality discrimination. Hence, a uniform quality will be offered to all countries, though, market in each country may not be fully covered.

Suppose the reservation utility of each buyer is zero. Hence, referring back to (2), a buyer of type α_{1j} will participate in the market if

$$V_{ij} \geq 0 \quad (3)$$

⁷ It is sufficient to assume that $\alpha_P < \alpha_M < \alpha_R$ where $\alpha_j = \frac{n_{1j}}{N_j}\alpha_{1j} + \frac{n_{2j}}{N_j}\alpha_{2j} \forall j = P, M, R$

⁸ Cross-country price discrimination of price is feasible as parallel import of the innovated good is not allowed from the low price markets. Else, had parallel imports been allowed, arbitrage would lead to price convergence across all the markets. See Maskus (2001) for a survey of parallel imports (distinguished from illegal imports) in health-care goods and other copyright-protected goods.

Here the tie-breaking rule that is applied is if a buyer is indifferent between buying and not buying, then she buys the good.

So far the pricing is concerned, if the monopolist serves both types in market- j , by the individual rationality constraint (3), it sets a price $P_j = \alpha_{ij}s$ to extract all surpluses from the low-type buyers. This, however, leaves the high-type buyers with a strictly positive net surplus $(\alpha_{2j} - \alpha_{1j})s > 0$. But, if the firm serves only the high-type, it sets a price $P_j = \alpha_{2j}s$. The monopolist serves both types (in other words, opts for full market coverage) if⁹

$$\frac{n_{1j}}{n_{2j}} > \frac{\alpha_{2j} - \alpha_{1j}}{\alpha_{1j}} \quad (4)$$

We begin with the case of universal full coverage, that is, distribution of buyers satisfying condition (4) for all markets. The other combinations of partial and full coverages of markets are considered later.

3 Pre-CU Global Equilibrium

We begin with a global trade scenario where no trading bloc is formed and the countries unilaterally and non-cooperatively set tariff on imports. Since, we do not explicitly model the homogeneous good, so only the tariffs imposed by P and M on imports of the quality-differentiated good from R are relevant here. Suppose both P and M impose ad-valorem tariffs at the rates t_P and t_M respectively on the import of Z. The profit function of the monopolist is then

$$\pi(t_P, t_M) = [(1-t_P)N_P\alpha_{1P} + (1-t_M)N_M\alpha_{1M} + N_R\alpha_{1R}]s^* - \frac{1}{2}(s^*)^2 \quad (5)$$

where, s^* denotes the endogenous level of quality at the non-cooperative tariff-restricted global trade equilibrium.

Pre-union, countries set their respective non-cooperative tariff rates by maximizing their respective national welfares. Welfare of country- j

⁹ See Acharyya (2005), Ghosh and Acharyya (2012).

is composed of net surplus of the high-type buyers and the tariff revenue:

$$W_j = (\alpha_{2j} - \alpha_{1j})s + t_j N_j \alpha_{1j} \quad \forall j = P, M \quad (6)$$

For any given pair of non-cooperative tariffs set by P and M, the monopolist chooses the profit maximizing quality level $s^*(t_P, t_M)$. For such $s^*(t_P, t_M)$, each country maximizes welfare $W_j(t_P, t_M)$, $i \neq j$, given the other country's tariff. The optimum non-cooperative tariff rates, quality and welfare levels are as follows¹⁰:

$$t_P^* = \frac{1}{3\alpha_{1P}N_P} [G - 2n_{2P}(\alpha_{2P} - \alpha_{1P}) + n_{2M}(\alpha_{2M} - \alpha_{1M})] \quad (7)$$

$$t_M^* = \frac{1}{3\alpha_{1M}N_M} [G - 2n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})] \quad (8)$$

$$s^* = \frac{1}{3} [G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})] \quad (9)$$

$$\tilde{W}_P = \tilde{W}_M = (s^*)^2 \quad (10)$$

where, $G = \sum_j N_j \alpha_{1j} \quad \forall j = P, M, R$.

We now move to the formation of CU under alternative delegation rules.

