Global Supply Chains, Trade Agreements and Rules of Origin

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Abstract

Free Trade Agreements (FTAs) usually come with restrictions on the use of intermediate inputs in order for final goods to qualify for free trade. I focus on Rules of Origin (RoO), which limit expenses on nonmember country's intermediate inputs. In a three-country FTA formation game, I introduce international trade in intermediate inputs and RoO restrictions. In the case of symmetric countries, I show that as countries become more involved in global supply chains, measured by their input shares in foreign final goods production, global free trade is less likely to be a stable equilibrium outcome. Free riding is the main problem preventing countries from liberalizing trade. Countries are better off being nonmembers of FTAs between the other two countries relative to global free trade. Rules of Origin can solve this problem by limiting the benefits countries get from other countries' free trade agreements. In the case of asymmetric countries, an additional incentive exists for the smaller country not to join: such a country gives up more than it gains from joining an FTA for a sufficiently high degree of asymmetry in country sizes. I show that global free trade is a stable Nash Equilibrium under a larger region of asymmetric country parameter space in the case of RoO than without it. Therefore, it is shown that RoO is essential in order to attain global free trade.

JEL classification: F13, F15

Keywords: Free Trade Agreement, Multilateral trade liberalization, Rules of Origin.

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1 Introduction

There have been two key developments in international trade policy during the last two decades. First, according to the World Trade Organization (WTO) database, in 1990 there were only 70 Free Trade Agreements (FTAs), while in 2016 there are 267 in force. Second, as Johnson and Noguera (2012) show trade in intermediate inputs had little share in total trade in 1990, while after 20 years it accounts for as much as two-thirds of international trade. Starting from Bhagwati (1993) many prominent papers in the literature including Baldwin (1993), Bagwell and Staiger (1997, 1999), Ornelas (2005a,b), Saggi and Yildiz (2010, 2011) and Stoyanov and Yildiz (2015) explore whether FTAs are "building blocks" or "stumbling blocks" for the global multilateral liberalization process. The main question in these papers is: will the proliferation of FTAs lead to global free trade? However, the literature mostly focuses on trade in final goods only and therefore misses the increasingly important aspect of international trade emphasized here: trade in intermediate inputs. Thus, one of the main issues discussed in this paper is how such a dramatic increase in the participation of countries in global supply chains affects the formation of free trade areas. In particular, does trade in intermediate inputs make global free trade more likely?

In the three-country model of international trade initially developed by Bagwell and Staiger (1999) and later adapted by Saggi and Yildiz (2010), I introduce trade in intermediate inputs. In this model of "competing exporters", each country produces two goods while consuming all three. So, it imports the third good from the other two countries. The production technology in each country combines three inputs from all three countries in a constant returns to scale manner. The Cobb-Douglas production function exponents determine the share of income foreign firms get from selling goods produced at home. This share is an important variable in the model and is crucial in determining the equilibrium of the following game. In the first stage, each country announces the name of countries it wishes to form an FTA with. This determines the trade regime: all FTAs are formed in which both sides announce each others' name. In the next stage, given the trade regime, countries impose optimal tariffs. In the final stage, international trade and consumption take place.

When signing any FTA, each country compares its costs and benefits. The cost is reduced tariff revenue inclusive consumer surplus stemming from higher "world prices" of its imported good – the country gives up its ability to affect its terms of trade. The benefit is the duty-free access to the export market: the exporting industry faces higher (net of tariff) prices.

Note that, regardless of the foreigner's share in local production, the home country bears "the full cost" of the FTA. However, this is not true for the benefit: the higher is the foreigners' share, the lower is the share of the benefit that the home country receives. Thus an FTA might not be desirable anymore for sufficiently high share of foreigners. Moreover, when two other foreign countries form an FTA, since they use intermediate inputs supplied by the home country, the latter indirectly benefits from it. The nonmember country is a free rider. This free riding effect is strong enough for a sufficiently high share of domestic inputs in the foreign production that the home country chooses not to join the FTA of the other two countries. Therefore, for a sufficiently high degree of trade in intermediate inputs, global free trade is not an equilibrium outcome. This is problematic since, as in many models of trade agreements, here too global free trade is an efficient outcome from the global (world) welfare perspective. Thus, trade in intermediate inputs and the resulted free riding behaviour leads countries to an inefficient trade regime.

Article XXIV of the General Agreement for Tariffs and Trade (GATT) permits WTO member countries to pursue FTAs under which participating countries grant tariff concessions to each other that they do not have to extend to all member countries of the WTO. However, WTO allows participating countries to impose Rules of Origin (RoO) within the FTA. It specifies the rules (usually restricts the inputs used) under which any product is eligible for duty-free trade. In principle, RoO are meant to prevent trade deflection, i.e. to ensure that goods being exported from one FTA partner to another truly originate from the area. However, it is actually a protectionist measure as final goods producers of free trade area member countries are discouraged from using the inputs of nonmember countries. Therefore, FTA with RoO with sufficiently strict restrictions on the use of non-FTA originated inputs will generate negative effects for the nonmember country. In fact, this is exactly what is needed to counteract the free rider behaviour of the nonmember country through selling its intermediate inputs to FTA member countries identified above. RoO reduces this very indirect benefit that a nonmember gets and if this punishment is strong enough, such a country no longer prefers to stay out of the (global) free trade agreement. That is, the nonmember country prefers to join the FTA and thus form a global free trade with the other two FTA member countries. The free riding effect and the counteracting effect of RoO are the main mechanisms for achieving global free trade emphasized in this paper. These mechanisms represent the main contributions of the paper.

Apart from the major issues discussed above, I also consider different type of trade liberalization and compare them with each other. Article I of GATT requires member countries to undertake trade liberalization on a most-favored-nation (MFN) or non-discriminatory basis. So, any trade liberalization that countries undertake should treat all WTO member countries equally (*multilateralism*). However, GATT Article XXIV allows exceptions to the MFN principle and allows countries to form free trade areas (*bilateralism*). Since the both kinds of trade liberalizations, bilateral as well as multilateral, are allowed by GATT rules it is interesting to ask which one of them has a better shot at attaining global free trade. The role of bilateralism as opposed to multilateralism in the creation of global free trade is an a rapidly growing area of research and has been developed by Bagwell and Staiger (1999), Riezman (1999), Goyal and Joshi (2006), Furusawa and Konishi (2007), and more recently by Saggi and Yildiz (2010, 2011). The main reason why bilateral trade agreements are more successful in achieving global free trade is that they impose a discriminatory penalty on the non-participating country. In contrast to the multilateral liberalization case, this penalty is enough to persuade potentially nonmember country to join the FTA if the degree of asymmetry between countries is not large. To obtain this result, Saggi and Yildiz (2010) assume an endowment economy with final goods only. Once I incorporate trade in intermediate inputs and highlight the free riding effect, the superiority of bilateral over to multilateral trade agreements breaks down. It turns out that for a sufficiently high degree of trade in intermediate inputs, multilateralism achieves global free trade while bilateralism does not. However, similar to the case before, by having negative effects on the nonmember country, RoO can turn a bilateral trade agreement into much more successful kind of agreement than multilateral trade liberalization.

My paper is related to the recent literature on trade policy in global supply chains. In particular, similar to Blanchard et al. (2016), I derive optimal trade policy when global supply chains matter for final goods production. In doing so, I take into account RoO considerations too. Then, I take this into the framework developed by Saggi and Yildiz (2010). Since RoO generate a negative externality on the non-participating country, this country finds it optimal to join the FTA created by two other countries. Therefore, the main contribution and distinctive characteristic of my paper is that by introducing RoO, it is possible to reduce or completely eliminate the parameter space in Saggi and Yildiz (2010) where global free trade is not a unique equilibrium.

Blanchard (2007, 2010) and DeRemer (2016) are also interested in how should traditional trade policies or WTO rules adapt to the recent rise of intermediate goods trade. Namely, do the WTO rules of non-discrimination and reciprocity respond well to the recent increase in global value chains? The main message is that the basic principles (adjusted appropriately) still guarantee efficiency. In particular, DeRemer (2016) shows that the standard concept of reciprocal policy changes (which equally increase net export value at world prices) can nonetheless guide nations toward the efficiency frontier. While Blanchard (2007, 2010) shows that the basic principle of reciprocity still serves as a guide to efficiency, its application must account for the pattern of international ownership. Apparently, those studies are closely related to the present paper in the sense that I show that one of the "rules" that the WTO allows in free trade negotiations leads us to global free trade. However, what is distinctive feature of my paper is that the focus here is on the specific issue of the existence of RoO in FTA negotiations; which is different from the main issues in the above-mentioned papers. Moreover, the setup I examine, the three stage game which incorporates the model of "competing exporters" from Bagwell and Staiger (1999), is entirely different from theirs.

As far as RoO are concerned this paper is related to a literature on the economic effects of RoO where notable papers include Falvey and Reed (1998, 2002), Krueger (1993), Krishna and

Krueger (1995), Ju and Krishna (2005), Duttagupta and Panagariya (2007) and Chang and Xiao (2015). Moreover, Augier et al. (2005), and more recently Andersson (2015) and Conconi et al. (2016), look empirically at the trade diversion effects of RoO. My paper focuses on trade agreements and equilibrium trade regimes, while the papers above focus largely on the trade diversion and welfare effects of RoO. In contrast to the literature on the negative effects of RoO, my results demonstrate that RoO can actually help to promote global free trade. Moreover, there are cases in which countries agree to global free trade only if their preferential trade agreements (PTAs) include RoO. This highlights the necessity of RoO and gives a sense of its potential policy implications.

The rest of this paper is organized as follows. Section 2 introduces the basic model based on Saggi and Yildiz (2010). In Section 3, the FTA formation game is discussed. Section 4 and Section 5 solves the model in the case of symmetric and asymmetric countries, respectively. In Section 6 RoO is introduced and the resulting equilibrium is analyzed. Section 7 deals with multilateral trade liberalization and compares the results with those in the earlier sections. Finally, Section 8 concludes.

2 Underlying Trade Model

In this section, I set up the basic trade model, which builds on Saggi and Yildiz (2010). The framework used is the model of "competing exporters" developed by Bagwell and Staiger (1999).

There are three countries, i, j and k, three non-numeraire final goods I, J and K, and a numeraire final good, w. In each country i, there is a representative consumer, who has an additively separable quadratic utility function:

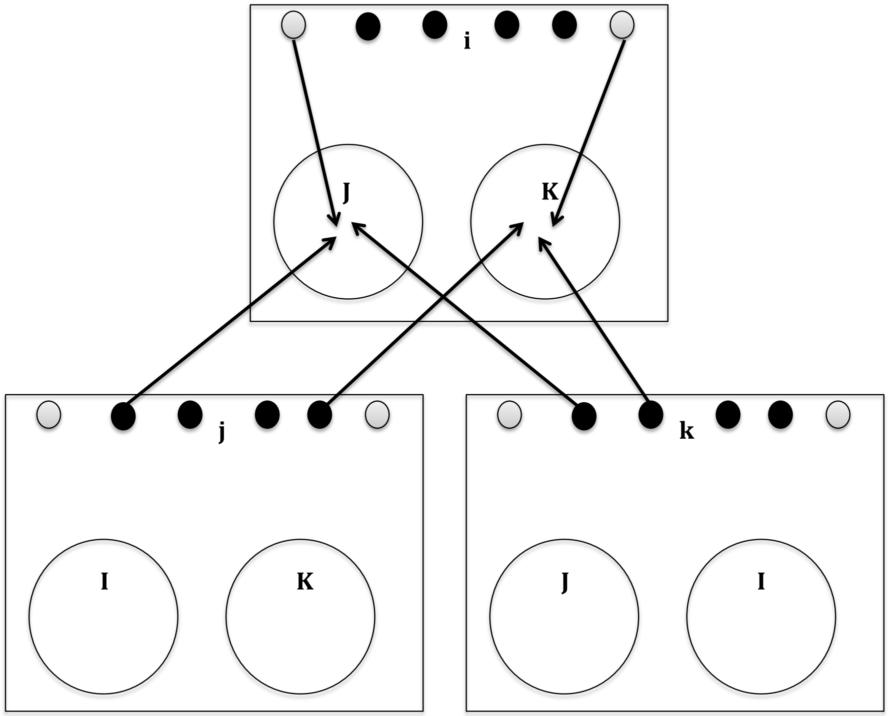
$$U_i\left(c_i^I, c_i^J, c_i^K, w_i\right) = \sum_{Z=I,J,K}\left[\alpha c_i^Z - \frac{\left(c_i^Z\right)^2}{2}\right] + w_i \tag{2.1}$$

These preferences generate a linear demand function for final goods:

$$d\left(p_i^Z\right) = \alpha - p_i^Z, \quad Z = I, J, K. \tag{2.2}$$

This representative consumer holds a large amount of the numeraire good, $\bar{w}_i$. In addition to that, country i produces two of the final goods, J and K, and imports good I. Analogously, countries j and k each produce two final goods only (I, K) and (I, J), while importing goods J and K, respectively. Therefore, country i's market of final good I is served by two competing exporting industries of countries j and k. Each country holds endowments of intermediate inputs used in the production of the final goods in all three countries. The production of each final good requires inputs from all three countries. For model tractability, and similarly to Blanchard et al. (2016), it

Figure 2.1: The production of final goods in country i



is assumed that inputs are specific to the final goods produced in a given country. The production technology in country i combines domestic as well as foreign inputs in a constant returns to scale manner and is assumed to take the Cobb-Douglas form:

$$y_i^Z = \left(x_{ii}^Z\right)^{1-2\theta} \left(x_{ji}^Z\right)^{\theta} \left(x_{ki}^Z\right)^{\theta}, \quad Z = J, K \tag{2.3}$$

where, y_i^J and y_i^K refers to amount of final goods J and K produced in country i. x_{ii}^Z, x_{ji}^Z and x_{ki}^Z refer to the inputs country i sources locally and from country j and k, respectively to produce final good Z. This is represented graphically in Figure 2.1. Exactly analogous production technologies are employed by countries j and k. Since each country holds six types of intermediate input endowments, I assume for simplicity, that the two endowments specific to each destination countries are equal:

$$e_{ii}^J = e_{ii}^K, e_{ij}^I = e_{ij}^K \text{ and } e_{ik}^I = e_{ik}^J \tag{2.4}$$

It is assumed that the representative consumer owns the intermediate input endowments as well as final goods' producer firms. So, the whole income generated from firms finally ends up with the corresponding representative consumer in each of the three countries.

