

Expansion of a Free Trade Area: A Numerical Simulation of Trade Displacement

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Abstract

Trade creation, trade diversion, and trade displacement caused by the enlargement of a free trade area are examined by simulating a Ricardian model with a continuum of goods. The model is expanded to include four countries in order to simultaneously account for these three trade effects resulting from enlargement. Differentiating the countries by skill level, the simulation shows the potential for negative welfare effects on the existing members caused by the enlargement. The results demonstrate that low-skilled members of a free trade area are most vulnerable to the trade displacement effects caused by expansion.

Keywords: International Trade; Trade Displacement; Ricardian Trade Model; Integration; Free Trade Area

JEL Classifications: F11, F13, F15; F60

1. Introduction

The growth of a region of economic integration to include new members is often discussed in terms of social, political, and economic impacts. However, too often are these impacts focused on the overall effects, rather than examining the effects on individual new and existing member countries, as well as those countries which do not integrate. This paper incorporates the use of an expanded model of international trade based on the Ricardian model as presented by Dornbusch, Fischer, and Samuelson (DFS) (1977), and later Appleyard, Conway, and Field (ACF) (1989) to examine the potential effects on all countries involved in the expansion of economic integration. The DFS model outlines the two-country model, and the ACF work extends the framework to three countries, which allows for the examination of different trade agreements between trade partners. This paper uses a four-country version of the model as a basis for a numerical simulation in order to study the effects of the expansion of a free trade area (FTA).

When a FTA expands to include new members, trade creation and trade diversion take place, as when the original agreement was formed. However, a third effect also takes place during this expansion: trade displacement. Using a similar description to that of Viner (1950), trade displacement results in production from a high-cost producer to a low-cost producer, yet not in the same manner as Viner described trade creation. Trade displacement involves the movement of production from one member of the FTA to a lower-cost new member.

The formation of FTAs has been an important area of economic research since Viner (1950), Meade (1955), Gehrels (1956-7), and Lipsey (1957). However, new debates have emerged as preferential and regional trade agreements have increased in global importance over the last decades: “Regional trade agreements (RTAs) have become increasingly prevalent since the early 1990s. As of 8 January 2015, some 604 notifications of RTAs (counting goods, services and accessions separately) had been received by the GATT/WTO. Of these, 398 were in force.”¹ This increase in versions of economic integration has caused an increase in research into the effects of such agreements.² However, much of the attention in the economic literature has been on the effects of the formation of these agreements and areas of integration.

¹Source: <http://www.wto.org>

²See Bhagwati and Panagariya (1996), Panagariya (2000) and Freund and Ornelas (2010) for excellent reviews of the theoretical and empirical effects of regional trade agreements.

Authors have addressed whether the formation of a FTA increases member trade (Baier and Bergstrand (2007)), increases members' growth (Hur and Park, 2012), and even members' future trade policy (Nomura et al. 2013). While another group of literature examines the determinants of FTA formation (Baier and Bergstrand (2004, 2014), Magee (2003), and Baldwin (2008)), the effects of trade creation, diversion and displacement are of particular interest. Much of the literature focuses on the former two – with empirical tests of trade creation (Carrere (2006)) and trade diversion (Dai et al. (2014)).³ As Baldwin (1993) points out, it is important to distinguish between the formation and enlargement of a FTA.

Similar to the studies examining the determinants of FTA formation, another vein of literature, such as Vicard (2011), looks at the effectiveness of FTAs based on country characteristics. In the Ricardian model, as evidenced by the similar simulations in ACF, economic integration is most beneficial to those countries that are most dissimilar in terms of the good that they produce. This simulation permits comparison of various combinations of FTAs and potential accession countries, and the results suggest that current members could have different notions of which non-member should be allowed to integrate. In addition, the simulation of an expansion of a FTA demonstrates the possibility of a negative welfare effect on a current member.⁴

The paper is presented as follows: Section 2 of the paper briefly presents the four-country Ricardian model of trade. Section 3 presents the results of the four-country model simulation, including a welfare analysis of the enlargement process. Section 4 concludes, followed by tables, appendices, and references.

2. The Model

Four countries are denoted C_i , with $i = 1, 2, 3$, or 4 . An arrayed number of goods are produced (and consumed) and each good is positioned along the continuum $[0,1]$ by variable z . Following ACF, the following assumptions are made about technology, which shows through the labor-output ratio $a_i(z)$. For $A_i(z)=a_i(z)/a_I(z)$:

$$\frac{\partial A_2}{A_2} \left/ \frac{\partial z}{z} \right. = \alpha_2 < 0 \quad (1)$$

$$\frac{\partial A_3}{A_3} \left/ \frac{\partial z}{z} \right. = \alpha_3 < 0 \quad (2)$$

$$\frac{\partial A_4}{A_4} \left/ \frac{\partial z}{z} \right. = \alpha_4 < 0 \quad (3)$$

$$\alpha_4 < \alpha_3 < \alpha_2 < 0 \quad (4)$$

All together, the assumptions mean that comparative advantage, as z increases, shifts toward countries with a higher i under the assumption that national skill level increases from C_1 to C_2 to C_3 and to C_4 .

To include tariffs, a similar, a general model is formulated with each country levying a tariff on the other three trading partners. The tariffs are assumed to take the form of a uniform ad valorem tariff on all imports coming into the country. Define t_{ij} as the ad valorem tariff levied by C_i on imports from C_j , so

$$\tau_{ij} = (1 + t_{ij}) \quad (5)$$

Such tariffs will impact the pattern of trade as well as the real wage ratios, or the terms of trade, as demand shifts due to the changes in prices (with tariffs).

³Other recent work includes Magee (2008), Yang and Martinez-Zarzoso (2014), and MacPhee and Sattayanuwat (2014).

⁴As Baier and Bergstrand (2004) state, this would preclude such a member from signing any agreement that expands the FTA. This potential negative effect is caused by trade and wage effects, and I propose that social and political pressures may result in an incumbent member signing off on FTA expansion, as Baldwin (1993) suggests.

Countries will import from the producer with the cheapest tariff-inclusive price. For $k \neq i$ ($k = j$ is permissible, but $\tau_{jj} = 1$), C_i will export to C_j if and only if

$$\tau_{ji} a_i w_i \leq \tau_{jk} a_k w_k \quad (6)$$

For each potential trade partner, three inequalities must hold. Consider, for example, C_1 's exports to C_2 . The exports from C_1 to C_2 , tariff inclusive, must be cheaper than C_2 producing at home, so $\tau_{21} a_1 w_1 \leq a_2 w_2$. In addition, exports from C_1 to C_2 must be cheaper, tariff inclusive, than exports from country 3 or 4, so $\tau_{21} a_1 w_1 \leq \tau_{23} a_3 w_3$ and $\tau_{21} a_1 w_1 \leq \tau_{24} a_4 w_4$. Hence, with four countries, three partners each, and three inequalities, there are a total of 36 inequalities.⁵ Of these inequalities, twelve are binding and define twelve crossover goods. However, in some cases, which inequality is binding will be determined by the level of tariffs.