4 Formation of CU

Suppose P and M decide about forming a CU which in this framework imply setting a common tariff on imports of Z from R. Lets define the welfare of country- j under CU when country- i is the PM as $\tilde{W}_{CU,j}^i$ and the common external tariff as \tilde{t}_{CU}^i . Therefore, when country M is chosen as the PM, it sets the CET as the one that maximizes its own welfare:

¹⁰ See Ghosh and Acharyya (2012).

$$\frac{\partial \tilde{W}_{CU,M}^M}{\partial t_M} = 0 \Rightarrow \tilde{t}_{CU}^M = \frac{1}{2\alpha_{1M}N_M\gamma}[\alpha_{1M}N_M(G-m) - m\alpha_{1P}N_P] \quad (11)$$

where, $m = n_{2M}(\alpha_{2M} - \alpha_{1M})$, $\gamma = (\alpha_{1P}N_P + \alpha_{1M}N_M)$.

If, on the other hand, Country P was chosen as the PM, the CET would be:

$$\frac{\delta \tilde{W}_{CU,P}^P}{\delta t_P} = 0 \Rightarrow \tilde{t}_{CU}^P = \frac{1}{2\alpha_{1P}N_P\gamma}[\alpha_{1P}N_P(G-p) - p\alpha_{1M}N_M] \quad (12)$$

where, $p = n_{2P}(\alpha_{2P} - \alpha_{1P})$.

As shown in the appendix, if t_{CU}^* denotes the CET when a supra-national agent is delegated the tariff setting power, then tariffs under alternative delegations can be ranked as $\tilde{t}_{CU}^M < t_{CU}^* < \tilde{t}_{CU}^P$ if the following condition holds:

$$\frac{(\alpha_{2M} - \alpha_{1M})}{\alpha_{1M}}n_{2M} > \frac{(\alpha_{2P} - \alpha_{1P})}{\alpha_{1P}}n_{2P}\frac{N_M}{N_P} \quad (13)$$

But if condition (13) is reversed, then we have $\tilde{t}_{CU}^M > t_{CU}^* > \tilde{t}_{CU}^P$. Thus, the more aggressive country would be the one having smaller relative taste dispersion in the sense defined in (13). This highlights the role of taste diversity and willingness-to-pay in contrast to cost efficiency of firms [as in Gatsios and Karp (1991)] or endowment of export good [as in Gatsios and Karp (1995)] in determining an aggressive country. The size of the population matters only when $N_M < N_P$. This taste diversity condition along with population sizes has far reaching implications in decisions regarding delegation and CU formation.

Now consider the following delegation game. Both the players (in this case countries P and M) have the same strategy set – propose self (S) and delegate (D). If both choose S or D, the non-cooperative payoffs are obtained and hence, CU formation can't be sustained. However, if one chooses S and the other chooses D, then, formation of CU can be sustained with delegation. The country playing strategy S will become the PM and set the CET that maximizes its own national welfare while

Figure 1: Pay-off Matrix

		P	
		Self	Delegate
M	Self	\tilde{W}_M, \tilde{W}_P	$\tilde{W}_{CU,M}^M, \tilde{W}_{CU,P}^M$
	Delegate	$\tilde{W}_{CU,M}^P, \tilde{W}_{CU,P}^P$	\tilde{W}_M, \tilde{W}_P

the one playing D will accept the CET set by the PM. Countries choose their strategies simultaneously. The pay-off matrix for simultaneous-move delegation game is shown in Figure 1.

As evident from the pay-off matrix, when both choose either S or D, formation of CU with delegation is not feasible and each ends up with the pay-off \tilde{W}_i ($i = P, M$). However, if the strategy pairs (S, D) or (D, S) are played, then the PM ends up with the pay-off $\tilde{W}_{CU,i}^i$ ($i = P, M$) and the other member ends up with $\tilde{W}_{CU,j}^i$ ($i, j = P, M; i \neq j$).