As is usual in the literature, I assume that the numeraire good is traded freely (with zero tariffs).

GATT Article XXIV does not allow FTA member countries to increase tariffs on nonmembers after the formation of the FTA. Therefore, if the tariffs on the intermediate inputs were very low before signing FTA, for historical reasons for instance, the member countries cannot increase them after an FTA is created. I am interested in how countries can use non-tariff barriers as an alternative to tariffs on intermediate inputs. Therefore, for simplicity, I assume that the tariffs on intermediate inputs are predetermined at the level of zero before the FTA. So, there are no restrictions on trade in intermediate inputs until Section 6, where I introduce non-tariff barriers – Rules of Origin (RoO).

There are tariff barriers on final goods trading, however. Let t_{ij} and t_{ik} be the specific tariff imposed on country i's imports from country j and k, respectively. Then, if the prices of good I are p_i^I, p_j^I and p_k^I in the countries i, j and k, respectively, no-arbitrage on good I implies the following:

$$p_i^I = p_j^I + t_{ij} = p_k^I + t_{ik} \tag{2.5}$$

Analogous no-arbitrage conditions hold for goods imported in to countries j and k. Since the endowment levels of intermediate inputs are fixed and for now there are no RoO constraints, the size of final good production is predetermined by the production function (2.3). So, from (2.4) it follows that each country produces an equal amount of each of the two goods:

$$y_i^J = y_i^K \equiv y_i,\ y_j^I = y_j^K \equiv y_j \text{ and } y_k^I = y_k^J \equiv y_k \tag{2.6}$$

Given these final goods production levels, this model has an analogous structure for its final goods market as that in Saggi and Yildiz (2010). So, the determination of equilibrium prices follows in a similar way – by clearing markets for all three final goods. If we denote the equilibrium level of country i's import of good I by m_i^I, this value should be equal to the domestic demand since country i does not produce that good. On the other hand, the export of good I by countries j and k equals the difference between their production and their domestic consumption levels. So, their export volumes of good I are $exp_{ji} = y_j - (\alpha - p_j^I)$ and $exp_{ki} = y_k - (\alpha - p_k^I)$, respectively.

The equilibrium condition, which is going to determine prices and volume of trade, states that import demand equals the sum of export supplies:

$$\alpha - p_i^I = y_j - \left(\alpha - p_j^I\right) + y_k - \left(\alpha - p_k^I\right) \tag{2.7}$$

Therefore, given the tariff rates and final goods production, the prices of imported goods are determined by the following formula:

$$p_i^I = \frac{3\alpha - (y_j + y_k) + t_{ij} + t_{ik}}{3} \tag{2.8}$$

The corresponding prices in exporting countries are $p_j^I = \frac{3\alpha-(y_j+y_k)-2t_{ij}+t_{ik}}{3}$ and $p_k^I = \frac{3\alpha-(y_j+y_k)+t_{ij}-2t_{ik}}{3}$. Note that here each country is "large" in the standard sense: by imposing import tariffs only one-third of the tariff burden is on the consumers of the importing country, while two-thirds are borne by the exporting countries. So, each country has a unilateral incentive to impose an import tariff and thus improve its terms of trade.

Using these prices the trade volumes are the following:

$$m_i^I = \frac{(y_j + y_k) - (t_{ij} + t_{ik})}{3} \tag{2.9}$$

The corresponding exports from countries j and k will therefore be

$$exp_{ji} = \frac{(2y_j - y_k) + (t_{ik} - 2t_{ij})}{3} \text{ and } exp_{ki} = \frac{(2y_k - y_j) + (t_{ij} - 2t_{ik})}{3} \tag{2.10}$$

Note that trade balance in non-numeraire (i.e. protected) final goods does not necessarily hold. Smaller countries (i.e. those with smaller output of the final goods) import more and larger countries export more of the final goods. However, the numeraire good balances the trade between countries in equilibrium. I assume perfect competition in final goods production and no barriers to entry. So, given the Cobb-Douglas production technology and no restriction on inputs trade, revenue from final goods' sales is distributed among production factors according to the corresponding Cobb-Douglas exponents. For instance, since in equilibrium the final goods production is at the levels of y_i, y_j and y_k, the income of intermediate input suppliers from country i for the production of good I in countries j and k will be $\theta p_j^I y_j$ and $\theta p_k^I y_k$, respectively.

Since the profit of the final goods producers is zero in an equilibrium, a country's welfare can be defined as the sum of consumer surpluses from all three goods, intermediate goods producers' surplus and tariff revenue stemming from importing the non-numeraire final good. Indeed, given the final goods' prices $\left(p_i^I, p_i^J, p_i^K\right)$ and the numeraire good's endowment level $(\bar{w}_i)$, the representative consumer in country i solves the following problem:

$$Max\ U_i\left(c_i^I, c_i^J, c_i^K, w_i\right) \tag{2.11}$$

subject to

$$\sum_{Z=I,J,K} p_i^Z c_i^Z + w_i = Income_i \tag{2.12}$$

where the left hand side is the expenditure on the final goods and the right hand side is the total income from all sources:

$$Income_i = (1-2\theta)\left(p_i^J y_i + p_i^K y_i\right) + \theta\left(p_j^I y_j + p_k^I y_k + p_j^K y_j + p_k^J y_k\right)$$
$$+ t_{ij} exp_{ji} + t_{ik} exp_{ki} + \bar{w}_i.$$

The first order conditions for the non-numeraire final goods give us

$$\alpha - c_i^Z = p_i^Z, \text{ for } Z = I, J, K. \tag{2.13}$$

So, the total maximized welfare can be expressed in terms of prices and is equal to

$$\sum_{Z=I,J,K}\left[\alpha\left(\alpha - p_i^Z\right) - \frac{\left(\alpha - p_i^Z\right)^2}{2}\right] + Income_i - \sum_{Z=I,J,K} p_i^Z\left(\alpha - p_i^Z\right) \tag{2.14}$$

Therefore, given the quasilinear utility function and the income structure of each representative consumer the welfare of each country (after dropping a constant term $\bar{w}_i$) can be expressed as follows:

$$W_i = CS_i^I + CS_i^J + CS_i^K + (1-2\theta)\left(p_i^J y_i + p_i^K y_i\right)$$
$$+ \theta\left(p_j^I y_j + p_k^I y_k + p_j^K y_j + p_k^J y_k\right) + t_{ij} exp_{ji} + t_{ik} exp_{ki}$$

where, $CS_i^Z = \frac{\left(\alpha - p_i^Z\right)^2}{2}$, $Z = I, J, K$.[1]

Following the approach of Saggi and Yildiz (2010), I consider trade liberalization on a bilateral versus a multilateral basis to identify the role bilateralism has in promoting global free trade. Since in the real world free trade agreements come with RoO it is important to incorporate them in the analysis too.

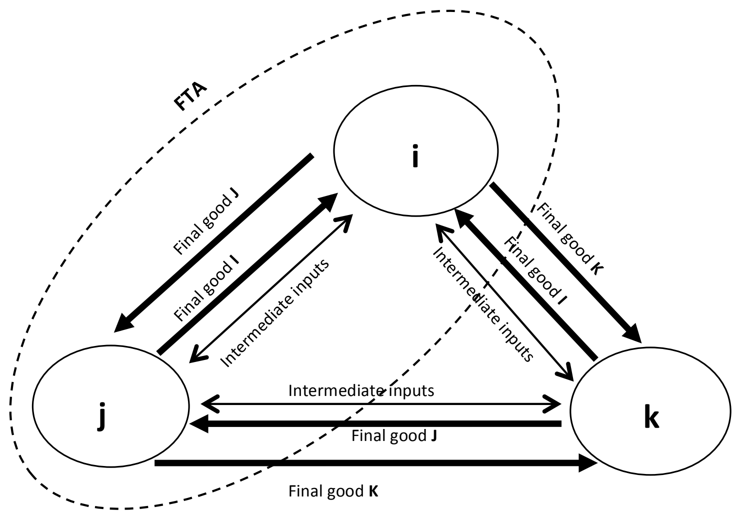
In Section 6, I will demonstrate the effect that RoO have on the formation of bilateral trade agreements. Thus, I will have a complete picture of the relative strength of bilateral FTA over multilateralism. More importantly, by comparing outcomes with and without RoO, I can identify the distinctive impact that RoO have on the equilibrium global trade regime. But for now, let us set aside RoO considerations and consider the game Saggi and Yildiz (2010) refer to as bilateralism.

3 Trade Regimes

I deal here with two types of trade liberalization: bilateralism and multilateralism. In Sections 4, 5 and 6 I examine bilateralism while in Section 7 I focus on multilateralism and compare it to

[1] In the Appendix, the robustness of the main results are shown by considering the model with political economy considerations in it.

Figure 3.1: Direction of trade in goods and free trade agreement $\{ij\}$



bilateralism.

Let us describe the three-stage game of trade liberalization. In the first case, referred to as bilateralism, during the first stage each country simultaneously announces whether or not it wants to sign a free trade agreement with each of its trading partners. So each country i has four possible strategies σ_i, depending on whether it wants to form an FTA or not for each trading partners. The set of all possible strategies is $\Omega_i = \{\{\emptyset, \emptyset\}, \{j, \emptyset\}, \{\emptyset, k\}, \{j, k\}\}$ where, $\{\emptyset, \emptyset\}$ refers to an announcement in which country i decides not to liberalize trade with any of its trading partners. $\{j, \emptyset\}$ refers to the announcement where country i decides to liberalize trade with only country j. Analogously, $\{\emptyset, k\}$ denotes trade liberalization only with country k. Lastly $\{j, k\}$ refers to the announcement in which country i decides to liberalize trade with both of its trading partner countries, j and k. Given the announcements of the countries in the first stage the world trade regime is determined.

There could be one of four types of global trade regimes after the first stage. 1) Status Quo, $\{\Phi\}$, which happens if there was no agreement achieved between any pair of countries. 2) Free trade between a pair of countries i and j is established if both countries announce each other's names, in other words, $i \in \sigma_j$ and $j \in \sigma_i$, and the third country either does not wish to liberalize trade or there is no match with countries i and j's announcements. This regime is denoted by $\{ij\}$. 3) Free trade between one of the countries with both of its partners, $i \in \sigma_j$, $i \in \sigma_k$, $j \in \sigma_i$ and $k \in \sigma_i$. This regime is denoted by $\{ij, ik\}$. Since in this case country i is a hub and other two are spokes, this regime is referred to as Hub and Spokes regime and is denoted shortly by $\{ih\}$, where h stands for a hub. 4) Lastly, if all the countries announce each other's names, a global free trade regime will be established, denoted by $\{F\}$. In the second stage of the game, given the realized world trade regime, countries impose optimal tariffs. In the last stage, the international trade in all types of goods and consumption takes place.

4 Symmetric Countries

4.1 Nash Equilibrium

It is instructive to begin the examination of the equilibrium in the case of symmetric countries. This means equal intermediate inputs $e^J_{ii} = e^K_{ii} = e^I_{ij} = e^K_{ij} = e^I_{ik} = e^J_{ik}$, therefore equal final goods too: $y_i = y_j = y_k \equiv y$. After the announcements are made, in the second stage governments set optimal tariffs given the prevailing trade regime. Now, I will solve for optimal tariffs for each of the possible trade regimes discussed above. In the case of Status Quo, Article I of GATT requires that all countries set tariffs on an MFN basis. Therefore, $t^{\Phi}_{ij} = t^{\Phi}_{ik} \equiv t^{\Phi}_i$ for all countries i. From the design of the model the terms in the welfare function that are affected by the import tariffs imposed by the country i are CS^I_i, $\theta(p^I_j y_j + p^I_k y_k)$ and $(t_{ij} exp_{ji} + t_{ik} exp_{ki})$. The first order condition gives us the optimal tariffs in the case of the Status Quo:

$$t^{\Phi}_i = Argmax\ W_i(\{\Phi\}) = \frac{y(1-3\theta)}{4} \tag{4.1}$$

In the case of symmetric countries, the optimal MFN tariffs depend on the output level and the share of foreign inputs in the final good production. This optimal tariff is denoted by t^{Φ}. As θ increases the optimal MFN tariffs that countries set to each other's export are declining. This is in line with the results of Blanchard et al. (2016) and it is intuitive since θ represents the domestic countries' share in the income generated by foreign firm's sales. In particular, domestic intermediate input suppliers generate a share θ of income from foreign final good producers' export to domestic country. Therefore, the higher θ is the lower the incentive for the domestic country to impose a high tariff on its imports is.

