

Title	Trading blocs and endogenous product quality under a vertically differentiated monopoly
Sub Title	
Author	Ghosh, Sunandan Acharyya, Rajat
Publisher	Keio Economic Society, Keio University
Publication year	2012
Jtitle	Keio economic studies Vol.48, (2012.) ,p.21- 46
JaLC DOI	
Abstract	In this paper we have analyzed the inter-relationship between endogenous trading bloc formation and innovation of a vertically differentiated good in a threecountry world economy. Trade bloc formation unambiguously increases the endogenous level of innovation by a patent holder monopolist MNC both in absence and presence of intra-country taste diversity. In the context of formation of a Free Trade Area (FTA), given the assumption that taste is less dispersed in the poor country relative to the middle-income country, the rich country is more likely to prefer the middle-income country over the poor country as its FTA partner when the formation of such FTA is feasible with or without side-payments. But the poor and middle-income countries will always prefer to form a customs union between them over FTA with the rich country. The joint welfare maximizing tariffset by them may be less than the Nash equilibrium tariffschosen unilaterally by them under no trade bloc formation. Most of these results are robust with respect to the extent of coverage of different markets by the MNC.
Notes	Articles
Genre	Journal Article
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AA00260492-20120000-0021

慶應義塾大学学術情報リポジトリ(KOARA)に掲載されているコンテンツの著作権は、それぞれの著作者、学会または出版社/発行者に帰属し、その権利は著作権法によって保護されています。引用にあたっては、著作権法を遵守してご利用ください。

The copyrights of content available on the KeiO Associated Repository of Academic resources (KOARA) belong to the respective authors, academic societies, or publishers/issuers, and these rights are protected by the Japanese Copyright Act. When quoting the content, please follow the Japanese copyright act.

**TRADING BLOCS AND ENDOGENOUS PRODUCT QUALITY UNDER A
VERTICALLY DIFFERENTIATED MONOPOLY**

Sunandan GHOSH

Department of Economics, Jadavpur University, Kolkata, India

and

Rajat ACHARYYA

Department of Economics, Jadavpur University, Kolkata, India

First version received March 2011; final version accepted August 2011

Abstract: In this paper we have analyzed the inter-relationship between endogenous trading bloc formation and innovation of a vertically differentiated good in a three-country world economy. Trade bloc formation unambiguously increases the endogenous level of innovation by a patent holder monopolist MNC both in absence and presence of intra-country taste diversity. In the context of formation of a Free Trade Area (FTA), given the assumption that taste is less dispersed in the poor country relative to the middle-income country, the rich country is more likely to prefer the middle-income country over the poor country as its FTA partner when the formation of such FTA is feasible with or without side-payments. But the poor and middle-income countries will always prefer to form a customs union between them over FTA with the rich country. The joint welfare maximizing tariff set by them may be less than the Nash equilibrium tariffs chosen unilaterally by them under no trade bloc formation. Most of these results are robust with respect to the extent of coverage of different markets by the MNC.

Key words: Trading Blocs, Vertically Differentiated Monopoly, Innovation, Taste Diversity.

JEL Classification Number: F12, F15, L12, O31.

1. INTRODUCTION

This paper examines the dynamic gains from forming Free Trade Area (FTA) and Customs Union (CU) among asymmetric countries in terms of the effect on innovation level in the member countries. The asymmetry among countries has been captured

Acknowledgments. We thank an anonymous referee for helpful suggestions. The usual disclaimer applies, however.

E-mail: juecosg@gmail.com, rajat.acharyya@gmail.com

Copyright©2012, by the Keio Economic Society

through per capita incomes and intra-country taste dispersion.

Apart from the conventional static effects like trade creation and diversion, trade liberalization comes with a bunch of dynamic gains. Baldwin (1992) argues that trade liberalization induces capital (both physical and human) accumulation and using a partial equilibrium model shows that such dynamic measurable gains from trade liberalization has a positive effect on growth. Wacziarg (2000) uses a panel of 57 countries over the period 1970–1989 to find that the rate of physical capital accumulation and technological transmission via FDIs ensuing from trade liberalization largely have considerable positive effect on growth.

Dynamic gains arise from removal of border restrictions on investments that allow firms to relocate and in the process exploit economies of scale via reduction in transaction costs. Vertical integration in firm level can set a competitive stage for South-South trade blocs vis-à-vis rest of the world. Schiff and Winters (2003) give a detailed discussion on the issues of locational advantages, FDIs and knowledge spillovers ensuing from trade bloc formation. However, regarding inter-member distributional issue they predict that divergence is more likely for South-South trade blocs. Acharyya (2005) argues that issues like trans-boundary pollution, environmental standards and efficient management of environmental resources can also be treated as gains from trade bloc formation.

But the implication of formation of trade blocs for level of innovation has not been explored. This is what this paper aims at. Since trade bloc formation combines elements of both trade liberalization (vis-à-vis members) and trade protection (vis-à-vis non-members), our analysis can also be related to the vast literature on trade policy impact on R&D and innovation. Effect of unilateral trade liberalization on innovation has been a long debated issue in the trade theory literature. The cornerstone of the debate lies in the welfare outcomes ensuing from removal of trade barriers so as to boost R&D (via increased international competition) vis-à-vis continuation of protectionist regime so as to insulate domestic industries from more efficient foreign counterparts.

Clemenz (1990) supports the earlier view given a two country two commodity world economy framework with both monopolistic and duopolistic (Bertrand) market structures. Clemenz attributes the improvement in R&D to both increased international competition and expanded market size as a country opens up to free trade from an autarkic regime. However, both direct R&D subsidy and tariff instruments prove to be welfare enhancing compared to free trade if the technology gap is initially high. Spencer and Brander (1983) opt for export subsidy under Cournot market structure instead of R&D subsidy or tariff instruments. Dixit (1988), on the other hand, finds that R&D competition may yield an innovation level higher than the socially optimal R&D level and hence he argues in favour of tax on R&D investment so as to achieve Pareto optimality.

Baldwin and Forslid (2000) use a two country, two factors of production and two commodity (one being vertically differentiated) trade model under monopolistic competition and IRS. They find trade liberalization to be a stimulating factor behind innovation given iceberg trade costs and one-time cost for innovation. Ederington and McCalman (2008), using a dynamic model of firm-level productivity, argue that lowering of trade

costs help a firm to adopt new technology and hence trade liberalization exerts a positive impact on innovation. However, Herguera *et. al.* (2000) find contradictory results using Voluntary Export Restraint (VER) under a duopolistic (Cournot) market structure. Bandyopadhyay and Acharyya (2006) and Gustafsson and Segerstrom (2010) find conditions for which trade protection may induce innovation and not liberalization.

Empirical models have also tried to address this issue using different econometric methods and varied geographical entities. Fontaign *et. al.* (1998) use panel data for the European Community over the period 1980–1994 and show that intra-industry trade in quality has rapidly increased compared to intra-industry trade in variety and inter-industry trade. Baldwin and Gu (2004) use a probit model on panel data for Canada over the period 1984–1996 and conclude that trade liberalization enhances innovation through R&D collaboration.

In contrast to these papers focusing on unilateral trade liberalization, here we consider bilateral and regional trade liberalization through the formation of trading blocs. The formation of trade blocs had been endogenously determined as we explicitly take into account choice of countries over free trade area (FTA) and customs union (CU). Those decisions depend on the innovation level itself and on the ensuing welfare levels. Thus, in a sense, our analysis focuses on inter-relationship between innovation and trade bloc formation. Another key element that separates out our present analysis from the existing literature on trade bloc formation and its implications is that we consider an environment of intra-country taste diversity with consumers differing in their marginal willingness to pay for the new innovation or quality¹. We consider a three-country world with poor, middle-income and rich countries and a patent holder innovating MNC belonging to the rich country to establish the following set of results. First, we find that trade bloc formation unambiguously increases the endogenous level of innovation by a patent holder monopolist MNC producing a vertically differentiated good both in absence and presence of intra-country taste diversity. Second, if FTA with rich country is profitable for all with or without side-payments, given the assumption that taste is less dispersed in the poor country relative to the middle-income country in a sense defined later, the rich country is more likely to prefer the middle-income country over the poor country as its FTA partner. Third, poor and middle-income countries will always prefer to form a customs union between them over FTA with the rich country. The joint welfare maximizing tariff set by them may be less than the Nash equilibrium tariffs chosen unilaterally by them under no trade bloc formation which raises the innovation level. Fourth, most of these results are robust with respect to the extent of coverage of different markets (partial or full coverage) by the patent holder MNC.

Rest of the paper is organized as follows. In section 2 we introduce the basic model and then extend it to the different trading bloc regimes in sub-section 2.2. In section 3 we introduce the case of intra-country taste diversity followed by the options of trading

¹ Acharyya and Garcia-Alonso (2008) and Valetti (2006) consider innovation choice by an MNC in presence of intra-country income disparity and cross-country asymmetry in such a respect. But trade policy choices, multilateral or bilateral, have not been modeled.

bloc regimes in sub-sections 3.1. Then we study the feasibility conditions for the enforcement of some of the trading bloc regimes in sub-section 3.2. In sub-section 3.3 we consider the case for CU between the poor and the middle-income countries. In section 4 we check the robustness of the results derived so far. Section 5 then concludes the paper.

2. THE MODEL

We consider a three country world and denote the three countries as poor (P), middle-income (M) and rich (R) with respective per-capita income levels being Y_P , Y_M and Y_R . To start with, we assume no intra-country income and demand dispersion. The population sizes of the three countries are denoted by N_P , N_M and N_R . Suppose all consumers in country- j have identical tastes (or marginal willingness to pay for quality) which is captured by the taste parameter α_j ($j = P, M$ and R). We assume that there is a positive association between income and taste parameter such that $\alpha_P < \alpha_M < \alpha_R$.

