Specialization of Production in a Multilateral Free Trade Area with a Continuum of Goods

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Abstract

By applying the framework of Dornbusch, Fischer, and Samuelson (1980) this paper extends the model for bilateral free trade arrangement into a multilateral free trade agreement (MFTA). We examine the determination of the area of specialization and the impact of a newly admitted country on the restructuring of specialization pattern for member countries of the MFTA. When the newly admitted country has already been sufficiently open to the foreign competition, its specialization zone will expand and its GDP will improve relative to the incumbent countries after the entry into the MFTA. However, if this country's domestic market is too protected from foreign competition, its specialization zone will shrink along with the worsening of its GDP after entering the MFTA. Consequently we argue that the admission into the MFTA is not necessarily a free good. It may bring in a great amount of job losses in the short run due to the shrinkage of the specialization zone from the sharpened competition in the MFTA environment.

Key words: multilateral free trade agreement, product specialization, trade diversion, factor proportion theory, economic integration

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I. Introduction

A regional preferential agreement in the form of either customs union (e.g., MERCOSUR) or free trade area (e.g., NAFTA) involves only partial elimination of tariffs and can lead to unfavorable results from trade diversion as pointed out by Viner (1950). Furthermore, when extending the bilateral free trade arrangement into a multilateral free trade agreement (MFTA) we will confront a more stringent issue of competing for the area of product specialization among the member countries. This study is intended to examine the welfare implication of joining the MFTA with an emphasis on how the specialization of production is determined among the member countries.

The recent resurgence of the MFTA such as the Trans-Pacific Partnership(TPP) is proposed to enhance trade and investment among the TPP partner countries, promote innovation, economic growth and development, and support the creation and retention of jobs. There has been criticism and protest of the negotiations from global health experts, internet freedom activists, environmentalists, organized labor, advocacy groups and elected officials, primarily due to the expansive scope of the agreement, and controversial clauses in the drafts leaked to the public. Nobel Prize-winning economist Joseph Stiglitz warned that the TPP presented "grave risks". The *Economic Policy Institute* and the *Center for Economic and Policy Research* have argued that the TPP could result in further job losses and declining wages.[1] [2] Noam Chomsky warns that the TPP is "designed to carry forward the neoliberal project to maximize profit and domination, and to set the working people in the world in competition with one another so as to lower wages to increase insecurity."[3]

The root of disputes about the desirability of joining the MFTA lies in the sharpened competition for each country's advantageous sectors of industries and the inevitable job restructuring problem. Therefore, we need a model capable of determining the area of specialization for each member of the MFTA. In the Heckscher-Ohlin trade model with more goods than factors (Dixit and Norman 1980) there is a wide range of possible factor endowments across countries such that factor price equalization holds provided that technologies are the same across countries. However, the amount of production occurring in each country is indeterminate when factor prices are equalized. An elegant generalization is when there is a continuum of goods, as in Dornbusch, Fischer, and Samuelson (1980). Our study basically extends

[1] "No Jobs from Trade Pacts: The Trans-Pacific Partnership Could Be Much Worse than the Over-Hyped Korea Deal". *Economic Policy Institute*. July 18, 2013

[2] "Gains from Trade? The Net Effect of the Trans-Pacific Partnership Agreement on U.S. Wages." *Center for Economic and Policy Research*. September 2013

[3] Zach Carter and Ryan Grim (13 January 2014). "Noam Chomsky: Obama Trade Deal A 'Neoliberal Assault' To Further Corporate 'Domination'." *The Huffington Post*

the framework of Dornbusch, Fischer and Samuelson (1980) by considering a myriad of countries. To simplify the discussion without loss of generality a model of three countries in the MFTA is assumed in the paper. Furthermore, to highlight the effect on the specialization of production we assume that these countries are sufficiently distinct in their endowment structure so that factor prices are not equalized among them[4].

In a general case a member country in the MFTA usually encounters some countries with relatively more capital endowment (hereby called capital-rich countries) and others relatively labor endowed (called labor-rich countries). Those relatively capital rich countries will specialize in the production of relatively capital intensive goods, the labor rich countries specialize in the labor intensive goods while this particular country will produce the goods with factor intensity falling between the above two groups of goods. This study will first explore how the product specialization zone is associated with the economic size and the structure of factor income among the member countries. Then we will examine the impact of the admission of a new country into the MFTA on the range of product specialization zone for the new and incumbent countries. Finally, the welfare implication from the entry of the new member country will be thoroughly explored.

There exists massive theoretical and empirical underpinning of how pervasive the effect of factor proportions is on the structure of international trade.[5] The recent generalization of factor proportions model to explain the structure of commodity trade was conducted by Romalis (2004) that integrates a many-country version of a Heckscher-Ohlin model with a continuum of goods with Paul R. Krugman's (1980) model of monopolistic competition and transport costs. Regolo (2013) extends the Romalis (2004) model to explore how a country's export diversification varies across destination markets and yields two implications, i.e., exports between similarly endowed countries ("South–South" and "North–North") are more diversified than exports between differently endowed countries ("South–North" and"North–South") and low bilateral trade costs lead to greater export diversification. Morrow (2010) derives and estimates a unified and tractable model of comparative advantage due to differences in both factor abundance and relative productivity differences across industries and provides the conditions under which ignoring one force for comparative advantage biases empirical tests of the other. These studies vindicate that a generalized Heckscher-Ohlin model with the multi-country and multi-good

[4] There are many ways to generate a failure of FPE in a Heckscher-Ohlin world. One way is to assume that factor proportions are sufficiently different that they are outside the FPE set. Another way is to introduce costs to international trade, which could have a strong effect on trade volume. This paper takes the first route.