In the case of two countries signing an FTA, they eliminate tariffs on imports from each other while setting their own optimal tariff on the nonmember country. Taking into account $t_{ij} = t_{ji} = 0$ the optimality condition gives the following result:

$$t^f_i = Argmax\ W_i(\{ij\}) = \frac{y(1-3\theta)}{11} \tag{4.2}$$

Similar to MFN tariffs, in the symmetric case the tariff on the nonmember country is the same for both trading partners. Moreover, in order to mitigate the adverse effect of the trade diversion caused by an FTA $\{ij\}$, member countries i and j reduce the tariff on the nonmember country k.

Therefore, the "tariff complementarity" effect of Bagwell and Staiger (1999) is valid here:[2]

$$t_i^f < t_i^\Phi \tag{4.3}$$

Note that I assume $\theta \leq 1/3$. This serves two purposes. First, it is natural to assume that production technologies are local input intensive: it uses more of the domestically supplied good than from any foreign country.[3] Second, it makes the FTA creating game more interesting to study, since otherwise, we would get governments motivated to be subsidizing imports instead of imposing tariffs. Therefore, for the purposes of free trade agreement issues, it is more relevant to focus on $\theta \leq 1/3$.

The terms of the welfare function affected by import tariffs are not influenced by the tariffs imposed by other countries. So, from an optimal tariff setting perspective, it does not matter whether other countries have an FTA or not. Therefore, the optimal tariff set by $\{ij\}$ member country i does not change in case countries j and k create FTA (and thus trade regime becoming $\{jh\}$) and is still determined by (4.2) in case of $\{jh\}$.

Given the optimal levels of tariffs in each trade regime, the corresponding welfare levels can be calculated from the social welfare formula in Section 2.[4] Figure 4.1 shows the welfare levels as a function of θ, where it is taken $\alpha = 2$ and $y = 1$.[5]

Note that we will get exactly the same optimal tariffs and welfare levels as in Saggi and Yildiz (2010) if we set the foreign input share in domestic production θ equal to zero. So, the starting point of each of the lines in Figure 4.1 corresponds to the welfare levels in their paper.

Now, we are ready to examine the Nash Equilibrium of the game. For $\theta = 0$ we have the following ordering of the welfare levels:

$$W_i(\{ih\}) > W_i(\{F\}) > W_i(\{ij\}) > W_i(\{jk\}) > W_i(\{jh\}) > W_i(\{\Phi\}) \tag{4.4}$$

Denote $\theta_0 = 0.05$ determined by the condition that country i is indifferent between global free trade and FTA between other trade partners: $W_i(\{F\}) = W_i(\{jk\})$. Even though the relative ranking of welfare levels changes in the interval $\theta \in [0, \theta_0)$, it is still true that in that parameter space global free trade is the second best option for country i, in particular $W_i(\{F\}) > W_i(\{jk\})$ and $W_i(\{F\}) > W_i(\{jh\})$. If the trade regime is $\{F\}$, then by deviating from it, a country can either end up being one of the spoke countries, or being a nonmember of an FTA between the two other countries. Because of these inequalities no country has the incentive to deviate from global

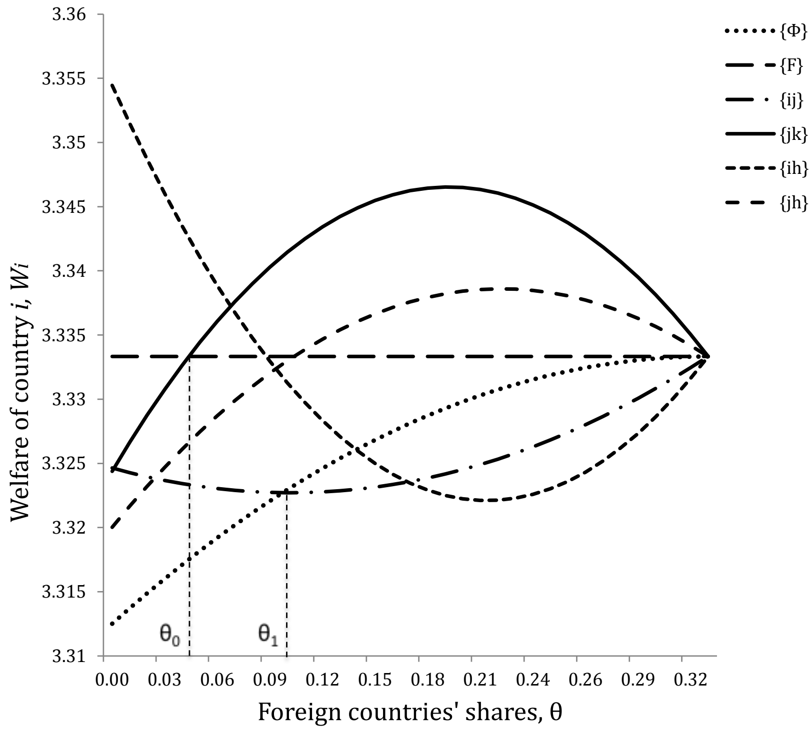
[2] Estevadeordal et al. (2008) provides empirical support for this effect.

[3] Though it is allowed that total foreign share to be bigger than domestic one, if $\theta > 1/4$.

[4] Analytical expressions of the welfare functions and other supporting calculations are provided in the Appendix.

[5] Since we are mainly interested in the relative value of the welfare levels, not the absolute per se, we can take that values without loss of generality.

Figure 4.1: Welfare levels and trade regimes in case of symmetry: Bilateralism



free trade and end up with one of the two other trade regimes. Therefore, global free trade regime $\{F\}$ is a Nash Equilibrium of this game.

However, $\{F\}$ is not the only Nash Equilibrium. $\{ij\}$ is also a Nash Equilibrium. Let this trade regime be generated by announcements $\{j, \emptyset\}$, $\{i, \emptyset\}$ and $\{\emptyset, \emptyset\}$ made by countries i, j and k, respectively. Since both countries i and j prefer a bilateral FTA between them to the Status Quo, $W_i(\{ij\}) > W_i(\{\Phi\})$ and $W_j(\{ij\}) > W_j(\{\Phi\})$, neither country has an incentive to deviate (to the Status Quo). The nonmember country cannot affect the equilibrium trade regime since even if it expresses the desire for FTA it will not happen because neither i nor j had announced country k's name in the first stage. Therefore, $\{ij\}$ is a Nash Equilibrium outcome generated by action profile $\{j, \emptyset\}$, $\{i, \emptyset\}$ and $\{\emptyset, \emptyset\}$. Also, since no country can unilaterally make an FTA happen without the partner country's will, the Status Quo generated by all countries announcing $\{\emptyset, \emptyset\}$ is, of course, a Nash Equilibrium outcome.[6]

Lastly, the Hub and Spokes trade agreement $\{ih\}$ is not a Nash Equilibrium outcome. The reason is that, each of the spoke countries j and k have an incentive to revoke their FTAs with

[6] Note that it is important to state how the trade regime is generated. There are several action profiles that generate the same trade regime, but some of them are Nash Equilibria and some not. For example, in the case when $\{ij\}$ is generated by the action profile $\{j, k\}$, $\{i, k\}$ and $\{\emptyset, \emptyset\}$, nonmember country k has some power to change the trade regime by deviating. So, this action profile is not a Nash Equilibrium because the nonmember would like to deviate to global free trade, $W_k(\{F\}) > W_k(\{ij\})$. However, this does not change the fact that $\{ij\}$ is a Nash Equilibrium outcome generated by action profile $\{j, \emptyset\}$, $\{i, \emptyset\}$ and $\{\emptyset, \emptyset\}$.

country i and be better off: $W_j(\{ik\}) > W_j(\{ih\})$ and $W_k(\{ij\}) > W_k(\{ih\})$.

The above discussion can be summarized in the following:

Proposition 4.1.

a) $\{\Phi\}, \{ij\}$ *type and* $\{F\}$ *are all Nash Equilibria for* $\theta \leq \theta_0$.[7]

b) $\{\Phi\}$ *and* $\{ij\}$ *type are both Nash Equilibria for* $\theta_0 < \theta \leq \theta_1$.

c) $\{\Phi\}$ *is the unique Nash Equilibrium for* $\theta_1 < \theta < \frac{1}{3}$.

Where θ_1 is determined by the condition $W_i(\{\Phi\}) = W_i(\{ij\})$. Note that part a) of Proposition 4.1 is consistent with the results of Saggi and Yildiz (2010) where the foreign input share in domestic production (θ) is assumed to be zero.

However, the second part of the Proposition 4.1 states that for larger values of θ, $\{F\}$ is no longer a Nash Equilibrium outcome. In particular, for higher θ (as long as it is not above θ_1) the equilibrium trade regime is in contrast to the results we see in Saggi and Yildiz (2010) for the $\theta = 0$ case. The reasons why $\{\Phi\}$ and $\{ij\}$ are both Nash Equilibria, while $\{ih\}$ is not, are exactly the same as in part a). Though, in contrast to the previous case $\{F\}$ is not a Nash Equilibrium outcome anymore. This is because country i finds it beneficial to deviate from a global free trade regime to $\{jk\}$, which it can always do unilaterally.

What is the economic intuition behind this distinctive result? Since this model is the extension of Saggi and Yildiz (2010) to global supply chains of production, it is logical that different results arise depending on the intensity of trade in intermediate inputs, which is characterized by θ. As θ rises from zero to a sufficiently high level, country i has a lower incentive to liberalize trade given that the other two countries already did so. The intuition is simple: since the share θ of all production taking place in countries j and k is "owned" by country i's intermediate input suppliers, it benefits more from $\{jk\}$ as θ starts increasing from zero. I call this a "free riding" effect since country i gets a benefit from the other two countries signing FTA without its own concessions. For sufficiently high θ this free riding effect becomes particularly strong. So, a country finds no reason to offer trade concessions to its trade partners in return for the reciprocal favor since they already receive it through selling intermediate inputs. If they did, they would get only part of the extra benefit from free trade (since not all the revenue from export goes to home welfare) while their consumers would still endure full costs regardless of θ. One major implication of Proposition 4.1 is that the observed spread of global supply chains might actually make global free trade less likely instead of more likely.

Finally, part c) of Proposition 4.1 states that when θ is sufficiently high, $\theta > \theta_1$, the only equilibrium is the Status Quo, in which each country sets optimal MFN tariffs. The main reason is similar to the previous one: trade liberalization of a home country offers more benefits to others

[7]Because of symmetry, by $\{ij\}$ type here I mean all three kinds of FTAs $\{ij\}, \{ik\}$ and $\{jk\}$.

than it does to home when the share of foreign input suppliers is higher in domestic production.[8] Therefore, when the share of income which goes to domestic intermediate input suppliers in the domestic final good production declines, it becomes less attractive for the home country to liberalize trade.

4.2 Stable Nash Equilibrium

Since in the first two cases of Proposition 4.1, there are multiple equilibria, I need to use some kind of equilibrium refinement. I follow Saggi and Yildiz (2010) and examine the coalition proof (i.e. stable) equilibria. Formally I apply the following:

Definition (Dutta and Mutuswami (1997))**.** Nash Equilibria are coalition proof i.e.*stable* if there exists no self-enforcing coalitional deviation.

So, in order to show that a trade regime is stable, we need to check if there is any self-enforcing coalitional deviation. A Nash Equilibrium is called stable if there are no self-enforcing coalition deviations. As for the definition of the latter, I appeal to the following:

Definition (Bernheim et al. (1987))**.** A coalitional deviation is self-enforcing if a proper subset of players in the deviating coalition has no incentive to undertake a further deviation.

Note also that there are no transfers between coalitions or between members of the coalition. So, the coalition decides to deviate if each member is better off after the deviation without any transfers. For instance, let us examine one of the Nash Equilibria – the Status Quo, when $\theta < \theta_0$, generated by the announcements, $\{\emptyset, \emptyset\}$, $\{\emptyset, \emptyset\}$ and $\{\emptyset, \emptyset\}$. Clearly, countries i and j have an incentive to jointly deviate from $\{\Phi\}$ to $\{ij\}$ since each will find it beneficial: $W_i(\{ij\}) > W_i(\{\Phi\})$ and $W_j(\{ij\}) > W_i(\{\Phi\})$. Moreover, none of them want to further deviate, so this coalition deviation is self-enforcing and therefore $\{\Phi\}$ cannot be a stable Nash Equilibrium outcome.[9]

Analogously, $\{ij\}$ is not a stable Nash Equilibrium because all three countries can jointly deviate to a global free trade regime. Since, $W_i(\{F\}) = W_j(\{F\}) > W_i(\{ij\}) = W_j(\{ij\})$ and $W_k(\{F\}) > W_k(\{ij\})$, all countries find it beneficial. Moreover, no proper subset prefers to deviate further. Therefore, the deviation is self-enforcing and $\{ij\}$ is not a stable Nash Equilibrium. Finally, using analogous arguments and the inequalities just mentioned, it is easy to check that $\{F\}$ is a stable Nash Equilibrium when $\theta < \theta_0$. This argument established part a) of the following:

Proposition 4.2.

a) $\{F\}$ is the only stable Nash Equilibrium for $\theta \leq \theta_0$.