A patent holder Multi-national Corporation (MNC) belongs to the rich country (R) and produces a vertically differentiated good. Consumers in the j th country have identical preference for a particular quality of the good innovated by the MNC. The utility function² for the representative consumer is given by

$$U_j = \alpha_j s \quad \forall \quad j = P, M, R \quad (1)$$

where, α_j is the taste parameter for the representative consumer of the j th country and s is the level of the innovated quality.

The MNC incurs only a sunk cost for innovation and the cost is assumed to be convex in quality level innovated

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

We assume that the rich country exports this innovated good to the other two countries and P_j is assumed to be the price of the differentiated good as sold by the MNC in the j th market. We further assume that the representative consumer buys only one unit of this innovated good (one can think of the good to be a consumer durable like a laptop or television set) or does not buy it at all. Hence, the market participation (or individual rationality) constraint for the representative consumer is given by

$$V_j = (\alpha_j s - P_j) \geq 0 \quad (3)$$

Welfare of the P and M countries equal sum of consumers' surplus and tariff revenue:

$$W_k = V_k N_k + t_k P_k N_k \quad \forall \quad k = P, M \quad (4a)$$

whereas, the welfare of the R country equals sum of consumers' surplus and MNC profit:

$$W_R = V_R N_R + \pi \quad (4b)$$

where π is the MNC profit. The MNC, being a monopolist, extracts the entire consumer surplus and sets the price $p_j = \alpha_j s$ in the j th market such that $V_j = 0$. Such a pricing,

² Similar framework had been used by Choi and Shin (1992).

on the other hand, also ensures the MNC that units of the good sold in the j th market will be N_j ($j = P, M, R$). Higher prices for which $V_j < 0$, there is no demand for this innovated good. Thus, given $\alpha_P < \alpha_M < \alpha_R$, the MNC price discriminates across countries.³

Countries P and M produce and export a homogeneous good. But we do not explicitly model production of such a good as we are not concerned here with trade flows among countries except for the vertically differentiated good. The homogeneous good can be taken as the numeraire good, which is produced at constant cost normalized to one. The good is produced under perfectly competitive conditions everywhere and is traded freely around the world with the marginal utility being one.⁴

2.1. The Benchmark Case

We begin with the benchmark case of no trade bloc being formed among the three countries. Let t_P and t_M denote the ad-valorem tariff rates that the countries P and M impose on their respective imports from country R. The tariff rates are chosen unilaterally and simultaneously.

The profit function of the monopolist MNC under the benchmark case (as noted by B in the superscript) is given by

$$\pi_R^B = [(1 - t_P)\alpha_P N_P + (1 - t_M)\alpha_M N_m + \alpha_R N_R]s - \frac{1}{2}s^2 \quad (5)$$

For any given set of tariffs the MNC chooses the optimal innovation level s^* so as to maximize the profit level which yields the innovation level as

$$s^* = (1 - t_P)\alpha_P N_P + (1 - t_M)\alpha_M N_m + \alpha_R N_R \quad (6)$$

Since the MNC extracts all surpluses of buyers in country- j , for both countries P and M, the national welfare level is equal to the tariff revenue accrued to the national government while importing the innovated good from R. We can write the national welfare level for P and M as

$$W_k = t_k \alpha_k N_k s^* \quad (k = P, M) \quad (7a)$$

and for R as

$$W_R = \frac{1}{2}(s^*)^2 \quad (7b)$$

which is just the MNC's profit.

Note that the national welfare levels depend on own as well as other country's tariff level since from (6), $s^* = s(t_P, t_M, \alpha_P, \alpha_M, N_P, N_M)$. This means the unilaterally optimum tariff levels are inter-dependent⁵. An increase in t_M , for example, lowers the innovation level. The optimum response for the poor country is then to lower its tariff level which mitigates the disincentive effect of the increase in t_M for the MNC and

³ We assume that countries do not allow parallel imports of the innovated good from the low-price markets so that cross-country price discrimination is feasible. Otherwise, arbitrage through parallel imports would lead to price convergence across all markets. See Maskus (2001) on a survey of implications of "parallel imports" (distinguished from illegal imports) in health-care goods and other copyright-protected goods.

⁴ We thank an anonymous referee for this suggestion.

⁵ See appendix A.1.

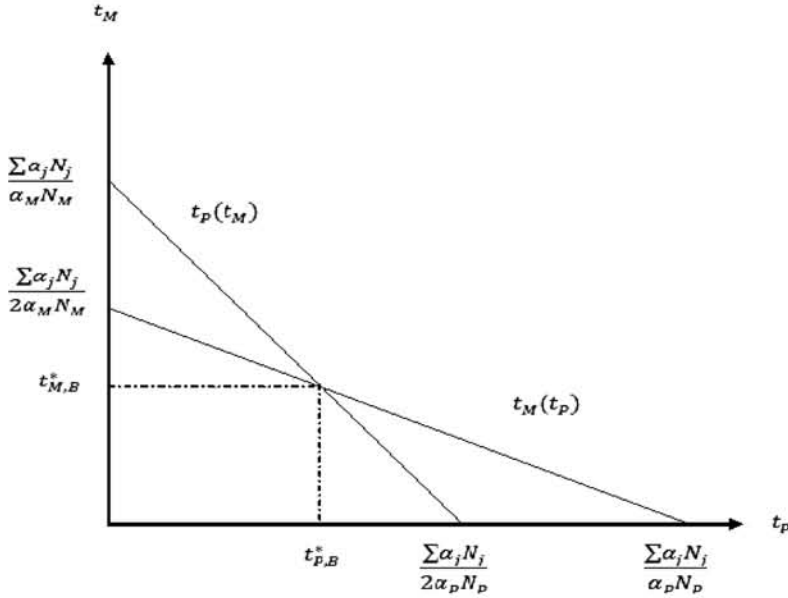


Figure 1. Nash equilibrium choice of tariff rates.

such a “gain” in terms of smaller reduction in innovation level overcompensates the welfare loss for P from lower t_P . Thus P country’s best-response unilateral tariff is inversely related to t_M . Similar is the best-response unilateral tariff of the M country. With algebraic details given in the appendix, the unilaterally optimum Nash equilibrium tariff levels can be calculated as

$$t_{k,B}^* = \frac{1}{3} \left[\frac{\sum_j \alpha_j N_j}{\alpha_k N_k} \right] \quad \forall \quad j = P, M, R; k = P, M \quad (8)$$

Figure 1 illustrates these Nash equilibrium choice of tariff rates.

Note that for equal country sizes, $t_{P,B}^* > t_{M,B}^*$ since $\alpha_P < \alpha_M$. Substitution of (8) in (6) yields the optimal level of innovation as chosen by the MNC to be

$$s_B^* = \frac{1}{3} (\sum_j \alpha_j N_j) \quad (9)$$

Note that the innovation level depends both on size of the markets, N_j , and the maximum willingness-to-pay, α_j .

Finally, substitution of (8) and (9) in (5) and (7) yields the maximum national welfare levels as

$$W_k^B = \frac{1}{9} (\sum_j \alpha_j N_j)^2 \quad j = P, M, R; k = P, M \quad (10a)$$

$$W_R^B = \frac{1}{18} (\sum_j \alpha_j N_j)^2 \quad (10b)$$

2.2. Trading Bloc Options

In this section we consider the possibilities of different trading blocs among the countries. The relevant possibilities are FTA_{RM} (FTA between countries R and M), FTA_{RP} (FTA between countries R and P) and CU_{PM} (customs union between countries P and M). We also consider the case of global free trade (GFT) regime along with. However, relevant calculations reveal that FTA_{RM} and FTA_{RP} are not feasible options, as in both these cases either country P or M won't agree to join a FTA with the rich country⁶. This happens due to the fact that the welfare of country- j (which consists only of tariff revenue) comes down to zero as it joins FTA_{Rj} and such loss in welfare is more than the gain in national welfare of the rich country. Given this, the only relevant trade bloc worth studying is formation of CU between the poor and middle-income countries.

2.2.1. Customs Union between Poor and Middle-income Countries

Given the case that countries P and M forms a customs union among themselves and impose a common tariff on their imports from R, the profit function of the MNC remains the same as given by equation (5) except for the individual tariffs imposed by countries P and M ($t_{k,B}^*$) being replaced by a common tariff (t^{CU}). We calculate the optimal tariff level as set by the customs union members (P and M) by maximizing the joint national welfare levels of P and M and the tariff level turns out to be

$$t^{CU} = \frac{1}{2} \frac{\sum_j \alpha_j N_j}{\sum_k \alpha_k N_k} \quad \forall \quad j = P, M, R; \quad k = P, M \quad (11)$$

Comparison of this tariff with the pre-CU unilaterally optimum tariff rates as defined in (8) reveals that

$$t^{CU} < \frac{1}{2} (t_{P,B}^* + t_{M,B}^*) \quad (11a)$$

For equal sized countries, by the weighted average rule and given $\alpha_P < \alpha_M$, $t^{CU} < t_{P,B}^*$. However, t^{CU} may or may not be larger than $t_{M,B}^*$. That is, the formation of CU does not necessarily lead to a higher rate of tariff being imposed on imports from the rich country. The following lemma makes a more precise statement:

LEMMA 1. *Joint welfare maximizing tariff set by the customs union members is smaller than both the pre-union unilaterally optimum tariff levels,*

$$t^{CU} < \min [t_{P,B}^*, t_{M,B}^*] \quad \forall \quad \frac{\alpha_M}{\alpha_P} \in \left(\frac{N_P}{2N_M}, \frac{2N_P}{N_M} \right).$$

Proof. From (7) and (10) it is immediate that,

$$t^{CU} < t_{M,B}^* \quad \text{if} \quad \frac{\alpha_M}{\alpha_P} < \frac{2N_P}{N_M}$$

and

$$t^{CU} < t_{P,B}^* \quad \text{if} \quad \frac{\alpha_M}{\alpha_P} > \frac{N_P}{2N_M}$$

On the other hand, $t_{P,B}^* > t_{M,B}^*$ if $\frac{\alpha_M}{\alpha_P} > \frac{N_P}{N_M}$. Hence, the claim. \square

⁶ See appendix A.2.

