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2004-51-ECO

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Existence of Equilibrium in Welfare-Enhancing Free Trade Areas

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September 2004

Abstract

Proving the existence of equilibrium having specified properties is often synonymous with proving the result in trade theory. The Grandmont-McFadden proposition that any autarkic allocation can be replaced by a Pareto superior free trade equilibrium involving domestic transfers only depends on an existence proof, for example. Comparable proofs for free trade areas have not been provided to date because unharmonized tariffs imply goods prices that vary by member country and require potentially complicated rules of origin that block standard proofs. This paper fills this gap by providing the missing proof that starting from an arbitrary world trade equilibrium, a free trade area equilibrium can be found involving *domestic* transfers only that is at least as satisfactory for every consumer as the original allocation.

JEL classification numbers: D60, F13, F15

Keywords: Walrasian equilibrium, Free trade areas, rules of origin, welfare analysis.

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1 Introduction

In the 1970s the economics profession expanded its ability to prove the existence of general equilibrium under much more general conditions than were known before. Gale and Mas-Colell (1975), Shafer and Sonnenschein (1975), McKenzie (1981) and others proved that competitive equilibria exist in economies with non-transitive, interdependent and price-dependent preferences. Competitive equilibrium also exists in the presence of production technologies where a finite amount of output can be generated by zero input, and even in more abstract circumstances where the income of every consumer is represented by any continuous function of prices. The search for ever more general conditions that support the existence of competitive equilibrium continues. In fact, for many research areas, proving the existence of general equilibrium is more than a side light: it is essential to the phenomenon under investigation.

In the study of welfare-enhancing preferential trade agreements, proving the existence of general equilibrium is often synonymous to the result under review. In the case of free trade areas, an important theoretical and practical objective is to show that for any arbitrary initial trade equilibrium, a Pareto superior equilibrium exists that is consistent with the simultaneous and possibly price-dependant assignment of purchasing power to agents needed to support the declaration that no one is worse off. Demonstrating that a new equilibrium would generate enough aggregate income to buy every agent a preferred bundle is not sufficient because the act of purchasing the bundles and distributing income in the needed direction will generally alter prices, thereby destroying the presumed equilibrium. In other words, showing that an equilibrium that has some features will also have other features does not show that the other features will be attained unless an existence proof is provided for the original equilibrium. In the study of free trade areas, finding the proof of existence has been blocked by the rules of origin and their complicated effects. This paper fills this gap by proving existence.

The modern theory of preferential trading agreements dates back to the pathbreaking work of Kemp and Wan (1976) who showed that any group of countries is capable of forming a customs union where the common external tariff is chosen to freeze prices in the rest of the world and appropriate intra-union transfers are used to guarantee that the union is welfare enhancing to each household of its member countries. They showed that a Pareto-improving equilibrium existed, but their method did not provide a description of how to find the compensations that support the welfare enhancement of the union households.

Grinols (1981) augmented Kemp and Wan (1976) by identifying transfers to compensate each union household consistent with Pareto improvement and the Grandmont-McFadden (1972) existence theorem. Grinols' transfers were self-financing in the sense that they summed to the tariff revenues of the customs union as a whole, and were necessary and sufficient in the sense that under certain circumstances, they are the only ones feasible to achieve a Pareto Superior allocation in a Kemp-Wan customs union. The transfers satisfy a revealed preference condition that each household has sufficient income to purchase its pre-union consumption bundle at post-union

prices. At the national level, the transfers imply that each member country is able to purchase at post-union internal prices its pre-union trade bundle. Kowalczyk and Sjostrom (2000), and Konishi, Kowalczyk and Sjostrom (2003) show that Kemp-Wan customs unions and the Grinols' compensation mechanism bring global free trade into the core and have other desirable properties.