[8] A similar idea but concerning optimal tariffs instead of welfare levels, is developed by Blanchard et al. (2016).

[9] Since country k is not in a coalition no more deviation from countries i or j changes the trade regime.

b) $\{ij\}$ type *are all stable Nash Equilibria for* $\theta_0 < \theta \leq \theta_1$.

c) $\{\Phi\}$ *is the unique stable Nash Equilibrium* $\theta_1 < \theta < \frac{1}{3}$.

Out of the two Nash Equilibria when $\theta_0 < \theta < \theta_1$, $\{\Phi\}$ is not a stable outcome for the same reason: a beneficial joint deviation of countries i and j from $\{\Phi\}$ to $\{ij\}$ is self-enforcing. However, $\{ij\}$ is a stable Nash Equilibrium. Since $W_k(\{ij\}) > W_k(\{F\})$, country k will not decide to form a coalition with countries i and j and go to global free trade. Other deviations are also trivially ruled out. Analogously, since $W_i(\{\Phi\}) > W_i(\{ij\})$ and $W_k(\{ij\}) > W_k(\{F\})$ when $\theta_1 < \theta < 1/3$, it is easy to show that $\{\Phi\}$ is the only stable Nash Equilibrium.

The surprising takeaway from the two propositions above is that once the global supply chain is sufficiently important in the world trading, global free trade is unlikely to be implemented via bilateral (i.e. regional) free trade agreements. The reason is the free riding problem discussed above. On the other hand, from (4.1) it follows that once θ is close to 1/3, global free trade is essentially obtained under Status Quo.

As Krugman (1991) and Grossman and Helpman (1995) have pointed out, asymmetries across countries can play a crucial role in determining incentives for bilateral (as well as multilateral) trade liberalization. To investigate whether this continues to the case when we allow for intermediate goods trade, in the next section I extend the above analysis to the case of asymmetric countries.

5 Asymmetric Countries

Country i produces two goods J and K, with y_i units each. Therefore, the asymmetry in countries is expressed via their corresponding final good's production levels. In order to focus on the asymmetry in the simplest manner, I assume that there are two larger and one smaller country. So, let us assume that final good endowments (determined by intermediate input endowments) are the following $y_i = y_j = y$ and $y_k = y/\psi$, where $\psi > 1$.

Following similar steps as in the symmetric countries case above we can derive the optimal tariffs for different trade regimes for asymmetric countries. Optimal non-discriminatory MFN tariffs take the following form:

$$t_i^{\Phi} = Argmax\ W_i(\{\Phi\}) = \frac{(y_j + y_k)(1 - 3\theta)}{8} \tag{5.1}$$

In the case of an FTA between countries i and j, each imposes its optimal external tariff on the nonmember, which does not necessarily have to be equal anymore. The optimal external tariff for country i is:

$$t_i^{f} = Argmax\ W_i(\{ij\}) = \frac{(5 - 6\theta)y_k - (4 - 3\theta)y_j}{11} \tag{5.2}$$

and for country j:

$$t_j^f = Argmax\ W_j(\{ij\}) = \frac{(5-6\theta)y_k - (4-3\theta)y_i}{11} \tag{5.3}$$

To guarantee that all tariffs are positive and the FTA creation game makes economic sense to study, I assume that:

$$min\{y_i, y_j, y_k\} \geq \left[\frac{4-3\theta}{5-6\theta}\right] max\{y_i, y_j, y_k\} \tag{5.4}$$

This constraint on the positive tariff implies that $\psi \leq (5-6\theta)/(4-3\theta)$. Recall from the symmetric countries case that for $\theta < \theta_0$ we had the following inequality:

$$W_i(\{F\}) > max\{W_i(\{jk\}), W_i(\{jh\}), W_i(\{ij\}), W_i(\{\Phi\})\} \tag{5.5}$$

It can easily be shown that for any $\theta < \theta_0$, inequality (5.5) still holds as long as the degree of asymmetry between countries is small enough, i.e. $\psi < \psi_0$. Similar to the determination of the threshold level for θ in the symmetric case, here we determine $\psi_0 = \psi_0(\theta)$ by the condition that country k is indifferent between global free trade and being nonmember in the $\{ij\}$ FTA: $W_k(\{F\}) = W_k(\{ij\})$. Note that, in contrast to the symmetric countries case, here the determination of the threshold is coming from the incentives of the smaller country. The reason is that, according to (2.9) and (2.10), the smaller country exports relatively less of the non-numeraire final good and imports relatively more of it. The case is completely opposite for larger countries. Therefore, it is the smaller country which would be more reluctant to create global free trade, not the larger countries. Also intuitively, moving from the symmetric to asymmetric countries case the equilibrium trade regime should not change as long as the ordering of the corresponding welfare levels is preserved (as in inequality (5.5)). Therefore, for a sufficiently small asymmetry parameter value ψ, all the results of the Proposition 4.1 will apply in the asymmetric case too.

Let us define one more threshold for the asymmetry parameter, $\psi_1 = \psi_1(\theta)$, determined by $W_i(\{ij\}) = W_i(\{\Phi\})$. The following results are formally proved in the Appendix and is expressed by:[10]

Proposition 5.1.

a) $\{\Phi\}, \{ij\}$ *and* $\{F\}$ *are all Nash Equilibria for* $\theta \leq \theta_0$ *and* $\psi < \psi_0$.

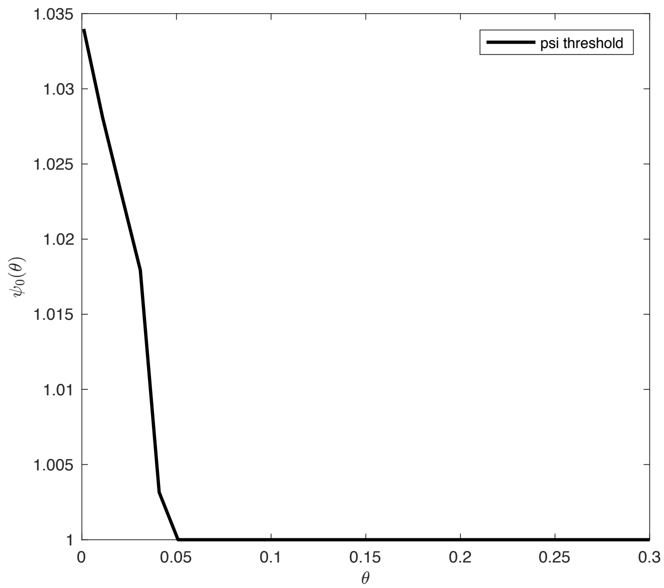
b) $\{\Phi\}$ *and* $\{ij\}$ *are both Nash Equilibria for* $\theta_0 < \theta \leq \theta_1$ *and* $\psi < \psi_1$.[11]

c) $\{\Phi\}$ *is the unique Nash Equilibrium for* $\theta_1 < \theta < 1/3$ *and* $\psi \geq 1$.

[10] For expositional reasons not all the possible parameter spaces are discussed. I focus only on those that have a higher chance of having $\{F\}$ as (a stable) Nash Equilibrium. This also serves the purpose of comparing the main results of the propositions for symmetric and asymmetric countries' cases.

[11] Note that here it is important that trade regime is $\{ij\}$ and not "$\{ij\}$ type", since in this case of asymmetric countries they are different.

Figure 5.1: "Free Trade" asymmetry parameter space



For sufficiently small values of θ, as shown in the Appendix, $\{F\}$ is no longer a Nash Equilibrium for $\psi \geq \psi_0$. One of the main threats to global free trade being a (stable) Nash Equilibrium is the free riding problem: the smaller country staying out of the free trade agreement between larger countries, $W_k(\{ij\}) > W_k(\{F\})$. In addition, a new incentive shows up for smaller country not to join $\{ij\}$. Since smaller countries import more and export less of the protected goods, the benefits, the duty-free access to foreign markets, overweighs the costs incurred by domestic consumers for larger countries. However, for the smaller country, this does not necessarily hold for a very large difference in country sizes (measured by final good's production). So, this force makes the smaller country k better off in the trade regime $\{ij\}$ relative to global free trade.

To rule out multiplicity I use the stable Nash Equilibrium concept from above. Using exactly analogous logic as in proving Proposition 4.2, we can show the validity of the following:

Proposition 5.2.

a) $\{F\}$ is the unique stable Nash Equilibrium for $\theta \leq \theta_0$ and $\psi < \psi_0$.

b) $\{ij\}$ is the unique stable Nash Equilibrium for $\theta_0 < \theta \leq \theta_1$ and $\psi < \psi_1$.

c) $\{\Phi\}$ is the unique stable Nash Equilibrium for $\theta_1 < \theta < 1/3$ and $\psi \geq 1$.

Moreover, as can be seen from Figure 5.1, $\partial\psi_0(\theta)/\partial\theta < 0$ for all $\theta < \theta_0$, and $\psi_0(\theta_0) = 1$. This means that as the foreigner's share in domestic production increases, the region of parameter space in which global free trade is a stable Nash Equilibrium, $\psi \in [1, \psi_0]$, shrinks. So, as θ increases it becomes increasingly more difficult to support global free trade as a stable Nash Equilibrium. Finally, at $\theta = \theta_0$ the only case where global free trade is the equilibrium outcome is when countries are symmetric.

To summarize, the major takeaway from Propositions 4.2 and 5.2 is that, simple incorporation of the trade in intermediate goods in the basic trade models makes the global free trade an unlikely candidate for the equilibrium trade regime. Free riding, which prevents global free trade from arising, exists because of the benefits nonmember countries get through intermediate input trade. In the next section, I introduce RoO, which by design limits this very benefit, and I show that can it mitigate the free riding problem.

6 Rules of Origin

Since regional free trade agreements usually come with a Rules of Origin (RoO) requirement, it is important to explore what role RoO play in the game we examined so far. There are several types of restrictions RoO might impose on FTA partners in order for exported goods to qualify for duty-free trade. This includes, but is not limited to, labor standards, change of goods' tariff classification, what type of inputs they use or how much foreign imported intermediate input can be used in the production. The latter feature be expressed in terms of physical units or in terms of value added, i.e. expenses spent on FTA-originated inputs versus inputs imported from nonmember countries.

Following Krishna (2004) one can formally classify the types of RoO into four main categories. These are:

(a) Requirements in terms of domestic content: content can be defined in terms of value-added or in physical terms.

(b) Requirements in terms of a change in tariff heading: RoO set in terms of a change in tariff heading are specified in terms of tariff categories. To satisfy origin requirements a product must change its tariff heading in a specified way. By making the changes needed more or less extensive, the origin requirement can be made more or less restrictive.

(c) Requirements in terms of specified processes that must be performed within the FTA: in the case of American imports of apparel under NAFTA, the rule is one of "triple transformation". Only if each step of the transformation from raw material to finished garment has been undertaken within the FTA will preferential treatment be given.

(d) Requirements that the product has been "substantially transformed". This is usually hard to pin down as it is loosely defined. In the United States the term "substantial transformation" has come to mean the determination of origin based on common law, reasoning from case to case. It then results in commodity-specific RoO which falls into one of the earlier three categories.

I focus on the first type of restriction because modeling other types of restrictions would be more complicated. Since we have perfectly competitive markets, this is equivalent to the restriction on the costs of the production of exported goods. Note that I focus on the expenses expressed in dollar terms rather than in physical units. This is the more frequently used measure in the literature (and in practice) and also fits the model developed here better.[12]

In what follows I set up the problem when there is a binding RoO constraint and the firm has to decide whether to comply with it or not. Of course, a firm might find it beneficial not to comply with the RoO and instead pay the MFN tariff set by the trading partner. This will happen if the trade cost saved by complying is not sufficient to compensate for higher production costs.[13] I will explore this decision later on in Section 6.3. Analysis of the symmetric case is not any simpler than the asymmetric case when we have RoO. So I will consider the general case directly. Note that if there is no FTA at all, i.e. the trade regime is the Status Quo, or there is global free trade, RoO have no effect: welfare levels and equilibria are exactly the same as in the baseline model. Since imposing RoO restrictions complicates the model, not all the remaining trade regime analysis will be the same. I examine them and determine the corresponding equilibria one by one.

6.1 FTA between any two countries

Let us first consider the situation in which exported goods produced in country i are freely traded to country j under the FTA $\{ij\}$, only if the ratio of the expenses on nonmember country inputs to the expenses on inputs from within the FTA is capped by κ. This parameter, which I refer to as the RoO restrictiveness parameter, will be the key determinant of the equilibrium values of prices, quantities, and corresponding welfare. The welfare levels in different cases determine the (stable) equilibrium trade regime. Therefore, based on how restrictive a RoO we have, equilibrium trade regimes will be different.