Following both ACF and DFS using a Mill demand construction, the per capita welfare function of C_i is

$$U_i = \int_0^1 E_i(z)^{b(z)} dz / L_i \quad (7)$$

where L_i is the labor force of C_i and $E_i(z)$ is the real expenditure on good z in C_i . Expenditure on each commodity is a constant share $b(z)$ of total expenditure and is identical across countries. The function $b(z)$ is assumed to be strictly positive, and integration on the continuum of goods from 0 to 1 results in unity. Hence, the demand side of the model follows the traditional, uniform, homothetic DFS assumptions that all consumers have identical Cobb-Douglas preferences over the continuum of goods and implies that the fraction of expenditure spent on a subset of goods is $\theta(z_i)$ and is defined by the equation:

$$\theta(z_i) = \int_0^{z_i} b(z) dz > 0 \quad (8)$$

The tariff-inclusive per capita welfare of C_i becomes

$$U_1 = \int_0^{z_4} \left[\frac{b(z)}{a_1(z)} \right]^{b(z)} dz + \int_{z_4}^{z_7} \left[\frac{b(z)\Omega_2}{a_2(z)\tau_{12}} \right]^{b(z)} dz + \int_{z_7}^{z_{10}} \left[\frac{b(z)\Omega_3}{a_3(z)\tau_{13}} \right]^{b(z)} dz \\ + \int_{z_{10}}^1 \left[\frac{b(z)\Omega_4}{a_4(z)\tau_{14}} \right]^{b(z)} dz \quad (9)$$

$$U_2 = \int_0^{z_1} \left[\frac{b(z)}{\Omega_2 a_1(z)\tau_{21}} \right]^{b(z)} dz + \int_{z_1}^{z_8} \left[\frac{b(z)}{a_2(z)} \right]^{b(z)} dz + \int_{z_8}^{z_{11}} \left[\frac{b(z)\Omega_3}{\Omega_2 a_3(z)\tau_{23}} \right]^{b(z)} dz \\ + \int_{z_{11}}^1 \left[\frac{b(z)\Omega_4}{\Omega_2 a_4(z)\tau_{24}} \right]^{b(z)} dz \quad (10)$$

$$U_3 = \int_0^{z_2} \left[\frac{b(z)}{\Omega_3 a_1(z)\tau_{31}} \right]^{b(z)} dz + \int_{z_2}^{z_5} \left[\frac{\Omega_2 b(z)}{\Omega_3 a_2(z)\tau_{32}} \right]^{b(z)} dz + \int_{z_5}^{z_{12}} \left[\frac{b(z)}{a_3(z)} \right]^{b(z)} dz \\ + \int_{z_{12}}^1 \left[\frac{b(z)\Omega_4}{\Omega_3 a_4(z)\tau_{34}} \right]^{b(z)} dz \quad (11)$$

$$U_4 = \int_0^{z_3} \left[\frac{b(z)}{\Omega_4 a_1(z)\tau_{41}} \right]^{b(z)} dz + \int_{z_3}^{z_6} \left[\frac{\Omega_2 b(z)}{\Omega_4 a_2(z)\tau_{42}} \right]^{b(z)} dz + \int_{z_6}^{z_9} \left[\frac{b(z)\Omega_3}{\Omega_4 a_3(z)\tau_{43}} \right]^{b(z)} dz \\ + \int_{z_9}^1 \left[\frac{b(z)}{a_4(z)} \right]^{b(z)} dz \quad (12)$$

which includes the optimal demand condition for C_i of $E_i(z_k)/L_i = b(z_k)w_i/P_i(z_k)$ for all k and the constant returns pricing condition $P_i(z_k) = a_j(z_k)w_j\tau_{ij}$ for all goods z_k produced in C_j , for $j = 1, 2, 3$, or 4 (recall, if $i=j$, then $\tau_{ij} = 1$). The consumer faces the tariff-inclusive cost of production of the country with comparative advantage.

Defining $l_i = L_i/L$ and simplifying our notation with $\theta_i = \theta(z_i)$ normalized trade balance equations are created:⁶

$$1 = \theta_1 \frac{l_2}{\Omega_2} + \theta_2 \frac{l_3}{\Omega_3} + \theta_3 \frac{l_4}{\Omega_4} + \theta_4 \quad (13)$$

$$1 = (\theta_7 - \theta_4) \frac{\Omega_2}{l_2} + (\theta_6 - \theta_3) \frac{l_4}{\Omega_4} \frac{\Omega_2}{l_2} + (\theta_5 - \theta_2) \frac{l_3}{\Omega_3} \frac{\Omega_2}{l_2} + (\theta_8 - \theta_1) \quad (14)$$

$$1 = (\theta_{11} - \theta_8) \frac{l_2}{\Omega_2} \frac{\Omega_3}{l_3} + (\theta_{10} - \theta_7) \frac{\Omega_3}{l_3} + (\theta_9 - \theta_6) \frac{l_4}{\Omega_4} \frac{\Omega_3}{l_3} + (\theta_{12} - \theta_5) \quad (15)$$

$$1 = (1 - \theta_{12}) \frac{l_3}{\Omega_3} \frac{\Omega_4}{l_4} + (1 - \theta_{11}) \frac{l_2}{\Omega_2} \frac{\Omega_4}{l_4} + (1 - \theta_{10}) \frac{\Omega_4}{l_4} + (1 - \theta_9) \quad (16)$$

⁵These inequalities are available from the author.

⁶It is assumed that importers pay the tariff and the government redistributes the revenue equally.

Combining the normalized trade balance equations and inequalities that determine which country is the source of production for all goods on the continuum, general equilibrium is reached with all respective z and Ω values. Of particular interest to this simulation is the movement of the equilibrium z and Ω values as tariff levels decrease, which is exactly what the simulation in the following section aims to clarify.

As part of the discussion of FTA enlargement, and more specifically trade creation, diversion, and displacement effects, the role of country size could increase or decrease the magnitude of these effects depending on whether the larger country is a member, the accession country, or non-member. In the particular case of the accession country being a relatively larger country than the others, the country's inclusion in an existing FTA could possibly have more dramatic effects on the pattern of trade. If the accession country is larger than the members, it would reason that the members would gain more (or be hurt less) by its inclusion. This result would be expected because the members would have greater access to cheaper goods – as the wage in the accession country is driven down by a larger population, so are the prices of the goods it produces. At the same time, the accession country now produces a larger set of goods, potentially directly competing even more with a member country's production. However, the welfare gain for the members caused by the ability to purchase cheaper goods is expected to outweigh the loss caused by a reduction in exported goods. In this sense, the magnitude of trade displacement that occurs may be greater if the accession country is larger, but the overall welfare effects will be positive (or less negative).

Another possibility for country size affecting the trade displacement and welfare of involved countries might occur if one of the members is larger or smaller than the other countries involved. In the case of a larger member country, the expectation is that accession of another country would reduce the gain or increase the loss observed by the member. In other words, the larger the member country is, the less there is to gain (or more to lose) from expansion of an existing FTA. This result is caused by an increase in the importance of trade displacement's effect on the member country.

Isolating these effects requires examination of the movement of the z values as member countries and accession country eliminate tariffs between one another. As discussed earlier, the direct and indirect effects of tariff changes on the crossover z values will result in changes in trade among all four countries.

3. Numerical Simulation

3.1 Preliminaries

A numerical simulation of the model will clarify the different ramifications of potential enlargement of a FTA. Production technology is given by

$$a_i(z) = \left(\frac{1}{f_i}\right)(z^{-S_i}) \quad (17)$$

so that $a_i(z)$ represents a labor-output coefficient for each C_i . S_i can be interpreted as skill index for C_i , and a country's skill index increases with i , so that C_1 has the lowest skill index (1) and C_4 has the highest (4). This production technology results in monotonically decreasing functions of $z, A_i(z)$. The f_i , which represent a constant technology coefficient unique to a country, are set so that $f_i/f_{i+1} = 0.5$. For now, labor endowments are assumed to be equal, $L_1=L_2=L_3=L_4$, and expenditure is the same across commodities, $\theta(z) = z$ for all z , which implies identical preferences for goods across the continuum.