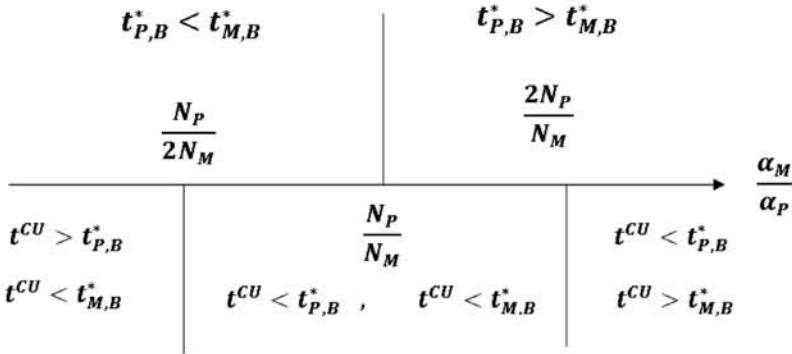


Figure 2. Ranking of pre-union and post-union tariff rates.

LEMMA 2. For equal sized poor and middle-income countries, $N_P = N_M$,

$$t^{CU} < t_{M,B}^* < t_{P,B}^* \forall \alpha_M < 2\alpha_P \quad \text{and} \quad t_{M,B}^* < t^{CU} < t_{P,B}^* \forall \alpha_M > 2\alpha_P.$$

Proof. It is sufficient to note that the assumption that $\alpha_M > \alpha_P$ implies that for equal sized countries, $\frac{\alpha_M}{\alpha_P} > \frac{N_P}{N_M}$ always holds and thus, $t_{P,B}^* > t_{M,B}^*$. The second part of the proof follows from Lemma 1. \square

The following Figure 2 illustrates the ranking of pre-union and post-union tariff rates for different parametric configurations.

The intuition behind $t_{P,B}^* > t_{M,B}^*$ for $N_P = N_M$ is straight forward. The MNC charges a lower price in poor country because of the lower marginal willingness-to-pay there ($\alpha_P < \alpha_M$). Thus, given the equal size, the same tariff rate yields lower tariff revenue in poor country. A higher tariff raises tariff revenue but lowers the innovation level. However, as evident from (6), increase in t_P lowers innovation level less than does an increase in t_M . On the other hand, the P-country government knows that if it raises $t_{P,B}^*$, the best-response of M-country will be lower its tariff which will absorb a part of disincentive effect of increase in $t_{P,B}^*$ on the MNC.

Now, given (11), the optimal innovation level under the CU_{PM} regime can be easily calculated to be

$$s_{CU}^* = \frac{1}{2}(\sum_j \alpha_j N_j) > s_B^* \quad (12)$$

Once again the intuition is straight forward. As indicated in (11a), the rate of tariff imposed by the CU-members is smaller than the average pre-union unilaterally optimum tariff levels. This encourages the MNC to raise the innovation level.

The joint welfare level of countries P and M turns out to be

$$W_{PM}^{CU} = \frac{1}{4}(\sum_j \alpha_j N_j)^2 > (W_P^B + W_M^B) \quad (13)$$

This ranking ensures that even if one of the members experiences welfare loss, the other member gains more so that a side-payment to compensate for its welfare loss and thereby enforce the CU is feasible. Note that (13) is sufficient in the above sense for formation of CU because FTA with R is not a feasible option. Now, as said earlier,

the welfare level of the rich country is equal to the profit of the MNC. The profit of the MNC in turn depends on the optimal level of innovation. The higher the level of innovation, the higher will be the profit of the MNC and hence, the welfare level of country R. Therefore, by (13), CU_{PM} raises the welfare level of country R above the pre-union non-cooperative level. Hence, a customs union between the poor and the middle-income countries is not only a feasible option but also welfare improving for the non-member rich country. The source of such welfare improvement lies in the improvement in the innovated quality of the product.

PROPOSITION 1. *In this set up, formation of a CU between poor and middle-income countries is feasible and this raises the innovation and welfare levels in the rich non-member country.*

Proof. Follows from the above discussion. □

2.2.2. Global Free Trade

For completeness of analyses let us consider unilateral free trade policy adopted by the countries that leads to global free trade (GFT). In such a case it is easy to check that both the levels of innovation and global welfare turns out to be maximum.

$$s_{GFT}^* = (\sum_j \alpha_j N_j) > s_{CU}^* > s_B^* \quad (14)$$

$$W_{Global}^{GFT} = \frac{1}{2}(\sum_j \alpha_j N_j)^2 > W_{Global}^{CU} > W_{Global}^B \quad (15)$$

However, under GFT national welfare levels for both countries P and M are zero. Hence, global free trade can only be sustained if country R make side-payments to both countries P and M.

This result is analogous to optimum tariff theory of international trade. For a (large) importing country, an import tariff raises its national welfare above the free trade level but is not globally optimal since the exporting country loses more. Similar result is reflected in (15).

3. INTRA-COUNTRY TASTE DIVERSITY

In this section we extend the benchmark model to the case of intra-country income diversity. We, however, restrict ourselves to the case of two discrete types in each country. There exists n_{1j} number of buyers with taste parameter α_{1j} and n_{2j} number of buyers with taste parameter α_{2j} with

$$\alpha_{1j} < \alpha_{2j} \quad \forall j = P, M, R. \quad (16a)$$

For the purpose of making comparisons with the above case of no intra-country taste diversity, we make a simplifying assumption that national incomes of the countries remain the same in the two cases, that is,

$$\alpha_{1j}n_{1j} + \alpha_{2j}n_{2j} = \alpha_j N_j \quad \forall j \quad (16b)$$

where $n_{1j} + n_{2j} = N_j \quad \forall j = P, M, R$.

This assumption implies that

$$\alpha_j = \gamma_{1j}\alpha_{1j} + \gamma_{2j}\alpha_{2j} \implies \alpha_{1j} < \alpha_j < \alpha_{2j} \quad (16c)$$

where, $\gamma_{1j} = \frac{n_{1j}}{N_j}$ is the population share of α_{1j} -class of buyers.

Thus the present case can be interpreted essentially as mean-preserving taste dispersion in each country. Note that by (16c), income (per-capita) and taste parameter are still positively related if we continue with the assumption $\alpha_P < \alpha_M < \alpha_R$, which now means that the population-share weighted average taste parameter is lowest in the poor country and highest in the rich country. However, in what follows, we need not specify how the highest (or lowest) taste parameters across countries compare to each other.⁷

Now, the MNC can serve only the high type buyers (and charge a higher price) or it can serve both types. Given assumption (16a) one can easily verify that the MNC serves both types of buyers if⁸

$$\frac{n_{1j}}{n_{2j}} > \frac{\alpha_{2j} - \alpha_{1j}}{\alpha_{1j}} \quad (17)$$

Such a result is similar to the profit maximizing separating menu as shown in Acharyya (1998, 2005). Now, under full market coverage (that is when the MNC serves both the types), it sets the price $P_j^f = \alpha_{1j}s_j^*$ ($j = P, M, R$).

3.1. Trading Bloc Options under Intra-Country Taste Diversity

Like the section (2.2), we again explore the different trading bloc possibilities available to the countries P, M and R and the levels of innovation associated to these various trading bloc regimes.

3.1.1. Benchmark Case (or FTA_{PM})

To start with we consider the case where P and M imposes ad-valorem tariff on their imports from R and hence, this situation is equivalent to the case where P and M have a FTA between them. Given the aforesaid tariff regime and intra-country taste diversity, the profit function as faced by the monopolist MNC of R can be written as

$$\tilde{\pi}_R^B = [(1 - t_P)\alpha_{1P}N_P + (1 - t_M)\alpha_{1M}N_m + \alpha_{1R}N_R]s_f - \frac{1}{2}s_f^2 \quad (18)$$

Profit maximization yields the optimal level of innovation under full market coverage given any pair of tariff rates t_P and t_M as

$$s_f = [(1 - t_P)\alpha_{1P}N_P + (1 - t_M)\alpha_{1M}N_m + \alpha_{1R}N_R] \quad (19)$$

Recall that, given the initial benchmark case involving no intra-country taste diversity, the welfare functions of the countries P and M consisted of only the tariff revenues accrued to the respective national governments. However, now with two types of buyers in each country, as the MNC caters to both types by charging a uniform price $P_j^f = \alpha_{1j}S_j^*$, which extracts all the surpluses from the poor (or low type) consumers, it leaves the rich (or, the high type) consumers with strictly positive surplus. The total surplus accruing to all richer buyers taken together in each country equals

⁷ We thank an anonymous referee for pointing this out. For example, for our results to hold good we need not assume $\alpha_{2P} < \alpha_{2M} < \alpha_{2R}$, or $\alpha_{1P} < \alpha_{1M} < \alpha_{1R}$.