In country i, the production of good K is not affected by RoO, because it is the international trade in good J (also in good I) which is subject to RoO restrictions. Therefore the equilibrium quantities, prices, consumer surplus and incomes stemming from good K will be identical to what we have seen in previous sections.

Here, I focus on the equilibrium determination for good J; a similar determination will be true for good I. The producers of the final good J in country i have to satisfy demand from both domestic as well as from foreign country j's consumers. However, note that those producers are only restricted in the input mix for the goods exported in country j and not for goods sold domestically. Therefore, we can think of a firm in country i as having two production lines in order to produce good J for each market. Production for domestic consumers is denoted by y_{ii}^J, while for country j's consumers it is denoted by y_{ij}^J. Similarly, the inputs from all three countries used in producing

[12] There are many papers in the literature using this definition of RoO. For example, see Ju and Krishna (2005)and Chang and Xiao (2015).

[13] Unlike Chang and Xiao (2015) and Celik et al. (2015) there is no fixed cost of meeting RoO requirements in my model. The decision is purely based on the (endogenous) production and trade costs without introducing a fixed cost.

good J in country i are divided between the production of the good for domestic and for foreign consumers. Let us denote this usage of intermediate goods coming from countries $i, j,$ and k by the set of pairs $\left(x_{ii}^J(i),\ x_{ii}^J(j)\right)$, $\left(x_{ji}^J(i),\ x_{ji}^J(j)\right)$ and $\left(x_{ki}^J(i),\ x_{ki}^J(j)\right)$, respectively where (i) stands for domestic and (j) stands for exporting to country j. The production level corresponding to those inputs will be

$$y_{ii}^J = \left(x_{ii}^J(i)\right)^{1-2\theta} \left(x_{ji}^J(i)\right)^{\theta} \left(x_{ki}^J(i)\right)^{\theta} \tag{6.1}$$

and

$$y_{ij}^J = \left(x_{ii}^J(j)\right)^{1-2\theta} \left(x_{ji}^J(j)\right)^{\theta} \left(x_{ki}^J(j)\right)^{\theta} \tag{6.2}$$

The sum of the inputs used in those two production lines must equal the total inputs from each source country. Therefore, in equilibrium we have the following:

$$\begin{cases} x_{ii}^J(i) + x_{ii}^J(j) = e_{ii}^J \\ x_{ji}^J(i) + x_{ji}^J(j) = e_{ji}^J \\ x_{ki}^J(i) + x_{ki}^J(j) = e_{ki}^J \end{cases} \tag{6.3}$$

It is clear that since using inputs originated from a nonmember country is now discouraged, the price of that input will be relatively low. However, regardless of the existence of RoO the prices of the identical inputs used in one line or another are the same. I denote prices of the intermediate inputs coming from any country $z = i, j$ or k to country i for the production of good J by r_{zi}^J.

Note that I can no longer rely on no-arbitrage conditions like in the baseline model, which in equilibrium would guarantee equal prices of the same goods in FTA member countries. This is because, even if the price of good J in country j, denoted by p_j^J, is higher than its price in country i, p_i^J, there are no arbitrage opportunities since the product exported to country j is (and has to be) produced with a different input mix than it is for domestic country i. Therefore, this difference in the mix of inputs generates the difference in unit costs and equivalently the difference between prices of the same good in FTA partner countries. Moreover, we no longer have the total volume of production of good J predetermined by the input endowment levels. Even though the production function is constant returns to scale, a different input mixtures (proportions) affect total production.[14] So, in what follows, I tackle the problem of solving for equilibrium prices, quantities, and welfare in that environment.

[14]Even though those goods are identical, in some sense we might treat "good J destined for local consumption" and "good J destined for export to country j" as different goods, as they have different prices and destinations.

6.1.1 Optimization problem of FTA member

A competitive firm in country i solves two optimization problems. One for domestic sale:

$$Max\left[p_i^J\left(x_{ii}^J(i)\right)^{1-2\theta}\left(x_{ji}^J(i)\right)^{\theta}\left(x_{ki}^J(i)\right)^{\theta}-\left(r_{ii}^J x_{ii}^J(i)+r_{ji}^J x_{ji}^J(i)+r_{ki}^J x_{ki}^J(i)\right)\right] \tag{6.4}$$

and one for export to FTA partner country j:

$$Max\left[p_j^J\left(x_{ii}^J(j)\right)^{1-2\theta}\left(x_{ji}^J(j)\right)^{\theta}\left(x_{ki}^J(j)\right)^{\theta}-\left(r_{ii}^J x_{ii}^J(j)+r_{ji}^J x_{ji}^J(j)+r_{ki}^J x_{ki}^J(j)\right)\right] \tag{6.5}$$

subject to Rules of Origin constraint:

$$r_{ki}^J x_{ki}^J(j) \le \kappa\left(r_{ii}^J x_{ii}^J(j)+r_{ji}^J x_{ji}^J(j)\right) \tag{6.6}$$

The first order conditions and zero profit conditions are the following for domestic sale:

$$\begin{cases} r_{ii}^J x_{ii}^J(i) = (1-2\theta)p_i^J y_{ii}^J \\ r_{ji}^J x_{ji}^J(i) = \theta p_i^J y_{ii}^J \\ r_{ki}^J x_{ki}^J(i) = \theta p_i^J y_{ii}^J \end{cases} \tag{6.7}$$

and for the export market:[15]

$$\begin{cases} r_{ii}^J x_{ii}^J(j) = \frac{(1-2\theta)}{(1-\theta)(\kappa+1)}p_j^J y_{ij}^J \\ r_{ji}^J x_{ji}^J(j) = \frac{\theta}{(1-\theta)(\kappa+1)}p_j^J y_{ij}^J \\ r_{ki}^J x_{ki}^J(j) = \frac{\kappa}{\kappa+1}p_j^J y_{ij}^J \end{cases} \tag{6.8}$$

As we can see in both markets i and j, the ratio of income that goes to FTA partner firms is fixed and determined by the relative share in the production of the final good J:

$$\frac{r_{ii}^J x_{ii}^J(i)}{r_{ji}^J x_{ji}^J(i)} = \frac{r_{ii}^J x_{ii}^J(j)}{r_{ji}^J x_{ji}^J(j)} = \frac{1-2\theta}{\theta} \tag{6.9}$$

Exactly θ share of income generated by selling good J domestically goes to nonmember country's input supplier industry. However, this share reduces to $\frac{\kappa}{\kappa+1} \le \theta$ for income generated by exporting to country j.

Using conditions (6.9)-(6.14) we can prove the following:

[15] I use the binding constraint since RoO constraint discourages the use of inputs from nonmember country k. As a result, the firm would like to use as much cheaper imported input from country k as possible as long as $\kappa \le \frac{\theta}{1-\theta}$. Therefore, it will ensure that (6.8) holds with equality in equilibrium.

Lemma. *a) Prices in the FTA member countries are related:*

$$p_i^J = \alpha(\theta, \kappa) p_j^J \tag{6.10}$$

where $\alpha(\theta, \kappa) = \frac{\kappa^\theta}{(\kappa+1)\theta^\theta(1-\theta)^{(1-\theta)}}$.

b) The more stringent the Rules of Origin constraint is (lower κ*), the higher is the price differential between FTA members:*

$$\frac{\partial \left(\frac{p_j^J}{p_i^J}\right)}{\partial \kappa} = \frac{\partial \alpha^{-1}(\theta, \kappa)}{\partial \kappa} < 0 \text{ for } \kappa \le \frac{\theta}{1-\theta},\ \theta < \frac{1}{3} \tag{6.11}$$

and $\alpha(\theta, \kappa) = 1$, $p_i^J = p_j^J$ *for* $\kappa = \frac{\theta}{1-\theta}$.

So whenever RoO constraint is not binding, $\kappa = \frac{\theta}{1-\theta}$, then we have $p_i^J = p_j^J$. This is intuitive, since in the unconstrained case, we are in the baseline scenario, where prices are equalized in the FTA partner countries. However, in the binding constraint case when $\kappa < \frac{\theta}{1-\theta}$, it is obvious that exporting is more expensive, and therefore $\frac{\partial \alpha(\theta,\kappa)}{\partial \kappa} > 0$ and $p_j^J > p_i^J$ for all $\theta < 1/3$. The more strict is the Rule of Origin requirement (lower κ), the higher is the relative price of the imported good in the FTA member country. This is intuitive since RoO restrict the input mix of exporters and thus potentially make exporters' production costs higher than the minimum possible level.

Also, since nonmember country k firms face no RoO restrictions, the usual no-arbitrage condition holds. Therefore, given the price p_j^J of good J in country j, its price in country k will be

$$p_k^J = p_j^J - t_{jk} \tag{6.12}$$

Since any production surplus of good J is exported from country k to j, in equilibrium we must have that the export volume is

$$y_k^J - d(p_k^J) = y_k^J - \alpha + p_j^J - t_{jk} \tag{6.13}$$

Where, $y_k^J \equiv y_k$ is the total production of good J in country k predetermined by intermediate inputs' endowment levels, as in the baseline model. So, the remaining deficit should be satisfied import from country i, so in equilibrium we have

$$y_{ij}^J = 2\alpha - 2p_j^J - y_k^J + t_{jk} = 2\alpha - 2p_i^J/\alpha(\theta, \kappa) - y_k^J + t_{jk} \tag{6.14}$$

Once we determine the relationship between prices of the good in FTA member countries, we can use that information to determine the relationship between domestically sold versus exported goods. In particular, it can be shown that the following holds:

$$\left(e_{ii}^J\right)^{1-2\theta}\left(e_{ji}^J\right)^{\theta}\left(e_{ki}^J\right)^{\theta}\left(y_{ii}^J+\beta_1 y_{ij}^J\right)^{-(1-\theta)}\left(y_{ii}^J+\beta_2 y_{ij}^J\right)^{-\theta}=1 \tag{6.15}$$

where, $\beta_1 = (\alpha(\theta,\kappa)(1-\theta)(1+\kappa))^{-1}$ and $\beta_2 = \kappa(\theta\alpha(\theta,\kappa)(1+\kappa))^{-1}$.

And finally, the last equation which will be used to determine p_i^J is the condition

$$y_{ii}^J(p_i^J) = d(p_i^J) = \alpha - p_i^J \tag{6.16}$$

Of course (6.15) is just an extension of the equilibrium conditions we had in the baseline model. Indeed, when $\kappa = \frac{\theta}{1-\theta}$ RoO constraint is not binding and the production of goods for local as well as foreign consumption use unrestricted mix of inputs. Also, it is easy to check that in this case $\beta_1 = \beta_2 = 1$ and therefore (6.15) reduces to the condition we already had before, namely that total production of good J is distributed among local and foreign consumption:

$$y_{ii}^J + y_{ij}^J = \left(e_{ii}^J\right)^{(1-2\theta)}\left(e_{ji}^J\right)^{\theta}\left(e_{ki}^J\right)^{\theta} \equiv y_i^J \tag{6.17}$$

Using (6.14) and (6.16) we can solve equation (6.15) and find p_i^J as a function of parameters and t_{jk}. This equation admits no analytical solution so instead I report numerical solutions.[16]

As far as equilibrium conditions for other goods are concerned, similarly for good I imported in country i, we have:

$$p_j^I = \alpha(\theta,\kappa)p_i^I \tag{6.18}$$

and

$$p_k^I = p_i^I - t_{ik} \tag{6.19}$$

and an exactly analogous method works in this case.

In addition, production of the third final good K is not distorted by RoO and therefore is predetermined by the endowment level of the intermediate inputs as in the baseline model. So equilibrium conditions, prices, and quantities are determined as in the baseline model. Once we know equilibrium prices and quantities we can easily calculate the welfare level.