In spite of the fact that free trade areas (FTAs) are popular and are more common than customs unions, existence results for free trade areas comparable to those for customs unions have not been extended to FTAs. An important advance occurred when Panagariya and Krishna (2002) showed that an equilibrium that incorporated a particular selection of rules of origin, with member countries choosing their respective tariffs to freeze individual country trade flows with the non-FTA rest of the world at the pre-formation level, and the use of appropriate cross-country transfers would imply the formation of a welfare-enhancing free trade area. Grinols and Silva (2003a) re-proved their result in a framework that provided for a marginally more general setting and eliminated the need for cross country transfers. A companion paper, Grinols and Silva (2003b), considered the additional issue of the welfare consequences of enforcing industrialization targets in a Panagariya-Krishna FTA. Industrialization targets are specified levels of industry variables such as consumption, output, or employment. They showed that satisfaction of industrialization targets through the application of commodity taxes directed to the variables of interest and applied at the minimum level necessary is superior to all other strategies, and that the strategy is optimal to each member country independently, whether or not cross-country transfers are present and whether or not other participant countries implement their optimal strategy. Policy and tariff independence therefore appears to be an advantage of free trade areas over customs unions.

Others have pointed out (see Feenstra, 2004 for example) that Panagariya and Krishna (2002) did not prove existence of the equilibrium described in their paper. The subsequent FTA results described above are in the same situation. This paper therefore provides a proof of the existence of competitive equilibrium for the FTA studied in Panagariya and Krishna (2002) and Grinols and Silva (2003a) using the Gale and Mas-Colell theorem (Gale and Mas-Colell, 1975). We also shed light on the relationship between the choice of rules of origin and welfare enhancing FTAs. Only FTAs whose rules of origin leave value added unrestricted within member countries can unambiguously guarantee welfare gains where each member chooses tariffs to keep its trade flows with the rest of the world constant at the pre-formation levels.

The results are provided in stages. Section 2 describes the model and states the main proposition on the existence of competitive equilibrium for Panagariya-Krishna FTAs. Section 3 explains and elaborates on the rationale for the existence of equilibrium theorem shown in Section 2. It also identifies the unique class of rules of origin that guarantee welfare gains consistent with the formation of a FTA where member countries choose tariffs to freeze their trade flows with non-FTA members at the pre-formation levels. Section 4 concludes with selected comments on the practical significance of being able to form Pareto superior equilibria as part of the move to freer world trade.

2 Transportation and Equilibrium

Consider an FTA formed by two countries named Home and Foreign that are denoted by H and F, respectively. The rest of the world is denoted by letter W. The extension to an FTA formed by several countries is clear and will not be pursued here. Goods are differentiated both by their characteristics and location. Any good can be used for final consumption or as an intermediate good in production. A good produced in one country and transported to another becomes a different good. We consider economies that produce K types of goods, implying $9K$ goods in total (3 countries of origin and 3 countries of destination). Since goods are differentiated by their location and description, the prices prevailing in the trade area are described in a $9K \times 1$ vector.

Assume that countries H and F can implement different tariffs and that internal free trade prevails between them. We will generically refer to countries H and F satisfying these conditions as a union without specifying whether it is a customs union, free trade area, or some other variant. Thus, goods originating in the rest of the world may have different prices in union countries' markets. Producers in the union desire to sell their output in the member market with higher price and, therefore, may create an impediment to member countries' independent tariffs setting. The argument used here can be found in Richardson (1992). Potential conflict arises from the ability to import a product from the rest of the world and transship it to the member market with the higher internal price. In this case, transportation implies a relationship between goods prices that is potentially inconsistent with the tariffs of union members. This issue will have to be treated in the proof of general equilibrium existence.

We list the following two assumptions. They will sometimes be assumed to apply and sometimes not, as circumstances direct.

Assumption 1 *(Limited Transshipment) There does not exist a transportation technology in the post-union situation to transport to the other union member a good imported from W.*

Assumption 2 *(Choice of Tariffs) Each union member chooses tariffs so that its trade with the rest of the world (country W) is unchanged between the initial pre-union situation 0 and the post-union-formation situation 1.*

Assumption 1 is a statement about physical capability. Assumption 2 deals with a meta-time comparison that supposes that non-member countries keep their trade policies unchanged. See Richardson (1995) for an example where non-members act strategically in real time and assumption 2 is not valid. See also Kemp and Shimomura (2001) for further comment on this. It is important to stress that any good originating in the rest of the world and that was imported by country H (F) indirectly through country F (H) in the original equilibrium is considered country H's $(F$'s$)$ import from W. When assumption 2 is satisfied goods imported indirectly through the partner country are considered part of the trade flows that have to be kept unchanged through the application of tariffs. This fact will play a crucial role in the welfare effects of FTAs as shown in

the next section. A country pairing that satisfies assumptions 1 and 2 differs from an FTA since, in the latter case, appropriate rules of origin would substitute for the operation of assumption 1.