With these parameters, many different simulations can be constructed to examine possible FTAs and enlargement. First, the two-country model is examined to give a basic sense of the model. Next, the simulation of the three-country model is presented, along with the various possible trade agreements. Finally, the simulation of the four-country model is presented. With the four-country model, there exist the autarky and free trade cases, the base tariff case, and six different two-country FTAs. For each of these six possible FTAs, there are two enlargement possibilities. For these simulations, of particular interest are the positions of the crossover goods, the wage ratios, and the welfare of each country. To examine the potential effects of enlargement, initial tariff rates are set at rates of 30%. In addition, by doing this, confirmation and comparison to ACF's results are also possible.

There are many cases examined in separate simulations. First, in the two-country setting, free trade and a base tariff case are examined for general introduction. Next, the three-country model is also outlined in the free trade, base tariff, and the three possible FTAs. Finally, the four-country model is introduced with the free trade, base tariff, and the ten possible FTAs. The results are summarized in tables 1-3.

3.2 FTA Formation

For the two-country model, presented in table 1, the tariffs create a section of non-traded goods between z values of 0.37 and 0.63. The elimination of both tariffs results in each country producing half of the goods, with C_1 producing and exporting the “low-skill” half and C_2 producing and exporting the “high-skill” half of the goods.

The results of the three-country model simulations, which provide identical crossover z values as presented in table 2 of ACF (1989), are presented here in table 2 along with wage ratios and nominal utility values.

The results of the four-country simulations are presented in table 3. As in the two- and three-country models, C_1 exports the “low-skill” goods located near zero on the indexed continuum of goods. Increasing z values from zero sees C_2 begin to compete with C_1 for lower values of z , then with C_3 for higher values of z . Continuing to move up (or right) along z spectrum, C_3 becomes the exporter until it competes with C_4 , and then C_4 , with the highest skilled labor force, becomes the exporter of goods with z values located near 1.

The base tariff case is presented first in table 3. Each country has at least one section of the continuum that is non-traded goods, i.e. produced domestically for domestic consumption only. C_1 exports between 0 and 0.30 and imports goods ranging from 0.40 to 1, leaving the range from 0.30 to 0.40 as non-traded goods for the low-skill country. C_2 ’s non-traded goods range from 0.23 to 0.30 and 0.51 to 0.66. C_3 ’s non-traded goods range from 0.39 to 0.51 and 0.72 to 0.93. C_4 ’s non-traded goods fall in the range from 0.55 to 0.72. One result of different FTAs is the changing – increasing, decreasing, or *moving* – the range on non-traded goods.

Following the base tariff case are the simulations for the free trade and two-country FTA cases. The changes in utilities are also presented in table 4.⁷ There are several interesting observations. First, C_1 strongly prefers a FTA with C_4 – nearly three times more than a FTA with C_3 and about seven times more than a FTA with C_2 . In every case for C_1 , a FTA with partner i drives down the value of Ω_i , while driving the value of Ω_j up for $j \neq i$. However, similar to the results in the three-country model where C_1 preferred C_3 for much the same reason, C_1 ’s choice of C_4 only slightly pushes Ω_4 down while Ω_2 and Ω_3 increase. As a result of C_1 and C_4 ’s integration, C_4 also no longer exports any goods to C_3 as a result of the changes in the terms of trade. The integration of C_1 and C_4 eliminates both countries’ ranges of non-traded goods, as the range of exports and imports both increased. From C_1 ’s perspective, C_4 has replaced C_3 as the source for the lower end of the high-skill goods – those goods ranging from 0.59 to 0.72. Welfare analysis shows that a FTA between C_1 and C_4 results in both countries experiencing increases (although C_1 ’s increase is far greater than C_4 ’s). However, C_2 and C_3 both experience a decrease in welfare as the terms of trade move against them.

The results for single partners of C_2 are similar to that of C_1 . C_2 prefers C_4 as a partner over C_3 and C_1 . Denoting a FTA of C_i , C_j , and possibly C_k as FTA_{ijk} , FTA_{24} provides interesting results, and will continue to do so when enlargement of the FTA is examined. Such an agreement eliminates exports (but not imports) from C_3 to C_2 , as well as exports from C_3 to C_4 . With the partners ‘surrounding’ C_3 , there is no longer a range of goods for which it is cheaper for either C_2 or C_4 to import from C_3 rather than either produce for itself or import from its partner. Again, there is a welfare gain by both countries in the FTA while those outside the FTA experience a welfare decrease.

The simulations show that C_3 would prefer C_4 as a partner, then C_1 followed by C_2 . This could be considered a break from expectations, where the one might not consider C_4 to be the most dissimilar FTA partner. But the agreement with C_4 increases the imports from cheaper producer – eliminating competition on the high-skill goods and non-traded goods, but allows C_3 to produce goods all the way down to 0.41 to export to C_4 . The FTA with C_4 allows C_3 to move its specialization of production for export – both the upper and lower limits – down the continuum. In the base tariff case, C_3 exported goods ranging from 0.51 to 0.72 (while producing from 0.39 to 0.93). After forming a FTA with C_4 , C_3 exports (and produces) goods with z values between 0.41 and 0.71. C_4 also prefers C_3 as a FTA partner over C_2 and C_1 , respectively, although the potential increases in welfare aren’t that of the other countries potential gains.

The results for the simulation of the four-country model also include the four possible three-countryFTAs. In each case, compared to the base tariff case, the country which is left out of the FTA experiences a welfare loss and an increase in the range of non-traded goods.

⁷Recall that these discussions of changing values of utility and welfare are isolated to those caused by the changes in trade patterns and relative wages.

Values of Ω also increase for the country that is excluded from the FTA. In the case of FTA₂₃₄, where C₁ is left outside of the FTA, all three values of Ω_2 , Ω_3 , and Ω_4 decrease, showing a decrease in the wage in C₁ relative to that of the other countries. For each of the four countries, there are three possible three-country FTAs that it can be a part of. In most cases, when compared to the base tariff case, a country prefers the FTA which includes the highest skilled countries possible. For example, C₁ prefers (in order) FTA₁₃₄ over FTA₁₂₄ and FTA₁₂₃. C₂ prefers FTA₂₃₄ over FTA₁₂₄ and FTA₁₂₃. C₄ prefers FTA₂₃₄ over FTA₁₃₄ and FTA₁₂₄. However, C₃ prefers FTA₁₃₄ over FTA₂₃₄ and FTA₁₂₃. This will be discussed further in the examination of enlargement possibilities.

3.3 FTA Expansion

Trade creation, diversion, and displacement effects are all produced in the numerical example. Trade creation occurs when non-traded goods begin to be imported or exported after trade is liberalized. Trade diversion occurs when a member begins to import a range of goods from a new member country that it had previously imported from the non-member. Finally, trade displacement occurs when a range of goods that had been previously imported by a member from another member is then imported from the accession country. Examination of table 3 allows for the analysis of trade creation, trade diversion, and trade displacement brought on by the enlargement of a FTA. The FTA possibilities in the three-country model (table 2) could be used to examine trade creation and trade diversion, but not trade displacement simultaneously. Table 3 lists the trade patterns, wage ratios, and nominal utility values for each of the two-country (six possibilities) and three-country (four possibilities) FTAs. Table 5 summarizes the changes in welfare for each country for each possible enlargement of a two-country FTA.