Note that the welfare function should be modified here relative to the baseline model. This is due to the fact that, that the share of income which goes to members of the FTA are no longer simply θ and $(1-\theta)$ and thus RoO change the income structure of each country. FTA member country i receives a $(1-2\theta)$ share of income coming from its own production of goods sold domestically

[16] This is the equation of very high degree polynomial at best, in the case of rational θ. According to Abel-Ruffini's "impossibility theorem" from Algebra, there are no general solution formulae for that type of algebraic equations.

or exported to the nonmember country. It gets $\frac{1-2\theta}{(1-\theta)(\kappa+1)} > 1-2\theta$ share from income generated by selling its goods to the FTA member country j. Also, it receives θ share of income generated from selling foreign goods except for goods exported from j to i where it gets $\frac{\theta}{(1-\theta)(\kappa+1)} > \theta$ share. Analogously, nonmember country k receives regular shares $(1-2\theta)$ and θ from domestic and foreign final goods' sales respectively, except for final goods traded between FTA member countries i and j. It receives only $\frac{\kappa}{\kappa+1} < \theta$ share from the latter income. Therefore we have the following:

The welfare level of FTA member country i:

$$W_i(\{ij\}) = CS_i^I + CS_i^J + CS_i^K + (1-2\theta)\left(p_i^J y_{ii}^J + p_i^K y_i\right) + \theta\left(p_k^I y_k + p_k^J y_k + p_j^K y_j + p_j^I y_{jj}^I\right)$$
$$+ \frac{(1-2\theta)}{(1-\theta)(\kappa+1)} p_j^J y_{ij}^J + \frac{\theta}{(1-\theta)(\kappa+1)} p_i^I y_{ji}^I + t_{ik} exp_{ki}$$

A similar expression holds for country j:

$$W_j(\{ij\}) = CS_j^I + CS_j^J + CS_j^K + (1-2\theta)\left(p_j^I y_{jj}^I + p_j^K y_j\right) + \theta\left(p_k^I y_k + p_k^J y_k + p_i^K y_i + p_i^J y_{ii}^J\right)$$
$$+ \frac{(1-2\theta)}{(1-\theta)(\kappa+1)} p_i^I y_{ji}^I + \frac{\theta}{(1-\theta)(\kappa+1)} p_j^J y_{ij}^J + t_{jk} exp_{kj}$$

And finally, welfare level of the FTA nonmember country k is:

$$W_k(\{ij\}) = CS_k^I + CS_k^J + CS_k^K + (1-2\theta)(p_k^I y_k + p_k^J y_k) + \theta\left(p_j^K y_j + p_j^I y_{jj}^I + p_i^J y_{ii}^J + p_i^K y_i\right)$$
$$+ \frac{\kappa}{\kappa+1}\left(p_j^J y_{ij}^J + p_i^I y_{ji}^I\right) + t_{ki} exp_{ik} + t_{kj} exp_{jk}$$

We no longer have analytical solutions for optimal tariffs as in the non-RoO case, (5.1)-(5.3). Numerical optimization of the welfare function of country j is then necessary to determine the optimal tariff t_{jk}. The algorithm I employ is as follows. For a given θ, I create a two-dimensional grid for the values of the (κ, t_{jk}) pair. For each grid point, I solve equilibrium conditions and evaluate welfares of each country. Then, I optimize welfare of country j over the tariff rates t_{jk}. This way I have the optimal welfare level of a country j under $\{ij\}$ FTA with RoO parameter κ. The objective is then to vary κ and have a final relationship between κ and welfare.

In the following subsection 6.2, I consider the equilibrium structure for Hub and Spokes trade regime and find the optimal welfare level as a function of κ. The final goal is to examine the stable equilibria based on the ordering of all those welfare levels.

6.2 Hub and Spokes trade regime

Now I examine the case where one country has a free trade agreement with two other countries, where the other two countries impose optimal non-zero tariffs on each other. The plan for the solution is similar. First of all, for the goods that are exported from the hub country, the determination of the equilibrium values is exactly as in Section 6.1. The reason is that when we consider the FTA between two countries, say i and j, and how it affects the price of the good imported in i, p_i^I, it does not matter whether j and k have an FTA since they do not trade good I between them. So, if the trade regime is $\{kh\}$, the prices of good I and J will be determined by the same exact procedure outlined in Section 6.1 as if the trade regime were $\{ik\}$ and $\{jk\}$, respectively.

The determination of the price of good K imported in the hub country k is not as straightforward. Now, given the price level in country k, p_k^K, we can still find the prices in i and j according to (6.10) formula in the Lemma in subsection 6.1. These prices will determine the local demand in countries i and j, respectively. Also, we will have a relationship between local and exported volumes according to (6.15) in each country. But there is no "nonmember country" here, which would have determined the residual demand, equal to export supply in equilibrium. This means that, the condition (6.14) which would have closed the model is no longer valid.

6.2.1 Smaller country is a hub

In the case when k is a hub we can utilize our assumption about symmetry between the larger countries i and j. In the equilibrium, this symmetry will result in the equal export of good K from i and j to k: each country satisfies half of the total demand in k. Therefore, the analog of condition (6.14) needed to close the model is the following:

$$y_{jk}^K = \frac{\alpha - p_k^K}{2} = \frac{\alpha - p_j^K/\alpha(\theta,\kappa)}{2} \tag{6.20}$$

Finally, we solve (6.15) using (6.16) and (6.20) modified for country k.

6.2.2 Larger country is a hub

Here the trade regime is $\{jh\}$ and we can no longer rely on the symmetry trick used to reduce the problem to solving the single equation. Instead, applying market clearing conditions leads to the following system of equations, with three variables y_{ij}^J, y_{kj}^J and p_j^J:

$$\begin{cases} y_{ij}^J + y_{kj}^J = \alpha - p_j^J \\ \left(e_{ii}^J\right)^{1-2\theta}\left(e_{ji}^J\right)^{\theta}\left(e_{ki}^J\right)^{\theta}\left(y_{ii}^J + \beta_1 y_{ij}^J\right)^{-(1-\theta)}\left(y_{ii}^J + \beta_2 y_{ij}^J\right)^{-\theta} = 1 \\ \left(e_{kk}^J\right)^{1-2\theta}\left(e_{ik}^J\right)^{\theta}\left(e_{jk}^J\right)^{\theta}\left(y_{kk}^J + \beta_1 y_{kj}^J\right)^{-(1-\theta)}\left(y_{kk}^J + \beta_2 y_{kj}^J\right)^{-\theta} = 1 \end{cases} \tag{6.21}$$

where the following three expressions can be used to solve the system: local prices in the exporting countries according to (6.10) $p_i^J = p_k^J = \alpha(\theta,\kappa)p_j^J$; and local demands there according to (6.16) $y_{ii}^J(p_i^J) = d(p_i^J) = \alpha - p_i^J$ and $y_{kk}^J(p_k^J) = d(p_k^J) = \alpha - p_k^J$, in i and k, respectively.

6.3 Equilibrium Analysis

Using similar steps to those we used in the Sections 4 and 5, we can determine the equilibrium when we have RoO in the model.

In order to check if the firm in i would like to comply with RoO we need to examine what would have been the firm's benefit in the case of not complying. Since the firms make zero profit in equilibrium (when complying with RoO), negative counterfactual profit would be the necessary and sufficient condition for deviating to non-compliant status:

$$p_i^J > p_j^J - t_{jk} \tag{6.22}$$

The right-hand side of the inequality in (6.22) is the net of tariff price firms get by exporting to j in the case of not complying with RoO, while the left-hand side is the price of the good J locally, in country i. Moreover, note that perfect competition and zero profit in each market leads us to the per unit production cost for domestic sale equal to domestic price. If the firm decides not to comply with RoO, it would solve an unconstrained optimization problem similar to the problem for the domestic market. As a result, the cost of production for local as well as foreign sales will be identical. Therefore, (6.22) compares the per unit cost and net price for exported goods and thus represents a negative counterfactual profit condition.

For $\{F\}$ to be the stable Nash Equilibrium we need it to be coalition proof. Like before, this will depend on the relative rankings of welfare levels in various trade regimes as in the chain of inequalities (4.4). Since the analysis of the previous sections underlined that the main threat to the global free trade regime is a free riding problem, I examine how changes in the RoO restrictiveness parameter κ affects the relative ranking of $W_i(\{jk\})$ and $W_i(\{F\})$. The idea is that for sufficiently small κ, we will get $W_i(\{jk\}) < W_i(\{F\})$, which with other supporting inequalities will guarantee global free trade as a stable equilibrium. Let us introduce new thresholds for this scenario:

For the symmetric case:

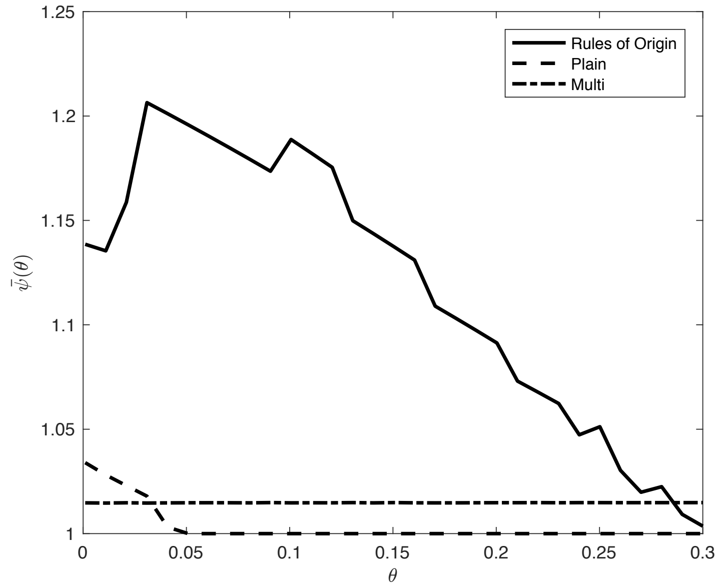
$$\bar{\theta} = sup\,\{\theta : \exists\kappa \text{ such that } \{F\} \text{ is stable NE } |\kappa\} \tag{6.23}$$

and for the asymmetric case:

$$\bar{\psi}(\theta) = sup\,\{\psi : \exists\kappa \text{ such that } \{F\} \text{ is stable NE } |\theta,\kappa\} \tag{6.24}$$

By checking numerical values of welfares and conditions for stability like in (4.4) we show that in the case of symmetric countries, it is possible to find a value of the RoO parameter κ such that

Figure 6.1: Significance of Rules of Origin



$\{F\}$ is a stable equilibrium:

$$\bar{\theta} = \frac{1}{3} > \theta_0 \tag{6.25}$$

Moreover, from the comparison of the unconstrained and constrained threshold level in (6.25), it is clear that the RoO is essential in achieving global free trade when θ is sufficiently large. This means that without RoO global free trade is not attained when there is a high degree of intermediate input trade across countries.

For asymmetric countries, the space is two dimensional and is depicted in Figure 6.1. It is clear that the solid line lies strictly above the dashed line which means that for all parameter values represented by the area between the lines, RoO is essential in attaining global free trade.

This finishes the analysis of the equilibria of the game in case of bilateralism. Consistent with WTO rules, member countries are free to choose one of the following options: *i*) no trade liberalization, *ii*) bilateral trade liberalization or *iii*) multilateral trade liberalization. The question is what would happen if countries were only restricted to options *i*) and *iii*): would the global free trade be more or less likely? In their endowment economy model without intermediate inputs Saggi and Yildiz (2010) answer that being free to pursue bilateral free trade increases the chances of global free trade. This is the issue that I examine in the next section, where I analyze the game in which trade liberalization is restricted to happen only on the MFN basis.

7 Multilateralism

The main characteristic of multilateralism, which differentiates it from bilateralism, is that any trade liberalization should be undertaken on an MFN basis. So, for instance, if countries i and j decide to sign a multilateral trade agreement they must do so in a non-discriminatory fashion. Given the notation above, the strategy set of a country under multilateralism is $\Omega_i = \{\emptyset, M\}$ where M refers to the announcement in favor of multilateral trade liberalization.

The game of multilateralism is defined in the following way. In the first stage of the game, each country decides in favor or against multilateral trade liberalization. This generates the world trade regime. In the second stage of the game each country chooses its optimal tariffs, given the announcements. Obviously, if none of the countries expresses a desire for liberalization it is not going to happen. Similarly, no one country finds it unilaterally optimal to liberalize trade by setting tariffs lower than Status Quo level because according to (2.8) each country tries to exploit its power by affecting terms of trade. If two countries i and j are in favor of multilateral trade liberalization while the third is against, those two will set their MFN tariffs accordingly to maximize their joint welfare, while the nonmember will set its own optimal MFN tariffs. We call this multilateral agreement $\{ij^m\}$. And, if all countries announce in favor, they all set optimal non-discriminatory tariffs which in this model is equal to zero (see Appendix). Finally, consumption and international trade take place, like in the bilateral game. Note that, in contrast to bilateralism case, even if countries i and j are in favor of multilateral trade liberalization but country k is against, the latter would not be penalized since the other two are not allowed to discriminate against country k.

7.1 Symmetric Countries

Following Saggi and Yildiz (2010), if countries i and j agree to sign multilateral trade agreement $\{ij^m\}$ they choose the tariff pair (t_i^m, t_j^m) to maximize joint welfare:

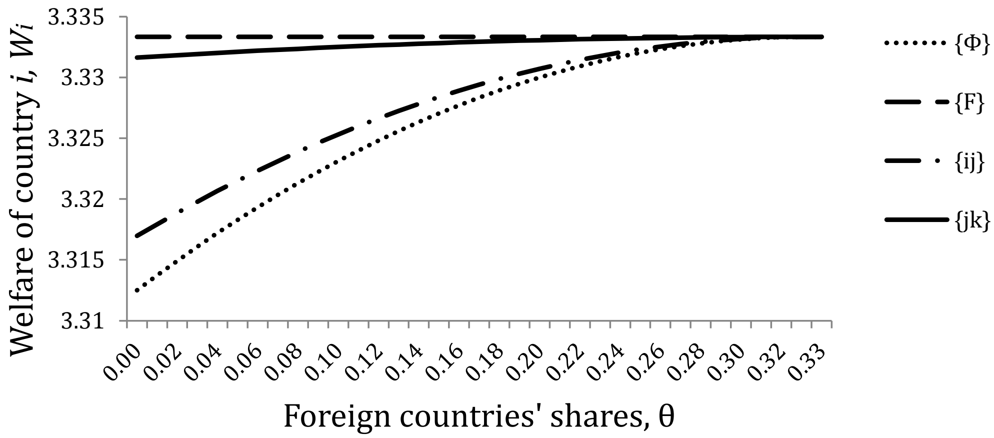
$$(t_i^m, t_j^m) \equiv Argmax[W_i(\{ij^m\}) + W_j(\{ij^m\})] \tag{7.1}$$

Using the expressions for welfare, maximization gives the following optimal tariffs:

$$t^m \equiv t_i^m = t_j^m = \frac{(1-3\theta)y}{7} \tag{7.2}$$

As we can see, $t^f < t^m$ but still country k suffers from discriminatory treatment in the bilateralism case while it is forbidden in the case of multilateralism. Also, $t^m < t^\Phi$ meaning that the nonmember country of the multilateral trade agreement benefits from it without offering any tariff concession itself. Note that as the participation of foreign input in domestic production increases, the optimal multilateral tariff declines. The intuition is similar to what we saw in previous sections: countries

Figure 7.1: Welfare levels and trade regimes in case of symmetry: Multilateralism



impose lower tariffs on imports as their own input suppliers get higher share production of those imported goods.