Now, the following welfare rankings under alternative delegation possibilities and under non-cooperative tariff setting can be verified from appendix.

$$\tilde{W}_{CU,M}^M > \tilde{W}_{CU,M}^P \quad (14a)$$

$$\tilde{W}_{CU,P}^P > \tilde{W}_{CU,P}^M \quad (14b)$$

Such a welfare ranking (as given in 14a and 14b) is intuitively straightforward. If a CU is formed, then either of the countries will be better off by becoming the PM itself vis-à-vis delegating the tariff setting power to the other country as the PM country chooses the common external tariff by maximizing its own welfare. Since, countries are asymmetric, so a tariff that maximizes country- i 's welfare does not maximize country- j 's welfare. However, the welfare of country- j under CU (that is both $\tilde{W}_{CU,j}^j$ and $\tilde{W}_{CU,j}^i$) may not be

greater than the welfare under stand-alone situation (\tilde{W}_j). Figure 2 provides some simulation results to illustrate that these welfare rankings depend on the relative extent of intra-country taste diversity of the potential CU members. To fix the idea, suppose the extent of taste diversity in country-M is larger than that in country-P in the following sense:

$$n_{2M}(\alpha_{2M} - \alpha_{1M}) > n_{2P}(\alpha_{2P} - \alpha_{2P}) \quad (15)$$

Note that for equal-sized countries ($N_P = N_M$) and the same value of the lowest taste parameter ($\alpha_{1P} = \alpha_{1M}$), condition (13) stated earlier boils down to condition (15). All the simulation results are based on this assumption (15). In simulation results we distinguish between three cases: all countries have the same population sizes, as illustrated in Figure 2; country-P has a larger population size than country-M (as illustrated in Figure 4 in the appendix) and country-M has a larger population size than country-P (as in Figure 5 in the appendix). In all the cases, however, we assume that $\alpha_{1P} = \alpha_{1M} = \alpha_{1R} = 1$.

In Figure 2 we plot four curves for relevant welfare rankings: $\tilde{W}_{CU,M}^M = \tilde{W}_M$, $\tilde{W}_{CU,M}^P = \tilde{W}_M$, $\tilde{W}_{CU,P}^M = \tilde{W}_P$ and $\tilde{W}_{CU,P}^P = \tilde{W}_P$. Given assumption in (15), the relevant regions are I, II, III and IV as being stated.

Given this, what can be observed is that for equal-sized partners, if, the extent of taste diversity in country-M is slightly larger than the same in country-P (such that we are in Region III of figure 2), then using (14a) and (14b) we have the following welfare ranking¹¹:

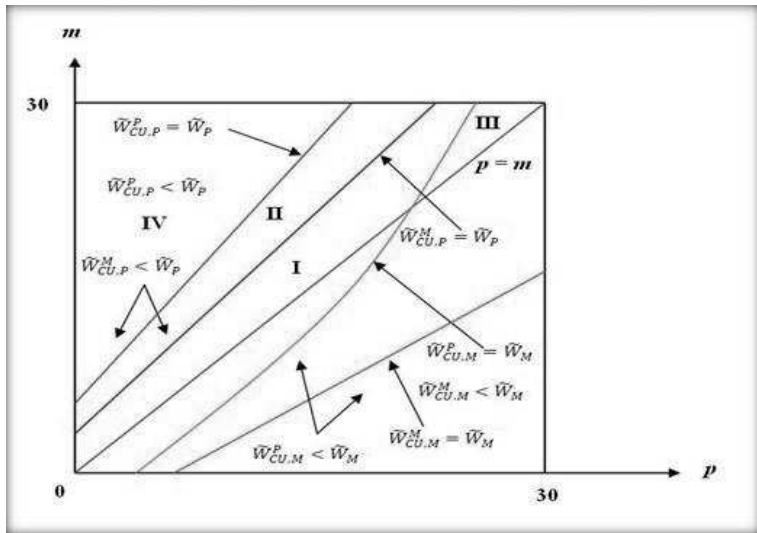
$$\tilde{W}_{CU,P}^P > \tilde{W}_{CU,P}^M > \tilde{W}_P \quad (16a)$$

$$\tilde{W}_{CU,M}^M > \tilde{W}_M > \tilde{W}_{CU,M}^P \quad (16b)$$

Given (14a), (14b), (16a) and (16b) it is easy to check that CU formation with country-M being delegated, that is strategy (S, D), turns out to be

¹¹ See appendix A.3.