Next, let the prices prevailing in the union be denoted by p. They differ from world prices p^W by tariffs t, $p = p^W + t$. Based on this we can write,

$$p \equiv \begin{pmatrix} p_{HH} \\ p_{FH} \\ \hline p_{WH} \\ p_{HF} \\ p_{FF} \\ \hline p_{WF} \\ p_{HW} \\ p_{FW} \\ p_{WW} \end{pmatrix} = p^W + t = p^W + \begin{pmatrix} 0 \\ 0 \\ \hline t_{WH} \\ 0 \\ 0 \\ \hline t_{WF} \\ t_{HW} \\ t_{FW} \\ 0 \end{pmatrix} \tag{1}$$

where $t_{ab} \epsilon R^K$ is the vector of tariffs applied to goods originating in country a and whose location of final use is country b. It is clear from equation (1) that country H selects tariffs t_{WH} on goods acquired from country W, which may differ from country's F tariffs on products originating in the same location, t_{WF}. The duties on products imported by one union member from the other are zero, $t_{HF} = t_{FH} = 0 \epsilon R^K$.

Country i's net production vector is $y^i \epsilon Y^i \subset R^{9K}$, $i = H, F$. A positive component of y^i is an output and a negative element is an input. Let's denote the consumption vector of country i by $x^i \epsilon X^i \subset R^{9K}$. The consumption vector of consumer j of country i is denoted by $x^i_j \epsilon X^i_j \subset R^{9K}$. The external trade vector of country i is denoted by $z^i \epsilon R^{9K}$. A positive element of z^i is an imported good and a negative element is an exported good. Endowments are denoted by $\omega^i \epsilon R^{9K}$. Many coordinates of the vectors x^i, y^i, ω^i and z^i will be zero. For example, external trade in goods produced and consumed in the same country is zero.

Based on the above, we can apply the Gale and Mas-Colell theorem to establish the following:

Proposition 1 *Assume that assumption 1 holds, and that countries H and F form a free trade area satisfying assumption 2. Then there exists a competitive equilibrium $\bar{\mathcal{E}}$ that has the property that consumers in countries H and F are not worse off compared to their pre-agreement consumption bundles.*

Proposition 2 *Let countries H and F be endowed with transportation technology to transport to the other a good imported from W. Then, with appropriate choice of rules of origin there exists an identical competitive equilibrium $\bar{\mathcal{E}}$ where countries H and F form a free trade area satisfying assumption 2. $\bar{\mathcal{E}}$ has the property that consumers in countries H and F are not worse off compared to their pre-agreement consumption bundles.*

In the next section we explain the intuition of the propositions and describe the rules of origin for proposition 2. Details of the application of the Gale and Mas-Colell theorem is provided in the appendix.

3 Rules of Origin, FTA Equilibrium and Welfare

3.1 Rules of Origin and Equilibrium

Transshipment transportation is a form of production that allows a producer to import a product from location a and re-export it to location b. Assumption 1 is a statement about the economy's capabilities that implies the absence of any linkage between the prices of goods imported from the rest of the world to H and F. If equilibrium exists for such an economy, it is unencumbered by transhipment-induced price vector constraints. The rationale for propositions 1 and 2 is based upon the relation between rules of origin that prevent transshipment and the transshipment capability of producers.

Consider an economy formed from countries H and F that possesses two important characteristics. First, the pre-union trade vector of each country is considered part of their production sets. Second, each country lacks the transshipment capability of importing a good from W and re-exporting it to the other country. This economy possesses a competitive equilibrium and general conditions that support its existence are given in the appendix. Since this equilibrium is equivalent to a preferential trade agreement that satisfies assumptions 1 and 2, the main result of proposition 1 is obtained.