Let us first examine the example of the enlargement of the FTA between C₁ and C₂ (FTA₁₂). Before looking at the two possibilities for enlargement, a few notes about FTA₁₂ should be made. First, while C₁ exports the same goods to all three other countries, C₂ exports a much larger array of goods to C₁ relative to its exports to C₄ and C₃. C₂'s exports to C₃ are very small, ranging only from 0.32 to 0.36 on the indexed continuum. Also of note is that C₄'s non-traded goods, [.56,.72], is larger than the goods which C₃ exports to C₁ and C₂, [.61,.72].

Either C₃ or C₄ can be the accession country in this first example, forming FTA₁₂₃ or FTA₁₂₄. In the former, C₁ continues to produce the same array of goods for export to all three other countries, and thus has little to no effects of trade creation, diversion or displacement with regard to its exports. However, the sources of C₁'s imports do change. The array of C₁'s imports from C₃ grows in both directions, moving from [.61, .72] to [.53, .82], partially due to trade displacement, and partially due to trade diversion. Trade displacement occurs as the new member's exports (C₃'s) displaces some of the other member's exports (C₂'s) to C₁.

Examining this effect in more detail shows a clear example of the trade displacement caused by the enlargement of this FTA. Prior to enlargement, C₂ was exporting the range [0.32, 0.61] to its FTA partner, C₁, while C₃ was exporting [0.61, 0.72] to C₁. After C₃ joins FTA₁₂, C₁ imports goods from C₃ that it had been importing from C₂, namely, the range [0.53, 0.61]. This range of goods represents C₂ exports which have been displaced by exports from the new member.⁸

In terms of welfare, this is beneficial to C₁, as its consumers pay a lower price for those imports. For C₂, this trade displacement has a negative welfare effect. However, C₂ and C₃ both benefit from trade creation between one another as C₃ joins FTA₁₂. C₂'s exports to C₃, which were small initially, grow significantly, as do C₃'s exports to C₂. Finally, trade diversion is also occurring. The addition of C₃ to FTA₁₂ causes C₁ and C₂ to import goods from C₃ that it was previously importing from C₄, even though C₄ continues to be the lowest-cost producer.

With the above description of the effects of the enlargement, positive welfare effects are expected for C₁, due to the reduction in prices its consumers face with no significant change in exports, and C₃, due to trade creation with C₂, displacement of exports to C₁ from C₂, and trade diverted to it from C₄ – meaning that C₃'s exports to the members have replaced exports from the non-member, C₄. A negative welfare effect for C₄ is expected, as trade is diverted away from it – meaning that its exports to the members have been replaced by the new member. The expected result for C₂'s welfare change depends on the magnitude of the effects. The net welfare effect will result from the combination of the positive effect of trade creation with C₃ and the negative effect of the trade displacement of its exports to C₁. In the simulation, the net welfare effect is a positive increase of 5.71%.

⁸ Part of this effect may also be caused by shifts in the wage ratios, but this is a rather explicit example of trade displacement caused by the enlargement of FTA₁₂ to FTA₁₂₃.

The net welfare effect on the world is positive, that is, the gains of C_1 , C_2 , and C_3 are larger than the welfare loss experienced by C_4 . The role of trade displacement plays an interesting one in this outcome. As noted, displacement is expected to have a positive impact on world welfare, as production moves from a high-cost source to a low-cost source. What has essentially happened is that the trade displacement caused by the enlargement of a FTA has reversed some of the effects of trade diversion caused by the original formation of the FTA. In the FTA₁₂₃ example, the addition of C_3 to FTA₁₂ eliminates some of the trade diversion that occurred as C_1 and C_2 formed the FTA. In the FTA₁₂ example, C_3 is the low cost producer for goods ranging from 0.47 to 0.72.⁹ So the original formation of the FTA caused trade diversion on the upper end of C_2 's exports to C_1 (at the expense of C_3 's exports), but the inclusion of C_3 in the FTA reverses this effect.

A similar analysis can be used to examine the effects of C_4 acceding into FTA₁₂ while C_3 remains the non-member. The results are very similar to those above, perhaps even more pronounced. C_1 's welfare increases, as C_1 's exports remain largely unchanged, it continues to import a fairly large array of goods from C_2 , and it imports a greater number of goods from C_4 . C_2 also experiences a large increase in welfare. There is little trade displacement away from it as in the preceding example, while it is the recipient of trade diversion (it now exports goods that C_3 can produce at a lower cost). Likewise, C_4 exports more goods to C_1 and C_2 , but no longer exports to C_3 at all. Trade is diverted away from C_3 on both ends of its region of production, and the negative welfare effect of this is illustrated.

One outcome of the simulation of the enlargement of FTA₁₂ is that the possible choices of accession countries can be ranked by each of the members. For both members in this example, C_1 and C_2 , the gain from C_4 accession is far greater than it would be if C_3 were to join the FTA. This does not come as a surprise, as we have seen that the low-skill countries stand to gain significantly from forming a FTA with the high-skilled country. So it is a reasonable extension that a “low-skilled FTA” would gain from adding a high skill country. Similarly, expansion of FTA₁₃ and FTA₂₃ to include C_4 is preferred for both member countries. In both cases, the lower skill country experiences a larger percentage change in welfare when C_4 joins the FTA instead of the other potential accession country.

Three cases – the enlargement of FTA₁₄, FTA₂₄, or FTA₃₄ – offer intriguing results. First, examining the enlargement of a FTA between the two higher skilled countries, C_3 and C_4 , shows that the current members may not prefer the same acceding country. C_3 experiences a larger gain from including C_1 in the FTA rather than C_2 , while C_4 gains more from including C_2 rather than C_1 . C_3 experiences a 1.56% increase in welfare with the addition of C_1 to the FTA, but only a 0.82% increase if C_2 accedes into the FTA. Conversely, C_4 experiences a 0.87% increase if C_2 joins the FTA, compared to a 0.61% increase if C_1 joins. While both members experience a net welfare gain through the enlargement of FTA₃₄, trade displacement has a significant effect on the magnitude of that gain. If C_2 is the accession country, then trade displacement occurs at the expense of C_3 , as C_2 now exports goods to C_4 that C_3 previously had. This effect is the main reason for the differences in the welfare gains for the two members.

Enlargement of FTA₁₄ or FTA₂₄ presents another key result of the simulation. Unlike enlargement of FTA₃₄, both incumbent members do prefer one of the acceding countries over the other. In these cases, C_3 is preferred to the other lower-skilled country. However, the important result is that, in both enlargement of FTA₁₄ or FTA₂₄, the low skilled country experiences a decrease in welfare if the other low skilled country is the acceding country. This shows that it is possible for a current member to be worse off after enlargement of the FTA.

Examining the enlargement of FTA₁₄, C_1 experiences a 1.37% *decrease* in welfare if C_2 joins the FTA, versus a 2.52% increase if C_3 accedes into the FTA. As for the potential members, C_2 experiences a 32.37% increase in welfare if it joins FTA₁₄, and a 4.12% decrease if C_3 joins instead. Meanwhile, C_3 experiences a 19.65% increase in welfare by joining FTA₁₄, and a 0.24% decrease in welfare if it is left outside the FTA. The increase in welfare for C_2 's joining FTA₁₄ represents the largest increase in welfare for any country as a result of forming or joining a FTA in the simulation.

⁹ The wage ratios of FTA₁₂ are used to determine the lowest-cost producer. Note that these values will change as the wage ratios change, so the lowest-cost producer of a good may change from one scenario to another. In the movement from FTA₁₂ to FTA₁₂₃, the goods for which C_3 is the lowest-cost producer changes from [0.47, 0.72] to [0.53, 0.63] using the given wage ratios. This highlights the general equilibrium nature of the model – as wages change, the trade pattern changes. Yet, as the trade pattern changes, the wage ratios also must change.