Figure 2: Simulated Welfare Rankings ($N = 90$; $N_P = N_M = N_R = 30$)



the unique NE. The pay-off matrix for Region III of Figure 2 clarifies this claim.

Such a NE is associated with lower CET than if country-P had been delegated [as $\tilde{t}_{CU}^M < \tilde{t}_{CU}^P$ given condition (13)]. Consequently, the level of quality associated is also higher.

However, if the extent of taste diversity in country-M is moderately larger than that in country-P (such that we are in Region I of Figure 2), both will prefer delegating the tariff-setting power to the other over setting it non-cooperatively. We thus have a property of the delegation game similar to the Battle of Sexes – it is optimal for each country to accept the tariff set by the other rather than setting its own tariff non-cooperatively.

When the extent of taste diversity in country-M is even more large than that in country-P (such that we are in Region II of Figure 2), strategy (D, S), that is, CU formation with country-P being delegated, turns out to be the unique NE. Note that in this case the CU results in a

Figure 3: Pay-off Matrix for Region III

		P	
		Self	Delegate
M	Self	$\tilde{W}_M ; \tilde{W}_P$	$\tilde{W}_{CU,M}^M ; \tilde{W}_{CU,P}^M$
	Delegate	$\tilde{W}_{CU,M}^P ; \tilde{W}_{CU,P}^P$	$\tilde{W}_M ; \tilde{W}_P$

higher common external tariff than when M is delegated the tariff-setting authority. This would result in a lower quality of the good since higher tariff lowers the marginal revenue from exports by the monopolist. Welfare on this account falls for both the potential members. But, as specified earlier, welfare of the potential members also have the tariff revenue component. In this instance, the higher tariff brings in higher revenue that compensates for the welfare loss from lower quality.

It is worth mentioning here that same results are obtained when we consider the simulation results using different values of total population size (N) and its symmetric distribution over the countries.

Turning to the cases of the members being asymmetric in population size¹², similar results are obtained for the case $N_P > N_M$. However, when $N_P < N_M$, no CU formation may be sustained as a unique NE. Detailed results are reported in Table 1 given below.

Proposition 1 *Given (15), the CU formation and delegation of tariff-setting authority depends on both the sizes of the potential members and the extent to which taste diversity in country-M is larger than that in country-P. More precisely we have the following results:*

- (i) $N_P < N_M$: No CU will be formed.

¹² See figures 4 and 5 given in the appendix.

- (ii) $N_P \geq N_M$: CU may be formed when taste diversity in country-M is slightly larger than that in country-P, with country-M being delegated the tariff-setting power. However, when taste diversity in country-M is moderately or significantly larger than that in country-P, then at the unique NE, country-P will be delegated.

Proof: Follows from the above discussion and Table 1.

Table 1: Summary of NE and Properties

Relative Populations Sizes of the Potential Members	Region: Cross-country Taste Diversity Difference ($m - p$)	NE and Properties
$N_P = N_M$	III: Low	Unique NE: (S, D) with lower common external tariff and higher quality.
	I: Moderate	Multiple NE: (S, D) and (D, S).
	II: Significant	Unique NE: (D, S) with higher common external tariff and lower quality.
$N_P > N_M$	I: Low	Unique NE: (S, D) with lower common external tariff and higher quality.
	II: Moderate	Multiple NE: (S, D) and (D, S).
	III: Significant	Unique NE: (D, S) with higher common external tariff and lower quality.
$N_P < N_M$	I: Low	Unique NE: (S, S) hence no CU will be formed.
	II: Moderate	NE does not exist.

$$m = (\alpha_{2M} - \alpha_{1M})n_{2M}, p = (\alpha_{2P} - \alpha_{1P})n_{2P}$$

5 Robustness

To check robustness, we now consider the cases of partial market coverage by the monopolist. Two cases are of particular relevance in

the present context – one is where country-P market is not fully covered and the other where country-M market is not fully covered.