In general, producers can be expected to have the ability to transship products to any location of a preferential trade area. Assumption 1 is not usually satisfied, therefore, and in practice the use of rules of origin operates in its place. However, an equilibrium without transshipment is functionally equivalent to equilibrium in an identical economy with transshipment capability but where rules of origin prevent transshipment. The following rules of origin are the weakest that prevent transshipment of pre-existing commodities.

Assumption 3 (Rules of Origin) *A good or service may enter duty free to one FTA country from the other if and only if it contains strictly positive value added of the sending FTA country. If the good is "new" (neither produced nor consumed at the initial pre-FTA situation 0), it may pass duty free to one FTA country from the other if and only if it contains 100 percent value added of the sending FTA country.*

We are now ready to explain the relation between proposition 2 and proposition 1. Assume that an FTA formed from countries H and F satisfies assumptions 2 and 3 but not necessarily assumption 1. Rules of origin are applied with the unique objective of preventing the transshipments of pre-existing commodities. They therefore have the effect of removing transshipment capability from countries H and F as described in assumption 1. Consequently, proposition 1 can be interpreted to say that an FTA that satisfies assumptions 2 and 3 is identical to the transshipmentless economy described above and possesses an identical competitive equilibrium. The competitive equilibrium is unencumbered by transhipment-induced price vector constraints and implies that member countries' independent tariff setting is consistent with the prices prevailing within the FTA. Proving existence of competitive equilibrium for this economy proves existence of equilibrium for the FTA with transshipment.

Propositions 2 also recognizes that the formation of an FTA that satisfies assumptions 2 and 3 is Pareto improving. We turn next to a framework to explain the welfare enhancing property of FTAs described in proposition 2. This framework is also used to show that rules of origin that satisfy assumption 3 are optimal as long as member countries set tariffs according to assumption 2.

3.2 Rules of Origin and Welfare

Krishna (2004) and Krueger (1997) maintain that the rules of origin implemented in practice often impose minimum requirements on the value that needs to be added within member countries to grant produced commodities duty-free access. The production choices available to an economy with the less restrictive assumption 3 rules of origin imposed are equivalent to the original production set intersected with the closed convex set formed from R^{9K} with transshipment vectors removed. The appendix discusses this in more detail. Consequently, rules of origin can be interpreted as a reduction in the production choices available to firms located within the union. If superscripts 0 and 1 describe the pre- and post-FTA situations, respectively, $Y^{i,0} \supseteq Y^{i,1}$ where Y^i is the production set of country i. The larger the set of goods for which rules of origin prevent transshipment, the smaller the set that the original production set is intersected with. Next we demonstrate the different effects of rules of origin as commonly applied and the rule described in assumption 3.[1]

To discuss the welfare effects of more restrictive rules of origin, we will use a framework in this section that is slightly less general than that used to prove proposition 1. The results shown in proposition 1 do not require that preferences be complete and transitive. Now let us assume, however, that each household j of country i has preferences that can be represented by a utility function u^i_j. Likewise, the income of every consumer in Proposition 1 can be any continuous function of prices. Here we assume that the distribution rule provides each consumer enough income to purchase his pre-agreement consumption bundle at post agreement prices, plus a non-negative supplement: $e^i_j(p^{i,1}, u^{i,1}_j) \equiv p^1 \cdot x^{i,0}_j + \theta^i_j \left[p^1 \cdot x^{i,1} - p^1 \cdot x^{i,0}\right]$ where $e^i_j(p^{i,1}, u^{i,1}_j)$ is the consumer's expenditure function, $\theta^i_j \geqslant 0$, and $\sum_j \theta^i_j = 1$.