⁸ See appendix A.3.

$$\widetilde{CS}_j^B = n_{2j}(\alpha_{2j} - \alpha_{1j})s_f \quad \forall \quad j = P, M$$

The national welfare thus now comprises of this consumers surplus and, as before, the tariff revenue and hence, can be written as:

$$\widetilde{W}_j^B = t_j^f \alpha_{1j} N_j s_f + n_{2j}(\alpha_{2j} - \alpha_{1j})s_f \quad \forall \quad j = P, M \quad (20a)$$

For the rich country, the national welfare comprises of MNC profit and net surplus of the high-type buyers

$$\widetilde{W}_R^B = \frac{1}{2}(s_f)^2 + n_{2R}(\alpha_{2R} - \alpha_{1R})s_f \quad (20b)$$

Once again, there is strategic inter-dependence of the unilaterally chosen tariff rates. Welfare maximization yields the Nash equilibrium tariffs set by P and M as:

$$t_P^B = \frac{1}{3\alpha_{1P}N_P} [G - 2n_{2P}(\alpha_{2P} - \alpha_{1P}) + n_{2M}(\alpha_{2M} - \alpha_{1M})] \quad (21a)$$

$$t_M^B = \frac{1}{3\alpha_{1M}N_M} [G - 2n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})] \quad (21b)$$

where, $G = (\sum_j N_j \alpha_{1j})$; $j = P, M, R$.

Substitution of the optimal tariffs in (19) yields the optimal level of innovation

$$s_f^B = \frac{1}{3} [G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})] \quad (22)$$

and the welfare levels of the countries can easily be calculated to be

$$\widetilde{W}_j^B = (s_f^B)^2 \quad \forall \quad j = P, M \quad (23a)$$

$$\widetilde{W}_R^B = \frac{1}{6} s_f^B [G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P}) + 6n_{2R}(\alpha_{2R} - \alpha_{1R})] \quad (23b)$$

Few comments are warranted at this point. First, by (16b) innovation level will be lower, that is, $s_f^B < s_B^*$.⁹ The reason is simple. Under full market coverage, the MNC charges a price according to the marginal willingness-to-pay of the lowest taste (or income) class, so a mean-preserving taste dispersion lowers the price and hence the return from innovation for the monopolist. The innovation level is thus smaller.

Second, comparing the welfare levels of the countries it is immediate that welfare levels will be lower under mean-preserving taste dispersion than under no taste diversity. This follows from the fact that welfare of the poor and middle-income countries are proportional to the innovation level, so that lower innovation lowers their welfare. For rich country, on top of this, the profit margin declines.

3.1.2. Global Free Trade

Again, as under no intra-country taste diversity, in this case also we have maximum level of innovation under global free trade and the level of innovation turns out to be

$$s_f^{GFT} = G > s_f^{CU} > s_f^B \quad (24)$$

⁹ See appendix A.4.

3.2. Feasibility of FTA Options for Rich Country

In this section we analyze the feasibility of FTA options available to the rich country R with either of the poor and middle-income states. The intra-country taste diversity presents a possibility of such FTA formation because though tariff revenue is lost under FTA, net surplus of high-type buyers may increase.

3.2.1. Welfare and Innovation Levels under FTA_{RP} and FTA_{RM}

We start with the case of FTA_{RP} where M imposes an ad-valorem tariff on the imports from R. Proceeding as before, the tariff levels set by P (or M) and the ensuing levels of innovation turn out to be

$$t_j^{Ri} = \frac{1}{2N_j\alpha_{1j}}[G - n_{2j}(\alpha_{2j} - \alpha_{1j})] \quad i = P, M; j = P, M; i \neq j \quad (25)$$

where, t_j^{Ri} is the tariff set by the j th country when R forms an FTA with the i th country. Note that, as shown in the appendix, $t_j^B > 0$ implies $t_j^{Ri} > 0$.

$$s_f^{Ri} = \frac{1}{2}[G + n_{2j}(\alpha_{2j} - \alpha_{1j})] \quad i = P, M; j = P, M; i \neq j \quad (26)$$

where, s_f^{Ri} is the optimum level of innovation given that R forms an FTA with the i th country under full market coverage.

It is easy to check that $t_p^{Ri} > t_p^*$. That is, the poor country sets a higher unilateral tariff on imports from R when R negotiates an FTA with M than when there is no trade bloc. This result follows from the strategic inter-dependence of tariff levels discussed earlier whereby best-response of the poor country to a lowering of t_M (which is in fact lowered to zero under FTA_{RM}) is to raise its own tariff rate. Similar is the case for FTA_{RP} . The same condition ensures that the innovation level is higher, that is, $s_f^{RP} - s_f^B > 0$. The reason for this is that though P raises its tariff when an FTA is formed between R and M, since M removes its tariff, incentives for the MNC rises on the whole to innovate a higher quality good.

Relevant calculations yield the national welfare levels as

$$\tilde{W}_j^{Ri} = (s_f^{Ri})^2 \quad i = P, M; j = P, M; i \neq j \quad (27)$$

$$\tilde{W}_j^{Rj} = (s_f^{Rj})[n_{2j}(\alpha_{2j} - \alpha_{1j})] \quad j = P, M \quad (28)$$

$$\tilde{W}_R^{Rj} = \frac{1}{4}(s_f^{Ri})[G + n_{2j}(\alpha_{2j} - \alpha_{1j}) + 4n_{2R}(\alpha_{2R} - \alpha_{1R})] \\ i = P, M; j = P, M; i \neq j \quad (29)$$

Note that \tilde{W}_j^{Ri} is the welfare of the non-member country- j when FTA is formed between R and country- i .

3.2.2. Feasibility Conditions for the Enforcement of FTA_{RP} and FTA_{RM}

In this section we move on to analyze and compare the levels of the national welfares and innovation under the two alternative FTA regimes and for the purpose we make a simplifying assumption

$$n_{2P}(\alpha_{2P} - \alpha_{1P}) < n_{2M}(\alpha_{2M} - \alpha_{1M}) \quad (30)$$

An interpretation of this condition is that for equal-sized Poor and Middle-income countries ($N_P = N_M$) this implies that $\gamma_{2P}(\alpha_{2P} - \alpha_{1P}) < \gamma_{2M}(\alpha_{2M} - \alpha_{1M})$. That is, the population size-weighted taste diversity is less in the poor country than in the middle-income country¹⁰.

From (22) and (26) it is readily verifiable¹¹ that

$$s_f^{RP} > s_f^B \quad \text{and} \quad s_f^{RM} > s_f^B \quad (31a)$$

Again from (31a) and using the assumption made in (30) we have¹²

$$s_f^{RP} > s_f^{RM} > s_f^B \quad (31b)$$

which, in turn, implies the following welfare ranking

$$\tilde{W}_R^{RP} > \tilde{W}_R^{RM} > \tilde{W}_R^B \quad (32a)$$

The above welfare ranking given in (32a) implies that R prefers FTA. This is obvious because, by forming FTA, it can ensure a larger market in the non-member country for its MNC and thereby induce it to raise the innovation level. Given (32a) an FTA with country- j is feasible and relatively profitable for the partner country- j if

$$\tilde{W}_R^{Rj} + \tilde{W}_j^{Rj} > \tilde{W}_j^B + \tilde{W}_R^B \quad \forall j = P, M. \quad (32b)$$

Note that this condition essentially implies that even when FTA is not welfare improving for country- j , side payments made by R to its FTA partner—that is P in the case of FTA_{RP} and M in the case of FTA_{RM}—to enforce the FTA is feasible. If (32b) holds then it follows that $(\tilde{W}_R^{Rj} - \tilde{W}_R^B) > (\tilde{W}_j^B - \tilde{W}_j^{Rj})$. The RHS is the side payments to be made to the trading partner to make it indifferent between accepting the offer of accession vis-à-vis rejecting it. The LHS, on the other hand, is the welfare gain for R from FTA with country- j . Hence side payments are feasible if (32b) is satisfied. Now to check whether (32b) holds or not we proceed as follows.

Recall that, welfare levels of both P and M are the same under the benchmark case

$$\tilde{W}_P^B = \tilde{W}_M^B = (s_f^B)^2 \quad (33)$$

Now, by (30)

$$\tilde{W}_P^{RP} - \tilde{W}_M^{RM} = \frac{1}{2}G[n_{2P}(\alpha_{2P} - \alpha_{1P}) - n_{2M}(\alpha_{2M} - \alpha_{1M})] < 0 \quad (34)$$

Therefore, combining (32a), (33) and (34) we observe that if $\tilde{W}_R^{RP} + \tilde{W}_P^{RP} > \tilde{W}_R^B + \tilde{W}_P^B$ then it must be that $\tilde{W}_R^{RM} + \tilde{W}_M^{RM} > \tilde{W}_R^B + \tilde{W}_M^B$. That is, if side-payments are viable for FTA with P, then so are for FTA with M. This is because, as shown in the appendix,

$$(\tilde{W}_R^{RM} + \tilde{W}_M^{RM}) > (\tilde{W}_R^{RP} + \tilde{W}_P^{RP}) \quad (35a)$$

¹⁰ Alternatively, (30) can be written as $(\alpha_{2P} - \alpha_{1P}) < \frac{n_{2M}}{n_{2P}}(\alpha_{2M} - \alpha_{1M})$. Hence, for $n_{2P} \geq n_{2M}$, this means that absolute taste diversity in Poor country must be less than that in the Middle-income country.

¹¹ See appendix A.6.

¹² So, $s_f^{RM} > s_f^{RP}$ if opposite of (30) holds.