First, we consider the case where the market of country-P is not fully covered but that of country-M is fully covered by the monopolist. Relevant calculations reveal that the following welfare rankings hold unambiguously:

$$\tilde{W}_{CU,P}^M < \tilde{W}_{CU,P}^P < \tilde{W}_P \quad (17a)$$

$$\tilde{W}_{CU,M}^M > \tilde{W}_{CU,M}^P > \tilde{W}_M \quad (17b)$$

Exactly diametrically opposite results are obtained in the case where the market of country-M is not fully covered but that of country-P is fully covered by the monopolist. Here we find that

$$\tilde{W}_{CU,P}^P > \tilde{W}_{CU,P}^M > \tilde{W}_P \quad (18a)$$

$$\tilde{W}_{CU,M}^P < \tilde{W}_{CU,M}^M < \tilde{W}_M \quad (18b)$$

Hence, as evident from the above equations, no NE can be reached in both the cases of partial market coverage by the monopolist.

Proposition 2 *CU formation by delegating the tariff-setting power to any union member cannot be sustained as a NE under partial market coverage.*

Proof: Follows from (17a)–(18b).

6 Conclusion

Formation of CUs involves greater degree of coordination and commitment among union members vis-à-vis formation of FTAs. In the absence of any supra-national agent and possibilities of side-payments among the union members, delegation of policy formulation becomes very crucial. This paper analyzes the effect of a delegation game between potential union members in the context of

formation of a CU under a vertically differentiated monopoly in a three country world.

Under universal market coverage, CU formation can be sustained as a NE of the delegation game depending on the relative sizes of the potential union members. When the size of the country with smaller intra-country taste diversity is larger or equal to that of the country with relatively higher intra-country taste diversity, CU formation with delegation can be sustained as a NE. The member setting the lower CET will be delegated the tariff-setting power when its taste diversity is not significantly higher than that in the other member country. When its taste diversity is significantly higher then, CU formation with the other member being delegated can be sustained as a unique NE. However, both the member countries prefer CU over setting tariff unilaterally and non-cooperatively but differ in the choice of the member being delegated. This might raise the possibility of generating multiple equilibria. Such a result corroborates to the proposition of Burtraw (1992) who established that in a Nash bargaining model multiple equilibria result with strategic delegation.

However, if the country with smaller relative taste diversity, as defined in (13), is smaller in size, then no CU formation can be sustained as a unique NE since both will prefer to set tariffs unilaterally and non-cooperatively over delegating the tariff-setting power and forming a CU.

Under partial market coverage, CU formation by delegating the tariff-setting power to any union member cannot be sustained.

The above results do indicate that formation of CU with delegation might be feasible under certain restrictive conditions. Otherwise, there exist either multiple equilibria (and hence, there does not exist any unique NE) or formation of CU is not feasible at all. However, such a finding is not surprising given the overwhelming dominance of FTAs and miniscule presence of CUs in the global economic order.

Appendices

A.1 Tariff Rankings

From (11) we have

$$\tilde{t}_{CU}^M = \frac{1}{2\alpha_{1M}N_M\gamma}[\alpha_{1M}N_M(G - m) - \alpha_{1P}N_Pm]$$

where, $p = n_{2P}(\alpha_{2P} - \alpha_{1P})$, $\gamma = (\alpha_{1P}N_P + \alpha_{1M}N_M)$ and $G = \sum_j N_j\alpha_{1j} \forall j = P, M, R$. From (12) we have

$$\tilde{t}_{CU}^P = \frac{1}{2\alpha_{1P}N_P\gamma}[\alpha_{1P}N_P(G - p) - \alpha_{1M}N_Mp]$$

where, $m = n_{2M}(\alpha_{2M} - \alpha_{1M})$.