Our first result is that this distribution plan is viable under assumptions 2 and 3 without requiring cross country transfers. Write the change in welfare for consumer j of member country $i = \{H, F\}$ using the distribution rule as $\Delta W^i_j \equiv e^i_j(p^1, u^{i,1}_j) - e^i_j(p^1, u^{i,0}_j)$, where $u^{i,0}_j$ and $u^{i,1}_j$

[1] According to Krishna (2004) the main types of rules of origin applied in practice require that at least one of the following criteria be fulfilled to grant duty-free access to member countries markets: (i) minimum regional content; (ii) a pre-specific change in tariff heading; (iii) a specific phase of the production process performed within the preferential agreement; (iv) substantial transformation of name and characteristic. Thus, the rules of origin implemented in practice constrain the profit maximization choices of firms.

represent his pre- and post-FTA utility levels. We have

$$\begin{aligned}\sum_j \Delta W_j^i &= \sum_j \left[p^1 \cdot x_j^{i,0} - e_j^i(p^1, u_j^{i,0})\right] && \text{Term 1}\\ &+ \sum_j \theta_j^i \quad p^1 \cdot \left[y^{i,1}\left(p^1, Y^{i,1}\right) - y^{i,0}\right] && \text{Term 2}\\ &+ \sum_j \theta_j^i \quad p^1 \cdot \left[z^{i,1} - z^{i,0}\right] && \text{Term 3} \qquad (2)\end{aligned}$$

where we used the identity $x^{i,t} = y^{i,t} + \omega^{i,t} + z^{i,t}$ in situation $t = \{0, 1\}$. Term 1 describes the substitution in consumption effects, Term 2 represents the production efficiency effects due to prices and technology, and Term 3 summarizes tariff revenue and terms of trade effects.[2]

Term 1 ≥ 0 because consumers minimize the cost of achieving a given level of utility subject to their budget constraint. Term 2 ≥ 0 by the assumption of perfect competition which implies producer efficiency under constant production choices (firms maximize the value of aggregate output). Term 3 = 0 by direct calculation: $p^0 \cdot (z^{i,0} - z^{i,1}) = (p^{W,0} + t^0) \cdot (z^{i,0} - z^{i,1}) = p^{W,0} \cdot z^{i,0} - p^{W,0} \cdot z^{i,1} + t^0 \cdot (z^{i,0} - z^{i,1}) = p^{W,0} \cdot z^{i,0} - p^{W,1} \cdot z^{i,1} + t^0 \cdot (z^{i,1} - z^{i,0}) = t^0 \cdot (z^{i,1} - z^{i,0}) = 0$.

Term 2 contains the effects of rules of origin on welfare. If assumptions 2-3 are satisfied then quantities of goods which were imported indirectly through the partner country in the pre-FTA situation can continue to be imported indirectly (see comments in section 2 about assumption 2) as long as the tariffs levied on goods originating in the rest of the world continue to be paid. Goods that contain strictly positive value added of the sending member country in the pre-FTA situation can continue to be traded among member countries without restrictions as well. Thus, producers located within the FTA have the production choice $y^{i,0}$ available in the pre- and post-FTA situations. Consequently, if rules of origin that satisfy assumption 3 are applied, then Term 3 ≥ 0 and a Pareto improving allocation without cross country transfers can be implemented with the formation of the FTA. Because Terms 1-3 are sums of individually non-negative terms, each consumer is no worse off.

Inspection of equation (2) shows that rules of origin that differ from assumption 3 can reduce social welfare in conjunction with the formation of FTAs based on assumption 2 because the production choices of firms located within the union are diminished with respect to their pre-FTA levels: $Y^{i,0} \supset Y^{i,1}$. In this case, Term 2 can be negative ($y^{i,0}$ may no longer be available) and the implementation of a Pareto superior FTA allocation can not be assured. The reason for an ambiguous effect depends on a second best argument. If each FTA member freezes its trade flows with the rest of the world at pre-FTA levels, then setting tariffs to zero on trade among members eliminates a distortion present in the economy described by the FTA. However, independent tariff setting requires rules of origin. These can introduce distortions into the economy if they do not satisfy assumption 3.[3] The appendix provides a more formal statement in Proposition 4. The

[2] See Grinols and Wong (1991).