Thus, all we need is to check whether side-payments are viable for FTA with P. However, this can not be ensured a priori. But that this is viable for certain parametric restrictions is evident from the simulation results shown in the appendix for some specific values of global population and extent of taste diversity in the rich country.

LEMMA 3. *FTA between R and country- j ($j = P, M$) may be feasible and welfare improving for certain parametric restrictions on the extent of taste diversity in the poor and middle-income countries.*

So, what follows is that FTA between R and country- j ($j = P, M$) may or may not be formed. However, given that, when FTA with P (with side-payments) is feasible, the FTA with M is also feasible. This leads us to the issue of the preference of R for its FTA partner. Of course, when one FTA is feasible and the other is not, the choice of FTA partner is trivial. Such a choice makes sense when both FTAs (with side-payments) are feasible.

Assuming that FTAs are feasible, there are two sub-cases. First sub-case is where FTAs can be enforced without any side-payments. That is the case when $\tilde{W}_j^{Rj} > \tilde{W}_j^B$ ($j = P, M$). Then by (32a), R prefers P over M as the FTA partner. But if the opposite inequality in (30) holds, then M would have been preferred since in that case $\tilde{W}_R^{RM} > \tilde{W}_R^{RP}$. The second sub-case is where side-payments are needed, that is, $\tilde{W}_j^{Rj} < \tilde{W}_j^B$ ($j = P, M$). By (33) and (34), it is straightforward to check that lower side-payments will be required for FTA with M:

$$\tilde{W}_M^B - \tilde{W}_M^{RM} < \tilde{W}_M^B - \tilde{W}_P^{RP}$$

But the absolute gain for R is lower for FTA_{RM}. However, using (33) and (35a) we have

$$\tilde{W}_R^{RM} - (\tilde{W}_M^B - \tilde{W}_M^{RM}) > \tilde{W}_R^{RP} - (\tilde{W}_P^B - \tilde{W}_P^{RP}) \quad (35b)$$

That is, the gain net of side-payments for R is larger for FTA with M than with P.

PROPOSITION 2. *If FTAs are feasible, then given (30), the rich country will prefer the poor country as the FTA partner when no side-payments are required to enforce the FTA. Otherwise, the rich country will prefer the middle-income country as its FTA partner.*

Proof. Follows from (32a) and (35b) in the two cases (with and without side-payments). \square

3.3. Customs Union between Poor and Middle-Income Countries

An alternative for the Poor and the Middle-income countries to forming an FTA with the Rich country is to form a customs union between them in which they impose a common tariff on their imports from R. Joint welfare maximization exercise yields the optimal tariff as

$$t_{CU}^* = \frac{1}{2K} [G - n_{2P}(\alpha_{2P} - \alpha_{1P}) - n_{2M}(\alpha_{2M} - \alpha_{1M})] \quad (36)$$

where, $K = (\alpha_{1P}N_P + \alpha_{1M}N_M)$

Comparing equations (21a), (21b) and (36), it can be easily verified that

$$2t_{CU}^* < t_P^* + t_M^* \quad (37)$$

Thus, the same ranking of pre-union unilaterally chosen Nash equilibrium tariffs and the common external tariff of the CU holds as in the case of no taste diversity.

The optimal level of innovation turns out to be

$$s_f^{CU} = \frac{1}{2}[G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})] \quad (38)$$

Comparison of equations (22) and (38) readily reveals $s_f^{CU} > s_f^B$. Once again the innovation level is higher after formation of CU for the same reason as spelled out earlier: lower than average of pre-union tariffs encourages the MNC to raise its innovation level.

The welfare levels of the countries under the customs union case turn out to be

$$\tilde{W}_{PM}^{CU} = \tilde{W}_P^{CU} + \tilde{W}_M^{CU} = (s_f^{CU})^2 \quad (39a)$$

$$\tilde{W}_R^{CU} = \frac{1}{4}s_f^{CU}[G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P}) + 2n_{2R}(\alpha_{2R} - \alpha_{1R})] \quad (39b)$$

Relevant calculations involving national welfare levels reveal that even under the existence of intra-country taste diversity, both P and M have incentives to form a customs union. That is, formation of CU between P and M raises their joint national welfare over that under the benchmark case unambiguously.

$$\tilde{W}_{PM}^{CU} > (\tilde{W}_P^B + \tilde{W}_M^B) \quad (39c)$$

Note that even if one of the members stands to loose through CU compared to its pre-union welfare level¹³, (39c) ensures that it is feasible for the other member to make a side-payment to compensate it for the loss, if any. Now, since FTAs between R and P and that between R and M are possible, benefit from CU formation accruing to P (and M as well) is to be weighed against that from the formation of FTAs with the rich country. However, the same welfare comparison in (39c) suggests that CU would be preferred by both over an FTA with R when such an FTA is to be enforced by side payments by R to the partner country.

For example, as argued above, if $\tilde{W}_P^{RP} < \tilde{W}_P^B$, then to enforce FTA with P, the Rich country must make side-payments that guarantees P the welfare level \tilde{W}_P^B . Thus, (39c) would be sufficient to ensure that P and M will prefer CU between themselves over an FTA with R individually. On the other hand, if $\tilde{W}_P^{RP} > \tilde{W}_P^B$, then no side payment is required to enforce the FTA. In such a case, the CU will be preferred by P and M over FTA with R individually if \tilde{W}_{PM}^{CU} is larger than $(\tilde{W}_i^{Ri} + \tilde{W}_j^B)$.

Now, it can be easily verified that

$$\tilde{W}_j^{CU} - \tilde{W}_j^{Rj} > 0 \quad \forall \quad j = P, M. \quad (40a)$$

Hence,

$$(\tilde{W}_i^{CU} + \tilde{W}_j^{CU}) - (\tilde{W}_i^{Ri} + \tilde{W}_j^{Ri}) = \frac{1}{4}[n_{2i}(\alpha_{2i} - \alpha_{1i})]^2 > 0$$

¹³ It is not unconditional that $\tilde{W}_j^{CU} > \tilde{W}_j^B$. But as we argue, this welfare ranking is not needed for CU to be jointly welfare improving and thus enforceable through side-payments.

$$\forall i = P, M; j = P, M; i \neq j \quad (40b)$$

Therefore, in the case when $\tilde{W}_j^{Rj} > \tilde{W}_j^B$, (40b) ensures that CU will be preferred by P and M. In such a case (40a) ensures that CU is individually preferred over FTA with R so that no side-payment is required to enforce CU.

PROPOSITION 3. *A mean-preserving taste dispersion does not alter the incentives for customs union formation for the poor and middle-income countries. The innovation level is still larger as well.*

Proof. See appendix A.9. □

4. ROBUSTNESS

In this section we examine how far our results derived above hold when the MNC does not fully cover the export markets. An obvious polar opposite to the case of full-coverage of both P and M markets would be catering to only the high types in both these markets. Of course, this will be the case when distribution of consumers is such that the inequality in (17) is reversed, that is,

$$\frac{n_{1j}}{n_{2j}} < \frac{\alpha_{2j} - \alpha_{1j}}{\alpha_{1j}} \quad (17a)$$

In such a case, the MNC charges a price P_j in the j -th market where

$$P_j = \alpha_{2j}s \quad \forall j = P, M.$$

Further, for partial coverage in the own-country market as well, the analysis becomes analogous to the benchmark case of no taste diversity as discussed in section 2. The equilibrium innovation and welfare levels are summarized in the following table.

Hence, the results obtained under the assumption of universal partial coverage (that

Table 1. Innovation and Global Welfare Levels under Universal Partial Coverage

Regime	Innovation Level	Global Welfare Level
GFT	K	$\frac{1}{2}K^2$
Benchmark (or, FTAPM)	$\frac{1}{3}K$	$\frac{5}{18}K^2$
FTARM	$\frac{1}{2}K$	$\frac{3}{8}K^2$
FTARP	$\frac{1}{2}K$	$\frac{3}{8}K^2$
CUPM	$\frac{1}{2}K$	$\frac{3}{8}K^2$

$$K = \sum \alpha_{2j}n_{2j} \quad \forall j = P, M, R$$

Table 2. Summary of the Cases with different Combinations of Partial and Full Coverage

Extent of Market Coverage*	Innovation Levels	FAT_{Rj} ($j = P, M$)	Choice of FTA Partner by R	CU_{PM}
p, f, f	$s_{pff}^{GFT} > s_{pff}^{CU} = s_{pff}^{RP} > s_{pff}^{RM} > s_{pff}^B$	Both FAT_{RP} and FAT_{RM} are conditionally feasible.	M is preferred to P.	CU_{PM} preferred by both P and M.
p, p, f	$s_{ppf}^{GFT} > s_{ppf}^{CU} = s_{ppf}^{RP} = s_{ppf}^{RM} > s_{ppf}^B$	Both FAT_{RP} and FAT_{RM} are conditionally feasible.	Indifferent.	CU_{PM} preferred by both P and M.
p, f, p	$s_{pfp}^{GFT} > s_{pfp}^{CU} = s_{pfp}^{RP} > s_{pfp}^{RM} > s_{pfp}^B$	FAT_{RP} is not feasible. FAT_{RM} is conditionally feasible.		CU_{PM} preferred by both P and M.
f, p, p	$s_{fpp}^{GFT} > s_{fpp}^{CU} = s_{fpp}^{RM} > s_{fpp}^{RP} > s_{fpp}^B$	FAT_{RM} is not feasible. FAT_{RP} is conditionally feasible.		CU_{PM} preferred by both P and M.
f, f, p	$s_{ffp}^{GFT} > s_{ffp}^{CU} > s_{ffp}^{RP} > s_{ffp}^{RM} > s_{ffp}^B$	Both FAT_{RP} and FAT_{RM} are conditionally feasible.	M is preferred to P.	CU_{PM} preferred by both P and M.