Had there been a supra-national agent, the common external union tariff obtained by joint welfare maximization¹³ of the union members turns out to be

$$t_{CU}^* = \frac{1}{2\gamma}(G - p - m) \quad (A1)$$

Comparing (11) and (A1) we have

$$\tilde{t}_{CU}^M - t_{CU}^* = \frac{1}{2\alpha_{1M}N_M\gamma}(\alpha_{1M}N_Mp - \alpha_{1P}N_Pm) \quad (A2)$$

Now from (A2) and using (13), we have

$$\tilde{t}_{CU}^M - t_{CU}^* < 0 \quad (A3)$$

Similarly comparing (12) and (A1) and using (13) we have

$$\tilde{t}_{CU}^P - t_{CU}^* = \frac{1}{2\alpha_{1P}N_P\gamma}(\alpha_{1P}N_Pm - \alpha_{1M}N_Mp) > 0 \quad (A4)$$

Hence, from (A3) and (A4) we have the unique ranking of tariffs to be

$$\tilde{t}_{CU}^M < t_{CU}^* < \tilde{t}_{CU}^P \quad (A5)$$

¹³ See Ghosh and Acharyaa (2012) for a complete derivation.

A.2 Proof of (14a) and (14b)

From (11) we have

$$\tilde{t}_{CU}^M = \frac{1}{2\alpha_{1M}N_M\gamma}[\alpha_{1M}N_M(G - m) - m\alpha_{1P}N_P]$$

The ensuing level of quality turns out to be

$$\tilde{s}_{CU}^M = \frac{1}{2} \left(G + \frac{\gamma}{\alpha_{1M}N_M} m \right) \quad (\text{A6})$$

Hence, the welfare of country-M when it is the PM turns out to be

$$\tilde{W}_{CU,M}^M = (\alpha_{1M}N_M\tilde{t}_{CU}^M + m)\tilde{s}_{CU}^M = \left[\frac{\alpha_{1M}N_M G^2}{4\gamma} + \frac{Gm}{2} + \frac{\gamma m^2}{4\alpha_{1M}N_M} \right] \quad (\text{A7})$$

Similarly, the welfare of country-M when country-P is the PM is

$$\begin{aligned} \tilde{W}_{CU,M}^P &= (\alpha_{1M}N_M\tilde{t}_{CU}^P + m)\tilde{s}_{CU}^M \\ &= \left[\frac{\alpha_{1M}N_M G^2}{4\gamma} + \frac{Gm}{2} + \frac{pm\gamma}{2\alpha_{1P}N_P} - \frac{\alpha_{1M}N_M\gamma p^2}{(2\alpha_{1P}N_P)^2} \right] \end{aligned} \quad (\text{A8})$$

Subtracting (A8) from (A7) yields (14a) as follows

$$(\tilde{W}_{CU,M}^M - \tilde{W}_{CU,M}^P) = \frac{\gamma(\alpha_{1P}N_P m - \alpha_{1M}N_M p)^2}{4\alpha_{1M}N_M(\alpha_{1P}N_P)^2} > 0$$

From (12) we have

$$\tilde{t}_{CU}^P = \frac{1}{2\alpha_{1P}N_P\gamma}[\alpha_{1P}N_P(G - p) - \alpha_{1M}N_M p]$$

The ensuing level of quality turns out to be

$$\tilde{s}_{CU}^P = \frac{1}{2} \left(G + \frac{\gamma}{\alpha_{1P}N_P} p \right) \quad (\text{A9})$$

Hence, welfare of country-P when it is the PM is

$$\tilde{W}_{CU,P}^P = (\alpha_{1P}N_P\tilde{t}_{CU}^P + p)\tilde{s}_{CU}^P = \left[\frac{\alpha_{1P}N_PG^2}{4\gamma} + \frac{Gp}{2} + \frac{\gamma p^2}{4\alpha_{1P}N_P} \right] \quad (\text{A10})$$