Given the optimal levels of tariffs in each trade regime the corresponding welfare levels can be calculated from formula above:

$$W_i(ij^m) = 2\alpha y - (33\theta^2 - 22\theta + 153)y^2/224 \text{ and } W_i(jk^m) = 2\alpha y - (3\theta^2 - 2\theta + 131)y^2/196 \quad (7.3)$$

Also, the welfare levels for $\{\Phi\}$ and $\{F\}$ are the same as in the previous case.

Since any trade agreement needs at least two members, $\{\Phi\}$ is a Nash Equilibrium outcome as in the case of bilateralism. Also, as can be shown formally and is clear from the Figure 7.1 (where again, $\alpha = 2$ and $y = 1$ is taken, without loss of generality), that:

$$W_i(\{F\}) > W_i(\{jk^m\}) > W_i(\{ij^m\}) > W_i(\{\Phi\}) \text{ for all } \theta. \quad (7.4)$$

Therefore, $\{ij^m\}$ is not a Nash Equilibrium since nonmember country k would benefit by joining it as well as member countries i and j. Since $\{F\}$ achieves the highest possible welfare for each country, none of them will unilaterally deviate from global free trade. Thus, $\{F\}$ is a Nash Equilibrium outcome. Moreover, it is also a stable equilibrium since there is no beneficial self-enforcing coalition deviation. This argument established the following result, which is consistent with the results from Saggi and Yildiz (2010):

Proposition 7.1.

a) $\{F\}$ *and* $\{\Phi\}$ *are both Nash Equilibrium for all* $\theta < \frac{1}{3}$.

b) $\{F\}$ *is the unique stable Nash Equilibrium for all* $\theta < \frac{1}{3}$.

From Propositions 4.1, 4.2 and 7.1 it is clear that multilateralism is (weakly) better than bilateralism in achieving global free trade in a case of the symmetric countries. This is in contrast with Saggi and Yildiz (2010) in which both types of agreements guarantee global free trade in equilibrium. Note that the relative position of the curves in Figures 4.1 and 7.1, representing the welfare levels for various trade regimes, is an important determinant of the (stable) equilibrium. It is interesting that these two Figures are very different. In particular, the response of the welfare functions to a change in the foreign countries' shares in domestic production is different depending on the setting – bilateral or multilateral. In the multilateralism case, we see that the original ordering of the welfare levels corresponding to $\theta = 0$ is preserved for any $\theta < 1/3$. However, there are dramatic changes in that ordering in the bilateral case. What explains this? Note that the crucial difference between the two cases is how the trade agreement signatory countries treat the nonmember country. While in the multilateral case the nonmember country enjoys the same privileges in accessing the markets of the member countries, the treatment is discriminatory in the bilateral FTA case. Therefore, in the case of multilateralism the share of income that goes to the nonmember country through intermediate input supply does not affect the welfare orderings since the privileges are the same for all countries regardless of their FTA status. However, in the case of bilateralism, it is more penalizing to the nonmember to not join the FTA at lower θ, as a benefit of the FTA is primarily accrued to member countries' traded final goods. Therefore, the lower the θ is, lower the free riding effect for the nonmember country is. Whereas for relatively high θ, the discrimination against the nonmember is weaker and the nonmember partially enjoys (indirect) free access to the FTA.

In the case of multilateralism, regardless of how big θ is, nondiscrimination guarantees that $\{ij^m\}$ benefits country k as much as country j. By contrast, in the case of bilateralism, when a country eliminates a tariff it experiences the full cost of this action (reduced tariff revenue inclusive consumer surplus), but only gains part of the benefit since a share θ goes to each of the remaining countries. So, this makes $\{ij\}$ not that attractive an option for member countries, for relatively high θ. As for the nonmember country, why does it not always want to join? Without joining, it already gets an indirect benefit through intermediate inputs. So, the additional benefit would be only a fraction of the total benefit, while it needs to endure a "full" amount of consumer surplus loss. For a relatively large θ, the third country prefers to stay out of the agreement.

In order to explore whether the dominance of multilateralism over bilateralism in achieving the efficient global trade regime is a more general phenomenon, next I explore this issue in the case of asymmetric countries.

7.2 Asymmetric Countries

Analogous to (7.2) the optimal tariffs in this case take the following form:

$$t_i^m = \frac{(1-3\theta)(2y_k - y_j)}{7} \text{ and } t_j^m = \frac{(1-3\theta)(2y_k - y_i)}{7} \tag{7.5}$$

while the nonmember country sets optimal MFN tariffs equal to:

$$t_k^m = \frac{(1-3\theta)(y_i + y_j)}{8} \tag{7.6}$$

Using the sufficient conditions (for the smaller country):

$$W_k(\{F\}) > W_k(\{ij^m\}) > W_k(\{ik^m\}) > W_k(\{\Phi\}) \tag{7.7}$$

and the usual arguments for determining the Nash and a stable Nash Equilibria (like in Proposition 7.1), we can show the validity of the following:

Proposition 7.2.

a) $\{F\}$ *and* $\{\Phi\}$ *are both Nash Equilibria for all* $\theta < 1/3$ *and* $\psi \leq \psi_0^m$.

b) $\{ij^m\}$ *is the unique Nash Equilibrium for* $\theta < 1/3$ *and* $\psi > \psi_0^m$.

c) $\{F\}$ *is the unique stable Nash Equilibrium for all* $\theta < 1/3$ *and* $\psi \leq \psi_0^m$.

d) $\{ij^m\}$ *is the unique stable Nash Equilibrium for* $\theta < 1/3$ *and* $\psi > \psi_0^m$.

Where ψ_0^m *is determined by* $W_k(\{ij^m\}) = W_k(\{F\})$ *and is independent of* θ.

As is summarized in Figure 6.1 there is no clear dominance of multilateralism or bilateralism (without RoO) in achieving global free trade. However, due to the presence of RoO it is possible to make bilateralism a more successful form of trade liberalization than multilateralism.

8 Conclusion

This paper has analyzed how non-tariff barriers can shape the global trade regime. In particular, I have focused on the effects of the Rules of Origin on achieving global free trade. In contrast to the literature on the negative effects of RoO, I show that these regulations can actually help to achieve global free trade. There are cases in which countries agree to global free trade only if their Free Trade Agreements include RoO. This highlights the necessity of RoO and suggests its potential policy implications.

In the wake of a dramatic increase in trade of intermediate inputs, should the WTO allow RoO in regional trade agreements? In the case of symmetric countries, I show that as countries become more involved in global supply chains, as measured by their input share in foreign final good production, global free trade is less likely to be an equilibrium outcome. Free riding is the main problem preventing countries from liberalizing trade. RoO can solve this problem by limiting the benefit that countries get from other countries' free trade agreements. In the case of asymmetric countries, I show that global free trade is a stable Nash Equilibrium under a larger region of the parameter space in the case when RoO apply than in the case when they do not. So, RoO is an essential element of a mechanism in which preferential trade agreements lead to global free trade.

The paper also contributes to the literature exploring the difference between bilateral and multilateral trade liberazations. I show that, in contrast to Saggi and Yildiz (2010), in case of symmetric countries multilateralism always achieves global free trade, while bilateralism does not. Bilateralism is not more successful in achieving global free trade in case of asymmetric countries either. However, RoO can turn bilateralism into a better form of trade liberalization than multilateralism.

For model tractability, I assumed no tariffs on the intermediate inputs. In the future, to make the model more general, one can relax this assumption and have tariff as well as non-tariff barriers. This would identify the distinctive effect that RoO have on forming the FTAs more clearly. Also, given the intermediate goods market structure, forming an FTA has effects only on the prices and not on the quantities of intermediate goods. Therefore it might be also interesting to relax the industry-specific input assumption and allow for substitutability of inputs across industries. Finally, the markets in the model is assumed to be perfectly competitive. Since in many trade models the market structure matters a lot, it would be interesting to examine for example Cournot competition model instead, à la Saggi and Yildiz (2011).[17]

[17] Krishna (2004)also emphasizes the importance of studying RoO in FTAs in an imperfectly competitive markets.

A Proofs and Calculations

This appendix contains supporting calculations and proofs of the propositions which were omitted in the main text.

A.1 Supporting Calculations

A.1.1 Welfare in the baseline model

Based on the optimal tariff levels and the social welfare formula the following are the welfare levels under six possible trade regimes:

Welfare under Status Quo: $W_i(\{\Phi\}) = 2\alpha y - (3\theta^2 - 2\theta + 11)y^2/16$

Welfare under global free trade: $W_i(\{F\}) = 2\alpha y - 2y^2/3$

Welfare of FTA member : $W_i(\{ij\}) = 2\alpha y - (-753\theta^2 + 150\theta + 2615)y^2/3872$

Welfare of FTA nonmember: $W_i(\{jk\}) = 2\alpha y - (303\theta^2 - 114\theta + 327)y^2/484$

Welfare of a hub country: $W_i(\{ih\}) = 2\alpha y - (-801\theta^2 + 336\theta + 703)y^2/1089$

Welfare of a spoke country: $W_i(\{jh\}) = 2\alpha y - (855\theta^2 - 372\theta + 1481)y^2/2178$

So, θ_0 determined by $W_i(\{F\}) = W_i(\{jk\})$, is the solution of the quadratic equation and $\theta_0 = 0.05$. Analogously, for θ_1 determined by $W_i(\{ij\}) = W_i(\{\Phi\})$, we get $\theta_1 = 0.09$.

Here I explore the $W_i(\{jk\})$ in detail.

$\frac{d}{d\theta}\left(W_i(\{jk\})\right) = \frac{3(19-101\theta)}{242} = \frac{d}{d\theta}\left(CS_i^I + TR_i^I\right) + \frac{d}{d\theta}\left(CS_i^J + CS_i^K\right) + \frac{d}{d\theta}\left([1-2\theta]Income_i\right) + \frac{d}{d\theta}\left(\theta(Income_j + Income_k)\right)$

$\frac{d}{d\theta}\left(CS_i^I + TR_i^I\right) = -\frac{1}{2}\theta \leq 0$. As θ grows, there is less tariff imposed according to (4.2). This means less protection and therefore higher "world prices" according to (2.8). So, this leads to less tariff revenue inclusive consumer surplus from consuming good I.

$\frac{d}{d\theta}\left(CS_i^J + CS_i^K\right) = -\frac{32-8\theta}{121} < 0$. As θ grows, there are less tariffs abroad i.e. less protected foreign markets, therefore higher "world price" of goods J and K. So, this leads to lower consumer surplus from consuming goods J and K.

$\frac{d}{d\theta}\left([1-2\theta]Income_i\right) = \frac{108}{33} - 4\alpha - \frac{16\theta}{11} < 0$. As θ grows the share of income from domestic production, $(1-2\theta)$ goes down. Despite prices going up abroad, total revenue accrued to domestic welfare decreases.

$\frac{d}{d\theta}\left(\theta(Income_j + Income_k)\right) = 4\alpha + \frac{7\theta}{11} - \frac{183}{132} > 0$. As θ grows the share of income from foreign production goes up. Moreover, because of lower tariffs everywhere, "world prices" go up. Therefore, total revenue going to domestic welfare increases.

A.1.2 Welfare in the model with RoO

Here, I provide the expressions for welfares in case of $\{ih\}$ with RoO (parameter κ).