* f = full coverage; p = partial coverage. For example, (p, f, p) implies partial coverage in P and R and full coverage in M and so on.

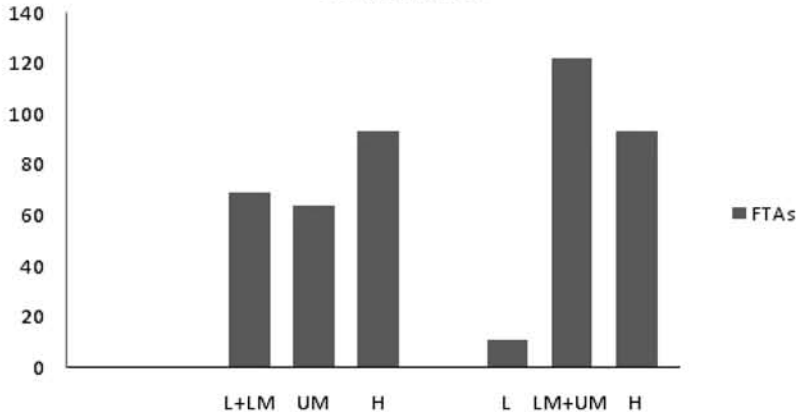
is when the MNC serves only to the high types in all the markets) corroborate to the claims made under propositions 1 and 3. However, now the global welfare level is the same under FAT_{RP} , FAT_{RM} and CU_{PM} .

One interesting case of partial market coverage is the case when the MNC serves both types in P and R but only the high type in M. Given there is no cost for innovation except for the sunk cost, as defined in (2), the MNC will serve all the markets with the same quality. The results differ from both the cases where the MNC opts for universal full coverage and where it opts for universal partial coverage. The innovation levels under different regimes can be ranked unambiguously as follows:

$$\bar{s}_{fpp}^{GFT} > \bar{s}_{fpp}^{CU} = \bar{s}_{fpp}^{RM} > \bar{s}_{fpp}^{RP} > \bar{s}_{fpp}^B \quad (41)$$

where, sub-script ‘‘fpf’’ stands for partial coverage in M and full coverage in P and R and the super-scripts depict the different trade regimes as discussed earlier in the paper. Formation of CU between P and M remains the best option for both the poor and middle-income countries as compared to the unilateral tariff regime or FTAs with the rich country. Hence, our claims, as given in propositions 1 and 3, are corroborated.

Composition of FTA Partners of High Income Countries



L = Lower Income Countries, LM = Lower Middle Income Countries, UM = Upper Middle Income Countries and H = High Income Countries.

Sources: Compiled from World Bank and WTO.

Figure 3. Distribution of Members of Bilateral FTAs by High-income Countries.

However, in this particular case of partial coverage of markets by the MNC, the result given in (35a) regarding preference of the rich country in choosing its FTA partner, is reversed and such a decision on the part of the rich country is independent of the assumption regarding taste diversity given in (30). That is, the rich country will prefer to have the poor country as its bilateral FTA partner compared to the middle-income country. Hence, this result is just the opposite of what we have earlier derived under the case of universal full coverage as given in (35a).

Apart from the two polar opposite cases of universal full coverage and universal partial coverage and the case discussed above, there are other cases where (17) does not hold for all the countries. The innovation levels and feasibility of formation of trade blocs in all these cases are summarized in Table 2.

These results corroborate, to some extent, to what can be observed regarding the types of FTAs that are being negotiated and signed. Out of 226 implemented bilateral FTAs formed by 19 high income nations, FTAs with Upper-middle income countries and those with Lower and Lower-middle income countries clubbed together are more or less the same in number. Whereas, number of FTAs with Lower-middle and Upper-middle countries clubbed together is larger than those with the High income countries.

5. CONCLUSION

In this paper we have analyzed the inter-relationship between endogenous trading bloc formation and innovation of a vertically differentiated good in a three-country world economy. In the benchmark model with no intra-country taste diversity, the level

of innovation is maximum under global free trade regime, though, the possibility seems to be an unlikely outcome given the assumptions of the model. Customs union between the poor and the middle-income countries is a feasible solution and the level of innovation is also higher than that under the rest of the possible regimes. The innovation levels under trade bloc formation seem to corroborate with the stream of relevant literature that argue trade liberalization favours innovation.

The basic findings remain more or less the same given the presence of intra-country taste diversity. Intra-country taste diversity also opens up the issue of the extent of market coverage in each country. What we observe is that in cases like universal full market coverage, the FTA between the rich country and poor or middle-income country (which was infeasible under the assumption of no intra-country taste diversity) may be feasible with side-payments by the rich country to its partner. However, in all cases of market coverage customs union between P and M remains to be the preferred trade bloc option. An interesting result obtained in this context is that the joint welfare maximizing customs union tariff may be less than the Nash equilibrium tariffs chosen unilaterally by them under no trade bloc formation.

Two interesting extensions constitute our future research agenda. First is to allow for parallel imports of the innovated good, which limits the scope of cross-country price discrimination by the patent holder MNC. With increasing number of countries allowing parallel imports, it may be worthwhile to examine robustness of our results in such a context. Second, following the literature on union formation [such as Gatsios and Karp (1991)], a delegation game between potential union members may be considered to examine its implications for post-union innovation level and consequently, on the choice of union formation itself.

REFERENCES

1. Acharyya, R. (1998). Monopoly and Product Quality: Separating or Pooling Menu? *Economics Letters*, Vol. 61, Issue 2, 187–194.
2. Acharyya, R. (2005). Regional Economic Groupings in the Global Trading System. In R. Acharyya (Ed.) *Essays on International Trade*. Allied Publisher : New Delhi.
3. Acharyya, R. and M. D. C. Garcia-Alonso (2008). Parallel Imports, Innovations and National Welfare: The Role of the Sizes of Income Classes and National Markets for Health Care. *The Singapore Economic Review*, Vol. 53, Issue 1, 57–79.
4. Baldwin, R. E. (1992). Measurable Dynamic Gains from Trade. *The Journal of Political Economy*, Vol. 100, Issue 1, 162–174.
5. Baldwin, R. E. and R. Forslid (2000). Trade Liberalization and Endogenous Growth: A q -theory Approach. *Journal of International Economics*, Vol. 50, Issue 2, 497–517.
6. Baldwin, J. R. and W. Gu (2004). Trade Liberalization: Market Participation, Productivity Growth and Innovation. *Oxford Review of Economic Policy*, Vol. 20, Issue 3, 372–392.
7. Bandopadhyay, S and R. Acharyya (2006). Does Input Sector Liberalization Promote Quality Innovation and Exports? *International Review of Economics and Finance*, Vol. 15, Issue 4, 443–462.
8. Choi, C. J. and H. S. Shin (1992). A Comment on a Model of Vertical Product Differentiation. *The Journal of Industrial Economics*, Vol. 40, Issue 2, 229–231.
9. Clemenz, G. (1990). International R&D Competition and Trade Policy. *Journal of International Economics*, Vol. 28, Issue 1-2, 93–113.

10. Dixit, A. K. (1988). International R&D Competition and Policy. In A. M. Spence and H. A. Hazard (Eds.) *International Competitiveness*. Rallinger Publishing Company, Cambridge.
11. Ederington, J. and P. McCalman (2008). Endogenous Firm Heterogeneity and the Dynamics of Trade Liberalization. *Journal of International Economics*, Vol. 74, Issue 2, 422–440.
12. Gatsios, K. and L. Karp (1991). Delegation Games in Customs Union. *Review of Economic Studies*, Vol. 58, 391–397.
13. Gustafsson, P. and P. Segerstrom (2010). Trade Liberalization and Productivity Growth. *Review of International Economics*, Vol. 18, Issue 2, 207–228.
14. Herguera, I., P. Kujal, and E. Petrakis (2000). Quantity Restrictions and Endogenous Quality Choice. *International Journal of Industrial Organization*, Vol. 18, Issue 8, 1259–1277.
15. Maskus, K. (2001). *Parallel Imports in Pharmaceuticals: Implications for Competition and Prices in Developing Countries*. Final Report to World Intellectual Property Organization.
16. Schiff, M. and L. A. Winters (2003). *Regional Integration and Development*. World Bank.
17. Spencer, B. J. and J. A. Brander (1983). International R&D Rivalry and Industrial Strategy. *Review of Economic Studies*, Vol. 50, Issue 4, 707–722.
18. Valletti, T. M. (2006). Differential Pricing, Parallel Imports and the Incentive to Invest. *Journal of International Economics*, Vol. 70, Issue 1, 314–324.
19. Wacziarg, R. (2000). Measuring the Dynamic Gains from Trade. *Stanford University Working Paper* No. 1654.

APPENDICES

A.1. BEST-RESPONSE TARIFF FUNCTION OF COUNTRY-P AND UNILATERALLY OPTIMUM NASH EQUILIBRIUM TARIFF LEVELS

From (6) we have $s^* = (1 - t_P)\alpha_P N_P + (1 - t_M)\alpha_M N_M + \alpha_R N_R$

From (7a) we have $W_P = t_P \alpha_P N_P s^*$

Hence we have $W_P = t_P \alpha_P N_P [(1 - t_P)\alpha_P N_P + (1 - t_M)\alpha_M N_M + \alpha_R N_R]$

As a result, the first order condition obtained while choosing the national welfare maximizing tariff rate yields

$$\frac{\delta W_P}{\delta t_P} = 0 \implies 2t_P \alpha_P N_P + t_M \alpha_M N_M = \sum \alpha_j N_j$$

Hence, when $t_M = 0$ we have $t_P^* = \frac{\sum \alpha_j N_j}{2\alpha_P N_P}$ and for $t_M = \frac{\sum \alpha_j N_j}{\alpha_M N_M}$ we have $t_P^* = 0$.