Similarly, the welfare of country-P when country-M is the PM is

$$\begin{aligned} \tilde{W}_{CU,P}^M &= (\alpha_{1P}N_P\tilde{t}_{CU}^M + p)\tilde{s}_{CU}^P \\ &= \left[\frac{\alpha_{1P}N_PG^2}{4\gamma} + \frac{Gp}{2} + \frac{pm\gamma}{4\alpha_{1P}N_P} - \frac{\alpha_{1P}N_P\gamma m^2}{(2\alpha_{1M}N_M)^2} \right] \end{aligned} \quad (\text{A11})$$

Subtracting (A11) from (A10) we have (14b) as follows

$$\tilde{W}_{CU,P}^P - \tilde{W}_{CU,P}^M = \frac{\gamma(\alpha_{1M}N_Mp - \alpha_{1P}N_Pm)^2}{4\alpha_{1P}N_P(\alpha_{1M}N_M)^2} > 0$$

A.3 Welfare comparisons

Let, \tilde{W}_{CU}^P be the total welfare of the customs union when P is being delegated the tariff-setting power. Hence, from (12) and (A9) we have

$$\begin{aligned} \tilde{W}_{CU}^P &= \tilde{W}_{CU,P}^P + \tilde{W}_{CU,M}^P \\ &= (\gamma\tilde{t}_{CU}^P + p + m)\tilde{s}_{CU}^P \\ &= \left[\left(\frac{1}{2}G + \frac{1}{2}p - \frac{\alpha_{1M}N_M}{2\alpha_{1P}N_P}p + m \right) \left(\frac{1}{2}G + \frac{\gamma}{2\alpha_{1P}N_P}p \right) \right] \end{aligned} \quad (\text{A12})$$

Similarly, we denote the joint welfare of the P and M countries by \tilde{W}_{PM} when both the countries set tariffs unilaterally and non-cooperatively. Hence from (10) we have

$$\tilde{W}_{PM} = \tilde{W}_P + \tilde{W}_M = \left[\frac{2}{9}(G + p + m)^2 \right]$$

Therefore, simple calculations reveal

$$\begin{aligned} \tilde{W}_{CU}^P - \tilde{W}_{PM} &= \left[\left(\frac{1}{2}G + \frac{1}{2}p - \frac{\alpha_{1M}N_M}{2\alpha_{1P}N_P}p + m \right) \right. \\ &\quad \left. \times \left(\frac{1}{2}G + \frac{\gamma}{2\alpha_{1P}N_P}p \right) \right] - \left[\frac{2}{9}(G + p + m)^2 \right] \end{aligned}$$

$$\begin{aligned}
&= \frac{1}{36}(G+m)(G-m) + \frac{1}{18}Gp + \frac{1}{18}(G-3m) \\
&\quad + \frac{1}{18}(p+2m) \\
&\quad + \frac{\alpha_{1M}N_M}{4\alpha_{1P}^2N_P^2}(2\alpha_{1P}N_Pm - \alpha_{1M}N_Mp)p \\
&> 0
\end{aligned} \tag{A13}$$

Let, \tilde{W}_{CU}^M be the total welfare of the customs union when M is being delegated the tariff-setting power. Hence, from (11) and (A6) we have

$$\begin{aligned}
\tilde{W}_{CU}^M &= \tilde{W}_{CU,P}^M + \tilde{W}_{CU,M}^M \\
&= (\gamma \tilde{t}_{CU}^M + p + m) \tilde{s}_{CU}^M \\
&= \left[\left(\frac{1}{2}G + \frac{1}{2}m + p - \frac{\alpha_{1P}N_P}{2\alpha_{1M}N_M}m \right) \left(\frac{1}{2}G + \frac{\gamma}{2\alpha_{1M}N_M}m \right) \right]
\end{aligned} \tag{A14}$$