[3] The welfare gains in question can be even greater if the necessity for rules of origin is eliminated. This explains the static efficiency superiority of customs unions relative to free trade areas. In customs union formation the trade with the rest of the world of the entire union needs to be frozen at the situation 0 levels so that the preferential trade agreement collapses to a customs union.

rules of origin defined in assumption 2 are the only ones that eliminate the possibility of welfare losses due to the formation of FTAs where each member freezes its trade flows with the rest of the world at pre-formation levels.

4 Conclusion

This paper makes two contributions. First, it fills a gap in the literature by providing a proof for the existence of welfare-enhancing free trade areas. Starting from an arbitrary initial world trade equilibrium involving countries H, F, and W it shows that there exists an alternative Pareto improving free trade area equilibrium characterized by free trade between countries H and F, rules of origin specified in assumption 3, and external tariffs of H and F selected to freeze pre-existing trade flows of each country with W. Consumers in countries H and F have the ability to purchase their original consumption bundle or a strictly superior bundle. Conditions in W are unchanged. The alternative equilibrium does not require cross country transfers.

Second, the paper considers the effect of alternative rules of origin and shows that assumption 3 rules are the least restrictive needed to generate the stated results. More restrictive rules of the type often applied in practice are equivalent to reductions in the production set, for which the existence of Pareto improving equilibria cannot be guaranteed in general.

From a political perspective the road to free trade is often opposed by individuals, regions, industries, and/or sectors that lose in the move to freer trade. The need to internationally coordinate common tariffs between countries and to arrange for international cross country transfers form two additional impediments. The existence of a free trade area equilibrium for countries H and F that is Pareto superior to an arbitrary initial trade equilibrium, does not involve cross country transfers, or require coordination of country tariffs addresses all three points. This may explain the apparent popularity of free trade areas compared to other forms of preferential trading arrangements. It explains why less restrictive rules of origin than are often encountered in practice are sufficient for gains, and provides arguments against more restrictive forms. Whether free trade areas ultimately will constitute an impediment to free trade because of the regional complacency of FTAs that view their trade to be free enough, may hinge on other issues yet to be explored.

Appendix

Lemma: Assume that production sets Y^i are closed, convex, contain the negative orthant, and have a bounded intersection with the positive orthant. Let $y_{WH,k}$ and $y_{WF,k}$ be goods of type k imported from W to H, and from W to F, respectively. Define set $A_k = \{y \epsilon R^{9K} \,|\, y_{WH,k} \leq 0 \text{ if } y_{WF,k} \leq 0 \bigwedge y_{WF,k} \leq 0 \text{ if } y_{WH,k} \leq 0\}$. Then, because A_k, $k = 1, ..., K$ are closed, convex, and contain the negative orthant the production set with transshipment capability removed between countries H and F for imported goods $\bar{Y}^i$ formed as the intersection $Y^i \bigcap_k A_k$ is also closed, convex, contains the negative orthant, and has a bounded intersection with the positive orthant.

Now consider the fictitious economy formed by countries H and F with transshipment capability removed where the fictitious endowment of each country consists of its usual endowments plus its pre-union trade vector. Let $\bar{Y}^i$ denote the total net production set (production plus fictitious endowments) without transshipment capability of country i. Consumer j of country i has a preference mapping denoted by $P_j^i : X_j^i \to 2^{X_j^i}$. Assume the real valued functions $\alpha_j^i(p)$ represent the consumer j's income.[4] Following Gale and Mas-Colell, we have the following four assumptions.

E.1– The sets $\bar{Y}^i$ are closed, convex, contain the negative orthant, and have a bounded intersection with the positive orthant.

E.2– The sets X_j^i are closed, convex, non-empty and bounded below.

E.3– The preference mappings P_j^i are irreflexive [that is, $x_j^i \notin P_j^i(x_j^i)$], have an open graph in X_j^i x X_j^i and their values are non-empty, convex sets.

E.4– The functions $\alpha_j^i(p)$ are continuous and satisfy $\alpha_j^i(p) > p \cdot x_j^{i,0} > \inf\, p \cdot X_j^i$ for all p where $x_j^{i,0}$ is consumer j's initial consumption bundle.