Now, $t_P = (\sum \alpha_j N_j - t_M \alpha_M N_M) / 2\alpha_P N_P$ gives the best-response function for country-P given any tariff rate set by country-M. Similarly, for country-M we get the best-response function to be

$$t_M = \left(\sum \alpha_j N_j - t_P \alpha_P N_P \right) / 2\alpha_M N_M$$

Solving the above two best-response functions we get the Nash equilibrium tariff levels to be

$$t_{k,B}^* = \frac{1}{3} \left[\frac{\sum_j \alpha_j N_j}{\alpha_k N_k} \right] \quad \forall \quad j = P, M, R; \quad k = P, M$$

A.2. INFEASIBILITY OF FTA_{RM} AND FTA_{RP}

Given the case of FTA_{RM} we have–

$$W_R^{RM} = \frac{1}{8} (\sum_j \alpha_j n_j)^2$$

$$W_M^{RM} = 0$$

Hence, the joint welfare of the bloc turns out to be –

$$(W_R^{RM} + W_M^{RM}) = \frac{1}{8}(\sum_j \alpha_j n_j)^2$$

However, under the benchmark case we have –

$$(W_R^B + W_M^B) = \frac{3}{18}(\sum_j \alpha_j n_j)^2 > (W_R^{RM} + W_M^{RM})$$

Hence, R can not make enough side-payments to M as compared to the benchmark level of welfare M had, and M will not agree to join FTA_{RM} .

Given the case of FTA_{RP} we have –

$$W_R^{RP} = \frac{1}{8}(\sum_j \alpha_j n_j)^2$$

$$W_P^{RP} = 0$$

Hence, the joint welfare of the bloc turns out to be –

$$(W_R^{RP} + W_P^{RP}) = \frac{1}{8}(\sum_j \alpha_j n_j)^2$$

However, under the benchmark case we have –

$$(W_R^B + W_P^B) = \frac{3}{18}(\sum_j \alpha_j n_j)^2 > (W_R^{RP} + W_P^{RP})$$

Hence, R can not make enough side-payments to P as compared to the benchmark level of welfare P had, and P will not agree to join FTA_{RP} .

A.3. CONDITION FOR MNC SERVING BOTH TYPES

If the MNC chooses to serve both the high and low type buyers then it will face the profit function

$$\pi_f = N_j P_j^f - \frac{1}{2} s_f^2$$

where, $P_j^f = \alpha_{1j} s_f$

Profit maximization yields the optimal innovation level to be

$$s_f^* = N_j \alpha_{1j}$$

Now, if the MNC chooses to serve only the high type in each market then it will face the profit function

$$\pi_p = n_{2j} P_j^p - \frac{1}{2} s_p^2$$

where, $P_j^p = \alpha_{2j} s_p$

In this case the optimal innovation level turns out to be

$$s_p^* = n_{2j} \alpha_{2j}$$

Now, the MNC serves both types if $\pi_f > \pi_p$ that is,

$$\frac{n_{1j}}{n_{2j}} > \frac{\alpha_{2j} - \alpha_{1j}}{\alpha_{1j}}$$

A.4. PROOF $s_f^B < s_B^*$

From (8) we have $s_B^* = \frac{1}{3}(\sum_j \alpha_j N_j)$

From (22) we have $s_f^B = \frac{1}{3}[G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})]$

Expanding equation (22) and subtracting (8) from it we have

$$s_f^B - s_B^* = \frac{1}{3}(\alpha_{1P}N_P + \alpha_{1M}N_M + \alpha_{1R}N_R + \alpha_{2M}n_{2M} - \alpha_{1M}n_{2M} \\ + \alpha_{2P}n_{2P} - \alpha_{1P}n_{2P} - \alpha_P N_P - \alpha_M N_M - \alpha_R N_R)$$

Using (16b) in the above equation we have

$$s_f^B - s_B^* = -\frac{1}{3}(\alpha_{2R}n_{2R}) < 0$$

A.5. PROOF OF $t_P^{Ri} > t_P^*$

Given (25) we have $t_P^{Ri} = \frac{1}{2N_P\alpha_{1P}}[G - n_{2P}(\alpha_{2P} - \alpha_{1P})]$

Again from (21a) we have $t_P^* = \frac{1}{3\alpha_{1P}N_P}[G - 2n_{2P}(\alpha_{2P} - \alpha_{1P}) + n_{2M}(\alpha_{2M} - \alpha_{1M})]$

Hence, $t_P^{Ri} - t_P^* = \frac{1}{6\alpha_{1P}N_P}[G - 2n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})] > 0$ since

from (21b) we have $t_M^* = \frac{1}{3\alpha_{1M}N_M}[G - 2n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})]$

A.6. COMPARISON OF INNOVATION LEVELS UNDER INTRA-COUNTRY TASTE DIVERSITY

From (22) we have the level of innovation under the benchmark case given intra-country taste diversity to be

$$s_f^B = \frac{1}{3}[G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})]$$

where, $G = (\sum_j N_j \alpha_{1j})$; $j = P, M, R$.

From (26) we have the levels of innovation under the FTA_{RP} and FTA_{RM} regimes to be respectively

$$s_f^{RP} = \frac{1}{2}[G + n_{2M}(\alpha_{2M} - \alpha_{1M})]$$

$$s_f^{RM} = \frac{1}{2}[G + n_{2P}(\alpha_{2P} - \alpha_{1P})]$$

Hence, we have

$$s_f^{RP} - s_f^B = \frac{1}{6}[G + n_{2M}(\alpha_{2M} - \alpha_{1M}) - 2n_{2P}(\alpha_{2P} - \alpha_{1P})] = \frac{1}{2}N_P\alpha_{1P}t_P^B$$

Therefore, $(s_f^{RP} - s_f^B) > 0$ if $t_P^B > 0$

Now, $t_P^B < 0$ if

$$2(\alpha_{2P} - \alpha_{1P})n_{2P} > G \quad \text{which is unlikely.}$$

Therefore, $t_P^B > 0$ and we have $(s_f^{RP} - s_f^B) > 0$

Similarly, we can easily prove

$$(s_f^{RM} - s_f^B) > 0$$

Again given assumption (30) we have

$$(s_f^{RM} - s_f^{RP}) < 0$$

Hence, combining the above results we have

$$s_f^{RP} > s_f^{RM} > s_f^B$$

A.7. PROOF OF INEQUALITY GIVEN IN 35(A)

$$\begin{aligned} \text{Let } \Delta &= (\tilde{W}_R^{RM} + \tilde{W}_M^{RM}) - (\tilde{W}_R^{RP} + \tilde{W}_P^{RP}) \\ &= \frac{1}{2} \left[(s_f^{RM})^2 - (s_f^{RP})^2 \right] + (s_f^{RM})(r+m) - (s_f^{RP})(r+p) \end{aligned}$$

where, $p = (\alpha_{2P} - \alpha_{1P})n_{2P}$, $m = (\alpha_{2M} - \alpha_{1M})n_{2M}$ and $r = (\alpha_{2R} - \alpha_{1R})n_{2R}$.

Now, from (26) and (30) we have $s_f^{RM} = \frac{1}{2}(G+p)$, $s_f^{RP} = \frac{1}{2}(G+m)$ and $p < m$.

$$\therefore \Delta = \frac{1}{8}(m-p)(2G-p-m-4r) \quad (\text{A})$$

Now, $(2G-p-m-4r) = (G-p-m-r) + (G-3r)$

From (17) we have $\alpha_{1j}n_{1j} > (\alpha_{2j} - \alpha_{1j})n_{2j}$. Using this we have $(G-p-m-r) > 0$. As $(m-p) > 0$, from (A) we can prove that $\Delta > 0$ if $\Theta > 0$ where, $\Theta = (G-3r)$.

$$\begin{aligned} \Theta &= (G-3r) = \alpha_{1P}N_P + \alpha_{1M}N_M + \alpha_{1R}N_R - 3n_{2R}(\alpha_{2R} - \alpha_{1R}) \\ &= \alpha_{1P}N_P + \alpha_{1M}N_M + \alpha_{1R}n_{2R} - 2n_{2R}(\alpha_{2R} - \alpha_{1R}) + \beta \end{aligned}$$

$$\text{where, } \beta = \alpha_{1R}n_{1R} - (\alpha_{2R} - \alpha_{1R})n_{2R} > 0$$

$$= \alpha_{1P}N_P + \alpha_{1M}N_M + 3\alpha_{1R}n_{2R} - 2\alpha_{2R}n_{2R} + \beta$$

Hence, $\Theta < 0$ if $2\alpha_{2R}n_{2R} > (\alpha_{1P}N_P + \alpha_{1M}N_M + 3\alpha_{1R}n_{2R} + \beta)$ which is unlikely.

Therefore, $\Theta > 0$ and $\Delta > 0$.

A.8. SIMULATION RESULTS

Let $\Delta W = (\tilde{W}_R^{RP} + \tilde{W}_P^{RP}) - (\tilde{W}_R^B + \tilde{W}_P^B)$. Using (23a), (23b), (28) and (29) we have

$$\Delta W = \frac{1}{6}(G+m-2p)r + \frac{1}{24}(-G^2 - m^2 - 4p^2 - 2Gm + 4Gp + 4pm)$$

Let, $\alpha_{1P} = \alpha_{1M} = \alpha_{1R} = 1$, that is, the lower taste parameter is the same in all the countries and equal to 1. Using this we have $G = \sum_j N_j = N$.