The accession of C₂ into FTA₁₄ causes significant trade displacement of C₁'s exports to C₄ (C₂ being the new source of imports for C₄). This trade displacement effect on C₁ dominates any positive trade creation and trade diversion effects, and C₁ experiences a net welfare loss.

The enlargement of FTA₂₄ offers similar results. If C₁ joins the FTA, C₂ experiences a 0.70% *decrease* in welfare, versus a 0.30% increase in welfare if C₃ were to join. As the accession country, C₁ experiences a significant increase (24.9%) in welfare through joining FTA₂₄. After enlargement FTA₂₄ to FTA₁₂₄, C₁ expands its exports to both C₂ and C₄ from [0, .25] to [0, .32]. Thus, the enlargement to FTA₁₂₄ has caused trade creation between C₁ and C₂, as production moved from the higher cost C₂ to the lower cost C₁. However, the increase in trade between C₁ and C₄ is trade displacement (away from C₂). Prior to enlargement, C₂ was exporting the range [.25, .32] to C₄ despite C₁ being the lowest-cost producer as a result of their membership to the FTA₂₄. After enlargement, this trade diversion caused by the initial formation of FTA₂₄ is reversed. The effects on C₃ are significant as well. Instead of exporting a wide array of goods to C₁ only, after enlargement to FTA₁₂₄, C₃ exports a smaller array of goods to all three countries. Trade has been diverted away from the non-member toward both of the members; that is, C₂ and C₄ both export some goods to C₁ that C₃ could produce at a lower cost.

The summary of the enlargement from FTA₂₄ to FTA₁₂₄ is thus: trade creation between C₁ and C₂, trade diversion away from C₃ as C₂ and C₄ export goods to C₁ despite C₃ being the lowest cost producer, and trade displacement away from C₂ as C₁ exports goods to C₄ that C₂ previously had. C₁ has a large, positive gain in welfare, as would be expected with trade creation and 'inward' trade displacement, and it now imports more goods from C₄ than C₃. C₄ also ends up better off, as it receives more goods from the lowest cost producer than it previously had. As anticipated, the welfare of C₃ decreases through the enlargement process, as trade is diverted away from it (and on both ends of its regions of production). The welfare effect of C₂ is the unusual result. C₂ experiences trade creation with C₁, trade diversion (at C₃'s expense) and trade displacement away from its production, or outward trade displacement. The net negative welfare effect suggests that the trade displacement effect dominates the trade creation and trade diversion effects.

3.4 The Role of Country Size

The relative sizes of the countries involved in the enlargement of a FTA are also expected to have an impact on the magnitude of the trade displacement effects caused by enlargement. The impact of differences in labor endowments is important because the enlargement effects are different, as the initial – prior to any FTA and enlargement – trade pattern is altered. A larger country, relative to the example where all countries are of equal sizes, has a lower relative wage and produces a larger section of the continuum of goods. For example, in the base tariff case of the simulation, if C₁ is 1.5 times larger than the other countries, it will produce and export the goods from [0,0.27] to C₂ and [0,0.35] to C₃ and C₄ instead of [0,0.21] and [0,0.30], respectively.

Results from similar simulations as above, yet allowing for changes in the labor endowment of countries 1 and 2, are presented in tables 6a-d and 7. Simulations are undertaken with both larger and smaller endowments for countries 1 and 2, and the growth of FTA₁₄ and FTA₂₄ to FTA₁₂₄ is examined. While the growth of FTA₁₄ to include C₂ results in some ambiguity in the role of country size of both the accession and the member country, the enlargement of FTA₂₄ to FTA₁₂₄ results in the expected changes. With C₁ being the accession country, the larger its labor endowment, the less negative (actually positive) the effect on C₂ of enlargement. This would suggest that the larger C₁, the less the importance of trade displacement relative to that of trade creation. Trade displacement certainly still occurs, as C₁ replaces C₂ as the source for some of C₄'s goods as in the original simulation, yet the overall welfare implications are different.

In addition to possible differences in the accession country's labor endowment, the size of the member country would also have an effect on the effects of enlargement. As seen in the enlargement of FTA₂₄ with C₁ acceding, the larger C₂'s labor endowment results in a more negative result of enlargement. In the original simulation where labor endowments were equal across all countries, the enlargement of FTA₂₄ to FTA₁₂₄ caused a decrease in C₂'s welfare of 0.7%. If C₂ were 1.5 times the size of the other countries, the decrease in per capita welfare rises to 1.61%. This would suggest that the larger the member country, the greater the relative importance of trade displacement effects.

The changes in the effects of enlargement depend on the size of the countries involved, and the result comes down to the potential income that each country stands to gain or lose directly through its exports and indirectly through its relative wages.

In the case of a FTA of FTA_{24} , the larger C_2 is, the wider the array of the continuum that it produces prior to enlargement (see Table 6c), and the larger country size causes its exports to C_4 to ‘encroach’ on the exports of either C_1 or C_3 to C_4 even more than FTA_{24} does in the case where labor endowments are equal¹⁰. Then, following enlargement to FTA_{124} , the decrease in C_2 ’s exports to C_4 (and C_1 ’s increase) has a greater negative impact on the welfare of C_2 .

4. Policy Implications and Conclusions

The expansion of the Ricardian trade model to four countries has allowed the investigation into the results of expansion of trade agreement areas. In some cases, expansion of a FTA resulted in an increase in the welfare of all included countries, and the best potential accession country was the same for both current members. However, in other cases, as the numerical simulation shows, the current members differ on which potential accession country would benefit the home nation the most. In addition, and perhaps most influential is the possibility of a member country experiencing a decrease in welfare as a result of expansion of the FTA. For low-skilled countries, the inclusion of another low-skilled country had negative effects on welfare.

These results have interesting policy implications. First, the model suggests that initial formation of a FTA is beneficial to those involved. However, after the initial formation, it may be in one’s best interest to prevent others from joining the FTA. Additionally, the model suggests that it is never beneficial to be left out of the FTA as it welcomes other countries. In a sense, for some countries, the best policy would be pro-enlargement, but only if they are accession candidates. If they are not a candidate for accession, it’s better if no other country is either. If the country does happen to be a candidate for accession, it might be in its best interest to prevent others from being a potential candidate. And if the country does enter the FTA, it could potentially be better off keeping all others out of the FTA.

The model has allowed insight into the process of enlargement through trade patterns and welfare analysis. While the model itself is general enough to account for all possible variations, the numerical simulation is unique due to the fixed parameters. Variations in the labor endowments resulted in some ambiguity, but other cases did provide the expected results. The results could potentially change depending on the development levels of the countries involved.

¹⁰ As seen in the tables 3 and 6a-c, in this simulation, FTA_{24} eliminates exports from C_3 to C_4 . However, when C_2 is sufficiently smaller, as presented in table 6d, then C_1 and C_3 both export to C_4 when FTA_{24} exists.