The fact that $\bar{Y}^i$ contains the negative orthant means that the fictitious economy exhibits the free disposal property. The condition that says preference mappings are non-empty is a non-satiation condition ruling out the existence of a satiation point for any consumer. To describe consumers' income by the continuous function $\alpha_j^i(p)$ is a mechanism to generalize distributions rules like the one used in Grinols (1981). These assumptions can be used to enunciate the following theorem which is an adaptation of the Gale and Mas-Colell theorem:

Proposition 3 *Let countries H and F satisfy assumptions E.1–4 where the trade flows of H and F with W are frozen and treated as part of the production of H and F and transshipment capability is removed through sets A_k. Then, there exists a competitive equilibrium for the economy consisting of H and F. Since this economy constitutes a preferential trade area satisfying assumptions 1, 2, and E.1-4 with respect to countries H, F, and W there is a competitive equilibrium for this preferential trade area. This equilibrium is consistent with assumption 3. Thus, there exists an equilibrium generated by the free trade area consisting of countries H, F with transshipment capability not limited. This equilibrium satisfies assumptions 2, 3, and E.1-4, and is identical to the competitive equilibrium. In both cases, there exists a tariff vector and appropriate redistribution scheme without cross country transfers such that every household, whether member of the union or not, is not worse off than before the creation of the trade area.*

Proposition 4 *(Panagariya and Krishna's rules of origin are optimal) Assume in situation 0 that countries H and F have formed an FTA where rules of origin satisfy assumption 3. Then no rules of origin that differ from assumption 3 can simultaneously support member countries independent tariff setting to hold trade flows with W constant and implement a Pareto Superior allocation.*

Proof: Consider alternative situation 1 in which countries H and F form an FTA where each member country chooses tariffs to keep its trade flows with the rest of the world constant at

[4] The functions $\alpha_j^i(p)$ can represent income net of factor earnings if individual i located in country j does not supply factors inelastically.

situation 0 levels. Write the change in welfare between situation 0 and situation 1 for household j of country $i = H, F$ as $\overset{o}{\Delta W}{}^i_j \equiv e(p^0, u^{i,1}_j) - e(p^0, u^{i,0}_j)$. Use the identities for $i = H, F$ that $x^{i,0} = y^{i,0} + \omega^{i,0} + z^{i,0}$ and likewise in situation 1. Then, by direct computation,

$$\begin{aligned} \sum_j \overset{o}{\Delta W}{}^i_j \;\; = \;\; & -\sum_j \left(p^0 \cdot x^{i,1} - e(p^0, u^{i,1}_j)\right) && \text{Term 1} \\ & -p^0 \cdot \left[y^{i,0} - y^{i,1}\left(p^1, Y^{i,1}\right)\right] && \text{Term 2} \\ & -p^0 \cdot \left(z^{i,0} - z^{i,1}\right) && \text{Term 3} \end{aligned}$$

where $y^{i,1}\left(p^1, Y^{i,1}\right)$ denotes the profit maximizing choice of y^i given prices p^1 and production set $Y^{i,1}$. Term 1 ≤ 0 because consumers minimize the cost of achieving a given level of utility subject to their budget constraint. Term 2 summarizes the effects of rules of origin. Note that if $Y^{i,0} = Y^{i,1}$ then $p^0 \cdot y^{i,0} \geqslant p^0.y^{i,1}\left(p^1, Y^{i,1}\right)$ by profit maximization. Since in situation 1 rules of origin might not satisfy assumption 3 firms have their production choices restricted with respect to situation 0 so that $Y^{i,0} \supseteq Y^{i,1}$. Then $p^0 \cdot y^{i,0} \geqslant p^0.y^{i,1}\left(p^1, Y^{i,1}\right)$ and Term 2 $\leqslant 0$. Term 3 $=$ 0 since at situation 1 each member country chooses tariffs to keep its trade flows with the rest of the world constant at situation 0 levels. Thus, welfare falls in the move to situation 1, $\sum_j \overset{o}{\Delta W}{}^i_j \leqslant 0$.■

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