The hub country i receives $(1-2\theta)$ share of income from its own production of goods sold domestically. It gets $\frac{1-2\theta}{(1-\theta)(\kappa+1)} > 1-2\theta$ share from income generated by selling its goods at FTA member countries j and k. Also, it receives θ share of income generated from selling foreign goods except for goods exported from j to i and k to i, where it gets $\frac{\theta}{(1-\theta)(\kappa+1)} > \theta$ share. Analogously, spoke countries j and k receive regular $(1-2\theta)$ and θ shares from domestic and some of the foreign final goods' sales, respectively. Exceptions are the final goods traded between FTA member countries in which case they get only $\frac{\kappa}{\kappa+1}$ shares; when they are FTA members where they get they get $\frac{\theta}{(1-\theta)(\kappa+1)}$ and $\frac{1-2\theta}{(1-\theta)(\kappa+1)}$ for imported and exported goods, respectively. Therefore, the modified welfare levels in case of RoO for Hub and Spokes trade regime $\{ih\}$ are the following:

Welfare of hub country i:

$$\begin{aligned} W_i(\{ih\}) = {} & CS_i^I + CS_i^J + CS_i^K + (1-2\theta)\left(p_i^J y_{ii}^J + p_i^K y_{ii}^K\right) + \theta\left(p_k^I y_{kk}^I + p_k^J y_k + p_j^K y_j + p_j^I y_{jj}^I\right) \\ & + \frac{(1-2\theta)}{(1-\theta)(\kappa+1)}\left(p_j^J y_{ij}^J + p_k^K y_{ik}^K\right) + \frac{\theta}{(1-\theta)\,(\kappa+1)}\left(p_i^I y_{ji}^I + p_i^I y_{ki}^I\right) \end{aligned}$$

Welfare of spoke country j:

$$\begin{aligned} W_k(\{ih\}) = {} & CS_j^I + CS_j^J + CS_j^K + (1-2\theta)(p_j^I y_{jj}^I + p_j^K y_j) + \theta\left(p_k^J y_k + p_k^I y_{kk}^I + p_i^K y_{ii}^K + p_i^J y_{ii}^J\right) \\ & + \frac{\kappa}{\kappa+1}\left(p_k^K y_{ik}^K + p_i^I y_{ki}^I\right) + \frac{\theta}{(1-\theta)\,(\kappa+1)} p_j^J y_{ij}^J + \frac{(1-2\theta)}{(1-\theta)(\kappa+1)} p_i^I y_{ji}^I + t_{jk} exp_{kj} \end{aligned}$$

Similar expression for spoke country k:

$$\begin{aligned} W_k(\{ih\}) = {} & CS_k^I + CS_k^J + CS_k^K + (1-2\theta)(p_k^I y_{kk}^I + p_k^J y_k) + \theta\left(p_j^K y_j + p_j^I y_{jj}^I + p_i^J y_{ii}^J + p_i^K y_{ii}^K\right) \\ & + \frac{\kappa}{\kappa+1}\left(p_j^J y_{ij}^J + p_i^I y_{ji}^I\right) + \frac{\theta}{(1-\theta)\,(\kappa+1)} p_k^K y_{ik}^K + \frac{(1-2\theta)}{(1-\theta)(\kappa+1)} p_i^I y_{ki}^I + t_{kj} exp_{jk} \end{aligned}$$

A.2 Proofs

Here, I show that $\{F\}$ is efficient trade regime from the global welfare perspective. For this, I consider the social planner problem who chooses MFN tariffs of all three countries to maximize the world welfare defined as the sum of individual welfares: $W = W_i + W_j + W_k$.[18] Given the social welfare function if the countries set non-discriminatory tariffs t_i, t_j and t_k, respectively the welfare

[18] This is for simplicity, efficient tariffs will be zero even in non-MFN case.

of a country i will be

$$W_i(t_i,t_j,t_k) = \frac{1}{18}\left(y_j+y_k-2t_i\right)^2 + \frac{1}{18}\left(y_i+y_k+t_j\right)^2 + \frac{1}{18}\left(y_i+y_j+t_k\right)^2 + \frac{(1-2\theta)\,y_i}{3}\left(6\alpha-2y_i-y_j-y_k-t_j-t_k\right) + \frac{\theta y_j}{3}\left(6\alpha-2y_j-y_i-y_k-t_i-t_k\right) + \frac{\theta y_k}{3}\left(6\alpha-2y_k-y_i-y_j-t_i-t_j\right) + \frac{t_i}{3}\left(y_j+y_k-2t_i\right)$$

Therefore, jointly optimal tariff triple from the world welfare maximization FOC is $Argmax\left[W(t_i,t_j,t_k) = W_i(t_i,t_j,t_k) + W_j(t_i,t_j,t_k) + W_k(t_i,t_j,t_k)\right] = (0,0,0)$.

Proof of Proposition 4.1. Note that regardless of θ, Status Quo (generated by announcements $\{\emptyset,\emptyset\}$, $\{\emptyset,\emptyset\}$ and $\{\emptyset,\emptyset\}$) is always a Nash Equilibrium since no single country can have trade agreement without a partner.

a) When $\theta \leq \theta_0$ we have $W_i\left(\{F\}\right) > W_i\left(\{jh\}\right)$ and $W_i\left(\{F\}\right) > W_i\left(\{jk\}\right) \Rightarrow \{F\}$ is a Nash Equilibrium, since no country i wishes to unilaterally deviate from $\{F\}$. Moreover, $W_i\left(\{ij\}\right) > W_i\left(\{\Phi\}\right) \Rightarrow \{ij\}$ generated by announcements $\{j,\emptyset\}$, $\{i,\emptyset\}$ and $\{\emptyset,\emptyset\}$ is a Nash Equilibrium since no country wishes to deviate. $W_j(\{ik\}) > W_j(\{ih\})$ and $W_k(\{ij\}) > W_k(\{ih\}) \Rightarrow \{ih\}$ is not a Nash Equilibrium.

b) When $\theta_0 < \theta \leq \theta_1$ we have $W_i\left(\{ij\}\right) > W_i\left(\{\Phi\}\right) \Rightarrow \{ij\}$ is a Nash Equilibrium trade regime since no country i wishes to unilaterally deviate from $\{F\}$. $W_j(\{ik\}) > W_j(\{ih\})$ and $W_k(\{ij\}) > W_k(\{ih\}) \Rightarrow \{ih\}$ is not a Nash Equilibrium. Moreover, $W_i\left(\{jk\}\right) > W_i\left(\{F\}\right) \Rightarrow \{F\}$ is not a Nash Equilibrium either.

c) When $\theta > \theta_1$ we have $W_i\left(\{\Phi\}\right) > W_i\left(\{ij\}\right) \Rightarrow \{ij\}$ is not a Nash Equilibrium. $W_j(\{ik\}) > W_j(\{ih\})$ and $W_k(\{ij\}) > W_k(\{ih\}) \Rightarrow \{ih\}$ is not a Nash Equilibrium. Moreover, $W_i\left(\{jk\}\right) > W_i\left(\{F\}\right) \Rightarrow \{F\}$ is not a Nash Equilibrium either. □

Proof of Proposition 4.2. a) From (4.4) it is clear that the only coalitional deviation outcome which would make country i better off relative to global free trade is $\{ih\}$. However, no other country, for instance j, would like to do so since there are no transfers and $W_j(\{F\}) > W_j(\{ih\})$. Therefore, $\{F\}$ is a stable Nash Equilibrium.

$W_i(\{ij\}) > W_i(\{\Phi\})$ and $W_j(\{ij\}) > W_i(\{\Phi\})$ so, Status Quo is not stable. Moreover, $W_i(\{F\}) = W_j(\{F\}) > W_i(\{ij\}) = W_j(\{ij\})$ and $W_k(\{F\}) > W_k(\{ij\})$ $\{ij\}$ is not a stable Nash Equilibrium.

b) $W_k(\{ij\}) > W_k(\{F\}) \Rightarrow$ country k will not decide to form coalition with countries i and j and go to global free trade. $W_i\left(\{ij\}\right) > W_i\left(\{\Phi\}\right)$, therefore $\{ij\}$ is a stable Nash Equilibrium. This last inequality also implies that $\{\Phi\}$ is not a stable Nash Equilibrium.

c) Even though $\{F\}$ is a better option than $\{\Phi\}$ for all three countries, joint deviation of i, j and k from Status Quo to global free trade is not self-enforcing. Indeed, once $\{F\}$ is realized, each country has unilateral incentive to revoke its trade agreements with other two countries since $W_i(\{jk\}) > W_i(\{F\})$. Also, $W_i(\{\Phi\}) > W_i(\{ij\})$, therefore $\{\Phi\}$ is a stable Nash Equilibrium. $\square$

Proofs of the propositions in the symmetric and asymmetric cases are very similar, so I will provide brief sketches of proofs for some of the propositions only.

Proof of Proposition 5.1. When $\theta \leq \theta_0$ we have $W_i(\{F\}) > W_i(\{jh\})$ and $W_i(\{F\}) > W_i(\{jk\})$ as long as $\psi < \psi_0$. Thus, $\{F\}$ is a Nash Equilibrium, since no country i wish to unilaterally deviate from $\{F\}$[19]. However, as soon as asymmetry is larger than ψ_0 we have $W_k(\{ij\}) > W_k(\{F\})$ thus smaller country k prefers to free ride on the free trade agreement of the other two countries. Moreover, $W_i(\{ij\}) > W_i(\{\Phi\})$ since $\psi < \psi_0 < \psi_1 \Rightarrow \{ij\}$ generated by announcements $\{j, \emptyset\}$, $\{i, \emptyset\}$ and $\{\emptyset, \emptyset\}$ is a Nash Equilibrium since no country wish to deviate. $W_j(\{ik\}) > W_j(\{ih\})$ and $W_k(\{ij\}) > W_k(\{ih\}) \Rightarrow \{ih\}$ is not a Nash Equilibrium. Other cases are proved using very similar logic. $\square$

Proof of Proposition 7.1. a) $W_i(\{F\}) > W_i(\{jk\})$ so no country would deviate unilaterally from global free trade regime. Also, from (2.8) each country has terms of trade motive to impose positive unilateral tariffs. Thus, no country would like to give tariff concessions if there will not be reciprocal action from its trading partners . Therefore, $\{\Phi\}$ is a Nash Equilibrium.

b) Since $W_i(\{ij\}) > W_i(\{\Phi\})$ and $W_j(\{ij\}) > W_i(\{\Phi\})$ Status Quo is not stable, i and j have incentive to jointly deviate from $\{\Phi\}$ to $\{ij\}$. $W_i(\{F\}) > W_i(\{jk\})$ and $W_i(\{F\}) > W_i(\{\Phi\})$ so no unilateral or coalitional deviation makes i better off relative to $\{F\}$. Therefore, $\{F\}$ is a stable Nash Equilibrium. $\square$

B Political Economy Considerations

So far, the assumptions were that the government's objective is to maximize national income. However, many political economy models consider the possibility that the governments might be motivated by other incentives. Traditionally this is modeled as the objective function of the governments, which puts more weight on the producer surplus than on tariff revenue and consumer surplus. Suppose, the parameter $\eta \geq 0$ represents the extra weight that (all three) governments put on producer surplus in their welfare function. Then, the appropriate expression for the maximization problem

[19] This is true for all three countries, and "i" in this particular instance is used for indexing any of the three countries.

will be:[20]

$$W_i = CS_i^I + CS_i^J + CS_i^K + t_{ij}exp_{ji} + t_{ik}exp_{ki}$$
$$+ (1+\eta)\left[(1-2\theta)\left(p_i^J y_i + p_i^K y_i\right) + \theta\left(p_j^I y_j + p_k^I y_k + p_j^K y_j + p_k^J y_k\right)\right]$$

where, we still have $CS_i^Z = \frac{\left(\alpha - p_i^Z\right)^2}{2}$, $Z = I, J, K$.

In order to investigate whether the two main results provided in the previous sections, free riding effect and its mitigating factor Rules of Origin are robust, in the following subsections, I examine the validity of propositions proved above. Moreover, the main mechanism for attaining global free trade is the same in both, symmetric and asymmetric cases, with minor additional considerations for the latter. Therefore, for simplicity, I examine only the symmetric case here.

B.1 Bilateralism

In Saggi and Yildiz (2010) political considerations do not affect the bilateralism game because there is no import competing industry. In contrast to that, this effect exists here through intermediate inputs embedded in the imported final goods, and it is a very important factor.

The first order condition gives us the optimal tariffs in the case of Status Quo:

$$t_i^{\Phi} = Argmax\ W_i(\{\Phi\}) = \frac{y(1-3\theta(1+\eta))}{4} \tag{B.1}$$

In the case of two countries signing FTA, they eliminate tariffs on imports from each other while set their own optimal tariff on the nonmember country. Taking into account $t_{ij} = t_{ji} = 0$ the optimality condition gives the following result:

$$t_i^f = Argmax\ W_i(\{ij\}) = \frac{y(1-3\theta(1+\eta))}{11} \tag{B.2}$$

It is easy to see that we end up with the same tariffs values in (4.1) and (4.2), if we take $\eta = 0$ in (B.1) and (B.2), respectively.

B.2 Multilateralism

Additional weight on the producer surplus is internalized by the trade liberalizing countries. Using the expressions for welfare the maximization gives the following optimal tariffs:

$$t^m \equiv t_i^m = t_j^m = \frac{y(1-3\theta(1+\eta))}{7} \tag{B.3}$$

[20]Note, that final good producers make zero profit. So, it makes sense to put extra weight on the intermediate input suppliers, regardless which final good is produced using them, local or foreign.

Similar to the case of bilateralism, we end up with the tariff values of (7.2) if we take $\eta = 0$ in (A.3).

In order to have a reasonable environment to study the game of free trade agreements, I assume that $\theta \leq \frac{1}{3(1+\eta)}$. This guarantees that optimal tariffs in (B.1), (B.2) and (B.3) are non-negative.

Based on the usual ranking of the welfares in different trade regimes we can prove the following:

Proposition B.1.

$\{F\}$ is unique stable Nash Equilibrium under bilateralism for $\theta \leq \theta_0$, and $\eta \leq \eta_0(\theta)$.

$\{F\}$ is unique stable Nash Equilibrium under multilateralism for $\theta \leq 1/3$, and $\eta \leq \eta_1(\theta)$.

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