Table 1: Two-Country Case

Base tariff case					
	Country 1	Country 2			
Country 1 exports to:		[0, .37]	Ω_2	0.967	U_1 0.596
Country 2 exports to:	[.63, 1]				U_2 0.684
Free trade case					
	Country 1	Country 2			
Country 1 exports to:		[0, .5]	Ω_2	1	U_1 0.708
Country 2 exports to:	[.5, 1]				U_2 0.708

Table 2: Three-Country Case

Base tariff case					
	Country 1	Country 2	Country 3		
Country 1 exports to:		[0, .28]	[0, .36]	Ω_2	1.39 U_1 0.911
Country 2 exports to:	[.47, .65]		[.36, .50]	Ω_3	1.07 U_2 0.700
Country 3 exports to:	[.65, 1]	[.84, 1]			U_3 1.036
Autarky case					
	Country 1	Country 2	Country 3		
Country 1 exports to:				Ω_2	U_1 0.500
Country 2 exports to:				Ω_3	U_2 0.667
Country 3 exports to:					U_3 1.000
Free trade case					
	Country 1	Country 2	Country 3		
Country 1 exports to:		[0, .37]	[0, .37]	Ω_2	1.35 U_1 1.129
Country 2 exports to:	[.37, .65]		[.37, .65]	Ω_3	1.05 U_2 0.837
Country 3 exports to:	[.65, 1]	[.65, 1]			U_3 1.080
FTA ₁₂					
	Country 1	Country 2	Country 3		
Country 1 exports to:		[0, .38]	[0, .38]	Ω_2	1.32 U_1 0.985
Country 2 exports to:	[.38, .77]		[.38, .45]	Ω_3	1.12 U_2 0.744
Country 3 exports to:	[.77, 1]	[.77, 1]			U_3 1.031
FTA ₁₃					
	Country 1	Country 2	Country 3		
Country 1 exports to:		[0, .25]	[0, .43]	Ω_2	1.51 U_1 1.131
Country 2 exports to:	[.43, .54]		[.43, .54]	Ω_3	1.07 U_2 0.679
Country 3 exports to:	[.54, 1]	[.92, 1]			U_3 1.058
FTA ₂₃					
	Country 1	Country 2	Country 3		
Country 1 exports to:		[0, .29]	[0, .29]	Ω_2	1.32 U_1 0.873
Country 2 exports to:	[.49, .64]		[.29, .64]	Ω_3	1.02 U_2 0.830
Country 3 exports to:	[.64, 1]	[.64, 1]			U_3 1.068

Table 3: Four-Country Case

	Base tariff case					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .23]	[0, .30]	[0, .30]	Ω_2	1.64
Country 2 exports to:	[.40, .51]		[.30, .39]	[.30, .51]	Ω_3	1.61
Country 3 exports to:	[.51, .62]	[.66, .72]		[.51, .55]	Ω_4	1.12
Country 4 exports to:	[.70, 1]	[.70, 1]	[.93, 1]		U_1	1.500
	Free trade case					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .31]	[0, .31]	[0, .31]	Ω_2	1.59
Country 2 exports to:	[.31, .51]		[.31, .51]	[.31, .51]	Ω_3	1.56
Country 3 exports to:	[.51, .71]	[.51, .71]		[.51, .71]	Ω_4	1.09
Country 4 exports to:	[.71, 1]	[.71, 1]	[.71, 1]		U_1	1.881
	FTA ₁₂					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .32]	[0, .32]	[0, .32]	Ω_2	1.56
Country 2 exports to:	[.32, .61]		[.32, .36]	[.32, .47]	Ω_3	1.65
Country 3 exports to:	[.61, .72]	[.61, .72]		[.47, .56]	Ω_4	1.14
Country 4 exports to:	[.72, 1]	[.72, 1]	[.94, 1]		U_1	1.552
	FTA ₁₃					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .22]	[0, .37]	[0, .29]	Ω_2	1.74
Country 2 exports to:	[.37, .44]		[.37, .44]	[.29, .54]	Ω_3	1.50
Country 3 exports to:	[.44, .54]				Ω_4	1.16
Country 4 exports to:	[.84, 1]	[.65, 1]	[.84, 1]		U_1	1.621
	FTA ₁₄					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .22]	[0, .29]	[0, .37]	Ω_2	1.75
Country 2 exports to:	[.37, .51]		[.29, .39]	[.37, .51]	Ω_3	1.72
Country 3 exports to:	[.51, .59]	[.66, .77]		[.51, .59]	Ω_4	1.11
Country 4 exports to:	[.59, 1]	[.77, 1]			U_1	1.863
	FTA ₂₃					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .24]	[0, .24]	[0, .32]	Ω_2	1.59
Country 2 exports to:	[.41, .52]		[.24, .52]	[.32, .52]	Ω_3	1.54
Country 3 exports to:	[.52, .68]	[.52, .89]		[.52, .52]	Ω_4	1.13
Country 4 exports to:	[.68, 1]	[.89, 1]	[.89, 1]		U_1	1.496
	FTA ₂₄					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .25]	[0, .32]	[0, .25]	Ω_2	1.56
Country 2 exports to:	[.42, .48]		[.32, .37]	[.25, .60]	Ω_3	1.61
Country 3 exports to:	[.48, .74]				Ω_4	1.09
Country 4 exports to:	[.74, 1]	[.60, 1]	[.96, 1]		U_1	1.181
	FTA ₃₄					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .23]	[0, .30]	[0, .30]	Ω_2	1.66
Country 2 exports to:	[.39, .54]		[.30, .41]	[.30, .41]	Ω_3	1.55
Country 3 exports to:	[.54, .71]	[.70, .71]		[.41, .71]	Ω_4	1.09
Country 4 exports to:	[.71, 1]	[.71, 1]	[.71, 1]		U_1	1.195
	FTA ₁₂₃					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .32]	[0, .32]	[0, .32]	Ω_2	1.57
Country 2 exports to:	[.32, .53]		[.32, .53]	[.32, .50]	Ω_3	1.49
Country 3 exports to:	[.53, .82]	[.53, .82]			Ω_4	1.19
Country 4 exports to:	[.82, 1]	[.82, 1]	[.82, 1]		U_1	1.646
	FTA ₁₂₄					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .32]	[0, .32]	[0, .32]	Ω_2	1.56
Country 2 exports to:	[.32, .57]		[.32, .34]	[.32, .57]	Ω_3	1.79
Country 3 exports to:	[.57, .64]	[.57, .64]		[.57, .64]	Ω_4	1.08
Country 4 exports to:	[.64, 1]	[.64, 1]			U_1	1.176
	FTA ₁₃₄					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .21]	[0, .35]	[0, .35]	Ω_2	1.85
Country 2 exports to:	[.35, .45]		[.35, .45]	[.35, .45]	Ω_3	1.57
Country 3 exports to:	[.45, .70]	[.73, 1]	[.70, 1]		Ω_4	1.12
Country 4 exports to:	[.70, 1]	[.71, 1]	[.71, 1]		U_1	1.910
	FTA ₂₃₄					
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .25]	[0, .25]	[0, .25]	Ω_2	1.52
Country 2 exports to:	[.43, .51]		[.25, .51]	[.25, .51]	Ω_3	1.50
Country 3 exports to:	[.51, .71]	[.51, .71]		[.51, .71]	Ω_4	1.06
Country 4 exports to:	[.71, 1]	[.71, 1]	[.71, 1]		U_1	1.416

Table 4: Four Country Model; Two-country FTAs

	Base Tariff	FTA 12	FTA 13	FTA 14
U₁	1.500	1.552 (+3.47%)	1.621 (+8.09%)	1.863 (+24.21%)
	Base Tariff	FTA 12	FTA 23	FTA 24
U₂	0.934	0.994 (+6.46%)	1.024 (+9.62%)	1.184 (+26.84%)
	Base Tariff	FTA 13	FTA 23	FTA 34
U₃	1.024	1.078 (+5.31%)	1.055 (+3.00%)	1.195 (+16.67%)
	Base Tariff	FTA 14	FTA 24	FTA 34
U₄	1.656	1.677 (+1.27%)	1.688 (+1.93%)	1.697 (+2.45%)