Proceeding in a similar fashion it can be easily proved that

$$\tilde{W}_{CU}^M - \tilde{W}_{PM} > 0 \tag{A15}$$

Now, suppose $\tilde{W}_{CU,M}^M < \tilde{W}_M$. Then from (A15) and using (10) we must have

$$\tilde{W}_{CU,P}^M > \tilde{W}_P = \tilde{W}_M \tag{A16}$$

Similarly, using (A13) and (10) we can show that $\tilde{W}_{CU,P}^P < \tilde{W}_P$ if

$$\tilde{W}_{CU,M}^P > \tilde{W}_M = \tilde{W}_P \tag{A17}$$

A.4 Proof of $\tilde{W}_{CU}^M > \tilde{W}_{CU}^P$

From (A12) and (A14) we have

$$\begin{aligned}
\tilde{W}_{CU}^P &= (\tilde{W}_{CU,P}^P + \tilde{W}_{CU,M}^P) \\
&= \left[\left(\frac{1}{2}G + \frac{1}{2}p + m - \frac{\alpha_{1M}N_M}{2\alpha_{1P}N_P}p \right) \left(\frac{1}{2}G + \frac{\gamma}{2\alpha_{1P}N_P}p \right) \right] \\
\tilde{W}_{CU}^M &= (\tilde{W}_{CU,P}^M + \tilde{W}_{CU,M}^M) \\
&= \left[\left(\frac{1}{2}G + \frac{1}{2}m + p - \frac{\alpha_{1P}N_P}{2\alpha_{1M}N_M}m \right) \left(\frac{1}{2}G + \frac{\gamma}{2\alpha_{1M}N_M}m \right) \right]
\end{aligned}$$

Hence, using (13) it can be easily calculated that

$$\begin{aligned} & \tilde{W}_{CU}^P - \tilde{W}_{CU}^M \\ &= - \left[\frac{(\alpha_{1P} N_P m - \alpha_{1M} N_M p)^2}{2\alpha_{1P} N_P \alpha_{1M} N_M)^2} \{(\alpha_{1M} N_M)^2 - (\alpha_{1P} N_P)^2\} \right] > 0 \end{aligned} \quad (A18)$$

Figure 4: Simulated Welfare Rankings ($N = 90$; $N_R = 30$;
 $N_P = 40$; $N_M = 20$)

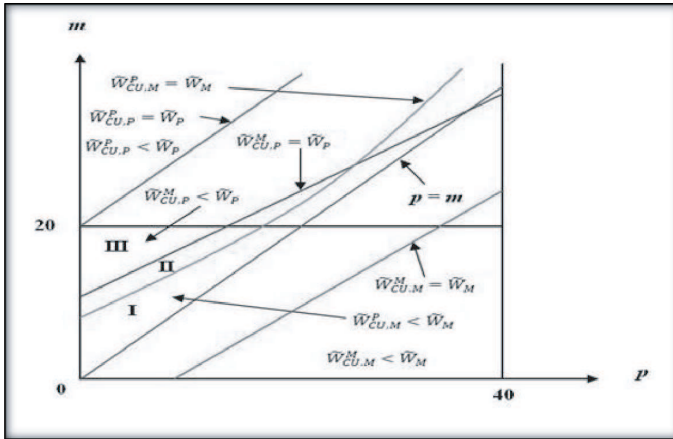
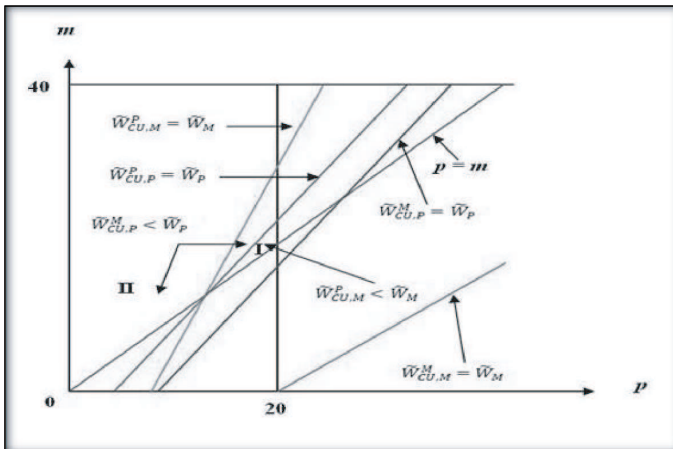


Figure 5: Simulated Welfare Rankings ($N = 90$; $N_R = 30$;
 $N_P = 20$; $N_M = 40$)



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