CASE-1: Let $N = 90$, $r = 10$

$$\Delta W = 4p^2 + m^2 + 140m - 280p - 4pm + 4500$$

Now plot $\Delta W = 0$ curve in the (p, m) space to find out the feasible range of FTA_{RP} . Note that p and m must be positive and less than $N = 90$. This is because by (17) $\alpha_{1P}n_{1P} > (\alpha_{2P} - \alpha_{1P})n_{2P} \implies \alpha_{1P}n_{1P} > p \implies p < n_{1P}$ and $n_{1P} < N = 90$.

The $\Delta W = 0$ curve is a positively sloped curve because along $\Delta W = 0$ we have

$$\frac{dm}{dp} = \frac{280 + 4m - 8p}{140 + 2m - 4p} = 2 > 0$$

Its position, however, is ambiguous since, for $m = 0$, we have

$$\Delta W = 0 \Rightarrow 4p^2 - 280p + 4500 = 0$$

which implies that $\Delta W = 0$ has two roots: $p = 25$, $p = 45$. These roots actually indicate the horizontal intercepts of the $\Delta W = 0$ curve. But by (30) $p < m$ so that the relevant region lies above the $p = m$ line and this rules out the $\Delta W = 0$ curve emanating from $p = 45$.

Now, to identify the $\Delta W > 0$ region, which is our target region as it implies that FTA_{RP} is possible, we examine the sign of $\frac{\delta \Delta W}{\delta p}$ in the region below and above the $\Delta W = 0$ line:

$$\frac{\delta}{\delta p} \Delta W = 8p - 4m - 280$$

The sign is ambiguous and hence we plot $\frac{\delta}{\delta p} \Delta W = 0$ line with the following properties. Along the $\frac{\delta}{\delta p} \Delta W = 0$ line $\frac{dm}{dp} = 2 > 0$ and for $m = 0$ we have $\frac{\delta}{\delta p} \Delta W = 0$ at $p'' = 35$. Thus, $\frac{\delta}{\delta p} \Delta W = 0$ line has same slope as the relevant $\Delta W = 0$ line and lies to the right of it.

We now have three regions labeled I, II and III. In regions I and II, $\frac{\delta \Delta W}{\delta p} < 0$ and in region III, $\frac{\delta \Delta W}{\delta p} > 0$. Given this, consider region I to the left of $\Delta W = 0$ line. For any

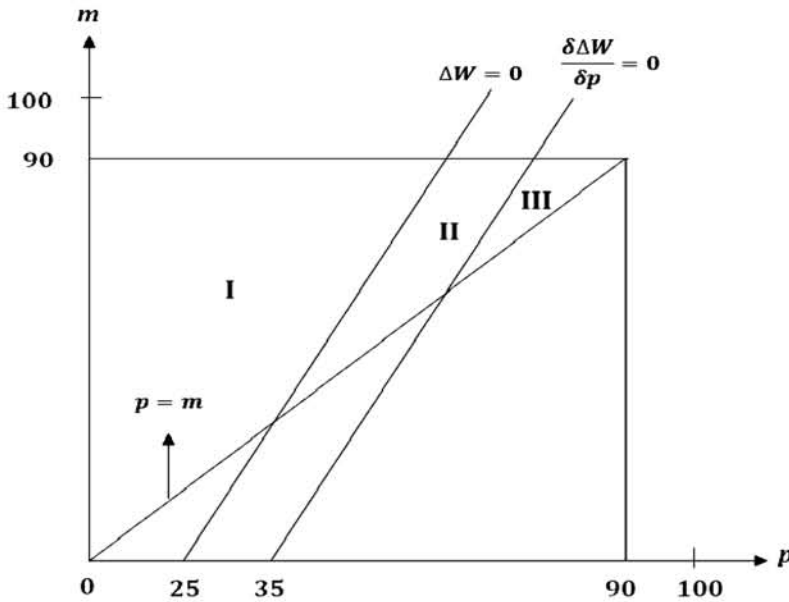


Figure 4. Feasibility of FTA_{RP} -Case 1.

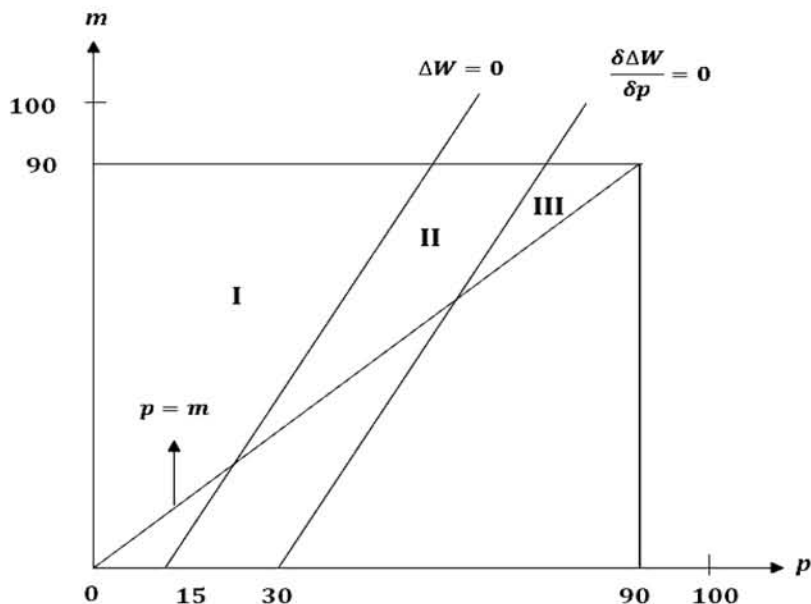


Figure 5. Feasibility of FTARP-Case 2.

given m , value of p in this region is smaller than the value of p for which $\Delta W = 0$. $\frac{\delta}{\delta p} \Delta W > 0$ in this region I means $\Delta W < 0$. In region II, p is larger than the value of p for which $\Delta W = 0$. Hence, given $\frac{\delta}{\delta p} \Delta W > 0$ in this region it means that $\Delta W > 0$. In region III, $\frac{\delta \Delta W}{\delta p} < 0$ and hence, $\Delta W < 0$.

Hence, given any combination of (p, m) in the region II, FTARP (and hence FTARM) is feasible.

Figures 5 and 6 similarly identify region II as the feasible region for FTA for other sets of values of r , that is, the extent of taste diversity in country-R.

CASE-2: Let $N = 90, r = 15$

$$\Delta W = 4p^2 + m^2 + 120m - 240p - 4pm + 2700$$

CASE-3: Let $N = 90, r = 20$

$$\Delta W = 4p^2 + m^2 + 100m - 200p - 4pm + 900$$

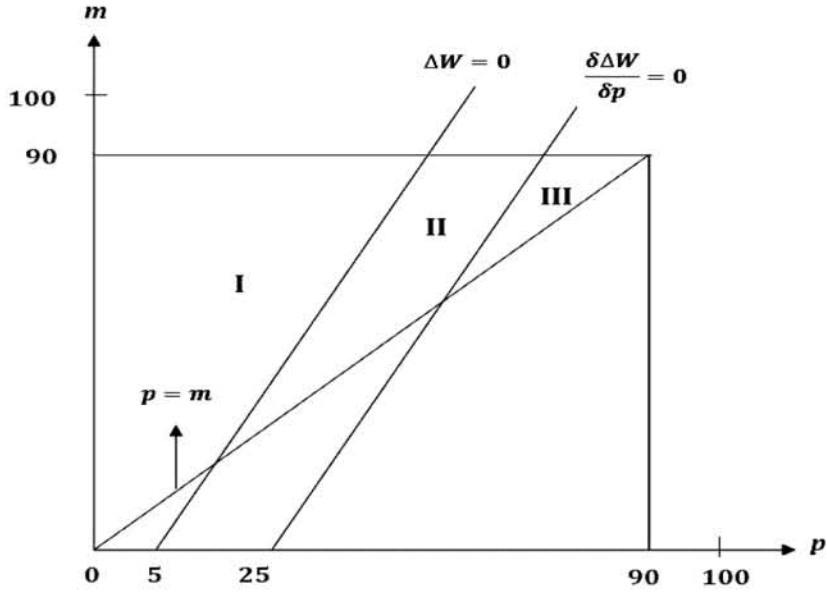
A.9. WELFARE COMPARISONS

Joint welfare level of P and M under customs union as given in (39a) is

$$\tilde{W}_{PM}^{CU} = \tilde{W}_P^{CU} + \tilde{W}_M^{CU} = (s_f^{CU})^2$$

where, $s_f^{CU} = \frac{1}{2}[G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})]$

Now, welfare levels of P and M separately under the benchmark case as given in (23a) are

Figure 6. Feasibility of FTA_{RP}-Case 3

$$\tilde{W}_j^B = (s_f^B)^2 \quad \forall \quad j = PM$$

where, $s_f^B = \frac{1}{3}[G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})]$

Putting, $K = [G + n_{2M}(\alpha_{2M} - \alpha_{1M}) + n_{2P}(\alpha_{2P} - \alpha_{1P})]$ we have

$$\tilde{W}_{PM}^{CU} = \frac{1}{4}K^2 \quad \text{and} \quad \tilde{W}_P^B + \tilde{W}_M^B = \frac{2}{9}K^2$$

Therefore,

$$\tilde{W}_{PM}^{CU} - (\tilde{W}_P^B + \tilde{W}_M^B) = \left(\frac{1}{4} - \frac{2}{9}\right)K^2 > 0$$