Table 5: Four Country Model; FTA Enlargement Possibilities

	FTA₁₂	FTA₁₂₃	FTA₁₂₄		FTA₁₃	FTA₁₂₃	FTA₁₃₄		FTA₁₄	FTA₁₂₄	FTA₁₃₄
U₁	1.552	1.653 (+6.50%)	1.837 (+18.39%)	U₁	1.621	1.653 (+1.95%)	1.910 (+17.81%)	U₁	1.863	1.837 (-1.37%)	1.910 (+2.52%)
U₂	0.994	1.051 (+5.71%)	1.176 (+18.30%)	U₂	0.913	1.051 (+15.11%)	0.852 (-6.69%)	U₂	0.888	1.176 (+32.37%)	0.852 (-4.12%)
U₃	1.021	1.106 (+8.33%)	1.012 (-0.89%)	U₃	1.078	1.106 (+2.54%)	1.213 (+12.51%)	U₃	1.014	1.012 (-0.24%)	1.213 (19.65%)
U₄	1.651	1.646 (-0.35%)	1.702 (+3.08%)	U₄	1.657	1.646 (-0.67%)	1.707 (+3.03%)	U₄	1.677	1.702 (+1.50%)	1.707 (1.78%)
	FTA₂₃	FTA₁₂₃	FTA₂₃₄		FTA₂₄	FTA₁₂₄	FTA₂₃₄		FTA₃₄	FTA₁₃₄	FTA₂₃₄
U₁	1.496	1.653 (+10.44%)	1.416 (-5.41%)	U₁	1.471	1.837 (+24.90%)	1.416 (-3.77%)	U₁	1.461	1.910 (+30.70%)	1.416 (-3.13%)
U₂	1.024	1.051 (+2.66%)	1.188 (+16.05%)	U₂	1.184	1.176 (-0.70%)	1.188 (+0.30%)	U₂	0.904	0.852 (-5.81%)	1.188 (+31.35%)
U₃	1.055	1.106 (+4.85%)	1.204 (+14.21%)	U₃	1.018	1.012 (-0.62%)	1.204 (+18.32%)	U₃	1.195	1.213 (+1.56%)	1.204 (+0.82%)
U₄	1.652	1.646 (-0.37%)	1.711 (+3.61%)	U₄	1.688	1.702 (+0.85%)	1.711 (+1.39%)	U₄	1.697	1.707 (+0.61%)	1.711 (+0.87%)

Table 6a: Four-Country Case; Country 1's labor Endowment is 1.5 x that of the other Countries

Base tariff case		Country 1	Country 2	Country 3	Country 4				
Country 1 exports to:		[0, .27]	[0, .35]	[0, .35]		Ω_2	1.44	U_1	0.830
Country 2 exports to:	[.45, .54]		[.35, .41]	[.35, .54]		Ω_3	1.34	U_2	0.884
Country 3 exports to:	[.54, .73]	[.70, .73]		[.54, .56]		Ω_4	0.91	U_3	1.026
Country 4 exports to:	[.73, 1]	[.73, 1]	[.95, 1]					U_4	1.671
Free trade case		Country 1	Country 2	Country 3	Country 4				
Country 1 exports to:		[0, .36]	[0, .36]	[0, .36]		Ω_2	1.38	U_1	1.028
Country 2 exports to:	[.36, .54]		[.36, .54]	[.36, .54]		Ω_3	1.28	U_2	1.118
Country 3 exports to:	[.54, .73]	[.54, .73]		[.54, .73]		Ω_4	0.88	U_3	1.202
Country 4 exports to:	[.73, 1]	[.73, 1]	[.73, 1]					U_4	1.746
FTA₁₄		Country 1	Country 2	Country 3	Country 4				
Country 1 exports to:		[0, .25]	[0, .33]	[0, .42]		Ω_2	1.54	U_1	1.010
Country 2 exports to:	[.42, .54]		[.33, .41]	[.42, .54]		Ω_3	1.43	U_2	0.834
Country 3 exports to:	[.54, .62]	[.70, .81]		[.54, .62]		Ω_4	0.89	U_3	1.019
Country 4 exports to:	[.62, 1]	[.81, 1]						U_4	1.704
FTA₂₄		Country 1	Country 2	Country 3	Country 4				
Country 1 exports to:		[0, .28]	[0, .36]	[0, .28]		Ω_2	1.38	U_1	0.815
Country 2 exports to:	[.47, .52]		[.36, .40]	[.28, .62]		Ω_3	1.32	U_2	1.111
Country 3 exports to:	[.52, .74]	[.62, 1]	[.96, 1]			Ω_4	0.89	U_3	1.024
Country 4 exports to:	[.74, 1]							U_4	1.709
FTA₁₂₄		Country 1	Country 2	Country 3	Country 4				
Country 1 exports to:		[0, .37]	[0, .36]	[0, .37]		Ω_2	1.35	U_1	1.001
Country 2 exports to:	[.37, .59]		[.37, .59]	[.59, .66]		Ω_3	1.49	U_2	1.114
Country 3 exports to:	[.59, .66]	[.59, .66]		[.59, .66]		Ω_4	0.87	U_3	1.017
Country 4 exports to:	[.66, 1]	[.66, 1]						U_4	1.729

Table 6b: Four-Country Case; Country 1's Labor Endowment is 2/3 x that of the other Countries

Base tariff case	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .20]	[0, .27]	[0, .27]	Ω_1	1.88	U_1	2.730					
Country 2 exports to:	[.34, .48]	[.27, .37]	[.27, .48]	Ω_2	1.95	U_2	0.985					
Country 3 exports to:	[.48, .71]	[.63, .71]	[.48, .54]	Ω_3	1.38	U_3	1.024					
Country 4 exports to:	[.71, 1]	[.71, 1]	[.92, 1]	Ω_4		U_4	1.645					
Free trade case	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .27]	[0, .27]	[0, .27]	Ω_1	1.85	U_1	3.459					
Country 2 exports to:	[.27, .49]	[.27, .49]	[.27, .49]	Ω_2	1.90	U_2	1.244					
Country 3 exports to:	[.49, .70]	[.49, .70]	[.49, .70]	Ω_3	1.35	U_3	1.215					
Country 4 exports to:	[.70, 1]	[.70, 1]	[.70, 1]	Ω_4		U_4	1.703					
FTA _{A14}	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .19]	[0, .25]	[0, .32]	Ω_1	2.01	U_1	3.438					
Country 2 exports to:	[.32, .48]	[.25, .37]	[.32, .48]	Ω_2	2.07	U_2	0.942					
Country 3 exports to:	[.48, .58]	[.63, .75]	[.48, .58]	Ω_3	1.38	U_3	1.011					
Country 4 exports to:	[.58, 1]	[.75, 1]	[.98, 1]	Ω_4		U_4	1.659					
FTA _{A24}	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .22]	[0, .28]	[0, .22]	Ω_1	1.78	U_1	2.676					
Country 2 exports to:	[.36, .45]	[.28, .35]	[.22, .58]	Ω_2	1.98	U_2	1.258					
Country 3 exports to:	[.45, .74]			Ω_3	1.34	U_3	1.013					
Country 4 exports to:	[.74, 1]	[.58, 1]	[.96, 1]	Ω_4		U_4	1.672					
FTA _{A124}	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .28]	[0, .28]	[0, .28]	Ω_1	1.82	U_1	3.391					
Country 2 exports to:	[.28, .54]	[.28, .32]	[.28, .54]	Ω_2	2.17	U_2	1.244					
Country 3 exports to:	[.54, .62]	[.54, .52]	[.54, .62]	Ω_3	1.34	U_3	1.008					
Country 4 exports to:	[.62, 1]	[.62, 1]		Ω_4		U_4	1.683					

Table 6c: Four-Country Case; Country 2's Labor Endowment is 1.5 x that of the other Countries

Base tariff case	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .22]	[0, .29]	[0, .29]	Ω_1	1.74	U_1	1.493					
Country 2 exports to:	[.37, .53]	[.29, .41]	[.29, .53]	Ω_2	1.63	U_2	0.590					
Country 3 exports to:	[.53, .74]	[.69, .74]	[.53, .57]	Ω_3	1.11	U_3	1.019					
Country 4 exports to:	[.74, 1]	[.74, 1]	[.96, 1]	Ω_4		U_4	1.664					
Free trade case	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .29]	[0, .29]	[0, .29]	Ω_1	1.72	U_1	1.876					
Country 2 exports to:	[.29, .55]	[.29, .55]	[.29, .55]	Ω_2	1.57	U_2	0.728					
Country 3 exports to:	[.55, .73]	[.55, .73]	[.55, .73]	Ω_3	1.08	U_3	1.191					
Country 4 exports to:	[.73, 1]	[.73, 1]	[.73, 1]	Ω_4		U_4	1.739					
FTA _{A14}	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .21]	[0, .27]	[0, .35]	Ω_1	1.84	U_1	1.844					
Country 2 exports to:	[.35, .53]	[.27, .41]	[.35, .53]	Ω_2	1.74	U_2	0.564					
Country 3 exports to:	[.53, .61]	[.69, .79]	[.53, .61]	Ω_3	1.09	U_3	1.015					
Country 4 exports to:	[.61, 1]	[.79, 1]	[1, 1]	Ω_4		U_4	1.685					
FTA _{A24}	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .23]	[0, .30]	[0, .23]	Ω_1	1.66	U_1	1.454					
Country 2 exports to:	[.39, .51]	[.30, .39]	[.23, .62]	Ω_2	1.62	U_2	0.732					
Country 3 exports to:	[.51, .75]			Ω_3	1.07	U_3	1.015					
Country 4 exports to:	[.76, 1]	[.62, 1]		Ω_4		U_4	1.707					
FTA _{A124}	Country 1	Country 2	Country 3	Country 4	Ω_1	Ω_2	Ω_3	Ω_4	U_1	U_2	U_3	U_4
Country 1 exports to:	[0, .30]	[0, .30]	[0, .30]	Ω_1	1.69	U_1	1.824					
Country 2 exports to:	[.30, .60]	[.30, .35]	[.30, .60]	Ω_2	1.83	U_2	0.720					
Country 3 exports to:	[.60, .67]	[.60, .67]	[.60, .67]	Ω_3	1.06	U_3	1.011					
Country 4 exports to:	[.67, 1]	[.67, 1]		Ω_4		U_4	1.723					

Table 6d: Four-Country Case; Country 2's Labor endowment is 2/3 x that of the other Countries

Base tariff case						
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .25]	[0, .32]	[0, .32]	Ω_2	1.57
Country 2 exports to:	[.42, .49]		[.32, .38]	[.32, .49]	Ω_3	1.60
Country 3 exports to:	[.49, .70]	[.64, .70]		[.49, .54]	Ω_4	1.14
Country 4 exports to:	[.70, 1]	[.70, 1]	[.91, 1]		U_1	1.512
Free trade case						
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .33]	[0, .33]	[0, .33]	Ω_2	1.50
Country 2 exports to:	[.33, .48]		[.33, .48]	[.33, .48]	Ω_3	1.55
Country 3 exports to:	[.48, .70]	[.48, .70]		[.48, .70]	Ω_4	1.11
Country 4 exports to:	[.70, 1]	[.70, 1]	[.70, 1]		U_1	1.894
FTA ₁₄						
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .23]	[0, .30]	[0, .39]	Ω_2	1.67
Country 2 exports to:	[.39, .49]		[.30, .38]	[.39, .49]	Ω_3	1.71
Country 3 exports to:	[.49, .58]	[.64, .76]		[.49, .58]	Ω_4	1.13
Country 4 exports to:	[.58, 1]	[.76, 1]	[.99, 1]		U_1	1.881
FTA ₂₄						
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .26]	[0, .34]	[0, .26]	Ω_2	1.48
Country 2 exports to:	[.44, .46]		[.34, .35]	[.26, .57]	Ω_3	1.61
Country 3 exports to:	[.46, .72]	[.57, .57]		[.57, .57]	Ω_4	1.12
Country 4 exports to:	[.72, 1]	[.57, 1]	[.93, 1]		U_1	1.494
FTA ₁₂₄						
	Country 1	Country 2	Country 3	Country 4		
Country 1 exports to:		[0, .34]	[0, .33]	[0, .34]	Ω_2	1.46
Country 2 exports to:	[.34, .54]			[.34, .54]	Ω_3	1.76
Country 3 exports to:	[.54, .62]	[.54, .62]		[.54, .62]	Ω_4	1.10
Country 4 exports to:	[.62, 1]	[.62, 1]			U_1	1.857
					U_2	1.913
					U_3	1.012
					U_4	1.687

Table 7: Summary of Various Country-Size Cases

C ₁ is Larger									
	Base	FTA ₁₄	FTA ₁₂₄	% change		Base	FTA ₂₄	FTA ₁₂₄	% change
U ₁	0.830	1.010	1.001	-0.90%	U ₁	0.830	0.815	1.001	22.77%
U ₂	0.884	0.834	1.114	33.59%	U ₂	0.884	1.111	1.114	0.33%
U ₃	1.026	1.019	1.017	-0.26%	U ₃	1.026	1.024	1.017	-0.75%
U ₄	1.671	1.704	1.729	1.46%	U ₄	1.671	1.709	1.729	1.17%
C ₁ is Smaller									
	Base	FTA ₁₄	FTA ₁₂₄	% change		Base	FTA ₂₄	FTA ₁₂₄	% change
U ₁	2.730	3.438	3.391	-1.36%	U ₁	2.730	2.676	3.391	26.75%
U ₂	0.985	0.942	1.244	32.10%	U ₂	0.985	1.258	1.244	-1.04%
U ₃	1.024	1.011	1.008	-0.33%	U ₃	1.024	1.013	1.008	-0.46%
U ₄	1.645	1.659	1.683	1.40%	U ₄	1.645	1.672	1.683	0.61%
C ₂ is Larger									
	Base	FTA ₁₄	FTA ₁₂₄	% change		Base	FTA ₂₄	FTA ₁₂₄	% change
U ₁	1.493	1.844	1.824	-1.07%	U ₁	1.493	1.454	1.824	25.49%
U ₂	0.590	0.564	0.720	27.77%	U ₂	0.590	0.732	0.720	-1.61%
U ₃	1.019	1.015	1.011	-0.33%	U ₃	1.019	1.015	1.011	-0.38%
U ₄	1.664	1.685	1.723	2.27%	U ₄	1.664	1.707	1.723	0.97%
C ₂ is Smaller									
	Base	FTA ₁₄	FTA ₁₂₄	% change		Base	FTA ₂₄	FTA ₁₂₄	% change
U ₁	1.512	1.881	1.857	-1.29%	U ₁	1.512	1.494	1.857	24.30%
U ₂	1.470	1.390	1.913	37.61%	U ₂	1.470	1.902	1.913	0.58%
U ₃	1.029	1.014	1.012	-0.18%	U ₃	1.029	1.023	1.012	-1.07%
U ₄	1.651	1.672	1.687	0.93%	U ₄	1.651	1.675	1.687	0.77%

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