[5] See Leamer (1980, 1984), Deardorff (1982), Bowen et al. (1987), or Davis and Weinstein (2001) for excellent literature survey of the factor proportion and the factor content studies.

extension is a useful vehicle to correlate factor endowment, industry structure and trade pattern, but do not explicitly address the issue of how a country's product specialization structure might alter and whether its welfare might gain or lose after entering into a regional (bilateral or multilateral) free trade agreement.

Baier, Bergstrand and Feng (2014) provides the evidence using gravity equations of both intensive and extensive (goods) margins being affected by economic integration agreements (EIAs) employing a panel data set with a large number of country pairs, product categories, and EIAs from 1962 to 2000; and examines the differential (partial) effects of various "types" of EIAs on these intensive and extensive margins of trade. Their study finds a novel differential "timing" of the two margins' (partial) effects with intensive-margin effects occurring sooner than extensive-margin effects but does not explore the welfare implication of EIAs.

According to Grinols and Wong (1991) and Ju and Krishna (2000), the welfare impact of tariff reforms like the MFTA can be summarized in two expressions. The first of these is the terms of trade effect: if the price of imports goes up or the price of exports goes down, this expression will be negative. The second term is the change in imports evaluated at the final tariff rate: a positive value indicates that marginal costs at home exceed international prices so it would be more efficient to import the good; if the value is negative, the country should be exporting the good. Therefore, this second term gives a measure of the efficiency gain (if positive) due to attracting imports towards protected sectors. Thus, in order for the MFTA to bring in an improved welfare it must avoid adverse terms of trade or efficiency effects.

Trade diversion effect as mentioned in Viner (1950) means that a member country in the MFTA switches from the lowest price supplier from outside the MFTA (where tariff revenue is collected) to another supplier within the MFTA (with no tariff revenue), so that the aforementioned second efficiency effect has fallen. Therefore, the country can be worse off. The result illustrates what is called a "second best" problem: by eliminating tariffs with the MFTA countries only but not outside the area there is no guarantee of gains.

This outcome makes it seem as if no general result on the desirability of customs union or free trade area (FTA) is possible. However, Kemp and Wan (1976) and Krishna and Panagariya (2002) were still able to obtain such a favorable result as long as the customs union or FTA keeps the world price fixed, or equivalently, keeps the purchases from the rest of the world fixed. (There is always a pattern of lump sum transfers within each country such that no individual is worse off and the government budget in each country is nonnegative) This paper is intended to relax the conditions required by the Kemp and Wan (1976) or Krishna and Panagariya (2002) and discuss whether the benefit from joining the MFTA is still valid for any country.

We are particularly interested in examining the welfare implication for the newly admitted member into the MFTA. By comparing the changes in the product specialization range and the factor prices prior and posterior to joining the MFTA we are able to understand under what conditions and to what extent this newly admitted country will become better off. This study concludes that the degree of specialization or globalization prior to the access to the MFTA turns up very critical to ensure the net gain from the MFTA membership.

When a country has long pursued a free trade policy in such a way that the force of competition in the global market has rendered its product specialization zone relatively concentrated in its comparatively advantageous sectors. As a result the country's factor endowment would be efficiently allocated in a relatively narrow portion of the factor intensity spectrum of industries (which is characterized by the factor share of capital in the total production and will be ranged between zero and one) as compared with its share of economic size (GDP) in the world. We then conclude that the entry of this country into the MFTA will further sharpen its advantage of competitiveness from the eradication of trade barrier, enlarging its specialization zone and raising its factors' reward or employment opportunity. Moreover, the admission of this country into the MFTA will shore up the capital rental-wage ratio for the capital rich countries and the wage-capital rental ratio for the labor rich countries in the MFTA. However, if a country's domestic market is too protected from the foreign competition so that it used to produce an overly wide range of goods (in terms of factor intensity ratio), then the admission into the MFTA will subjugate this country into stiffer competition and adversely affect its product specialization range. Unless this country can rapidly restructure its industrial base and relocate its factor employment accordingly, the downward pressure on its factor prices and employment would be inevitable.

In the section II we set up a Heckscher-Ohlin model that facilitates the discussion for a multilateral free trade arrangement with a continuum of goods. Some basic implications about the product specialization zone in the MFTA are addressed in section III. We then explore in section IV the welfare impact of admitting a new country into the MFTA. Finally a concluding remark is made in section V.

II. A Model of the Multilateral Free Trade Agreement

Drawing upon the setup by Dornbusch, Fischer, and Samuelson (1980) which is recapitulated in Feenstra (2004) we develop the basic framework for the MFTA as below. Let $z \in [0,1]$ denote the range of goods. The quantity of good z produced can be described as:

$$y(z) = f[L(z), K(z)] = AK(z)^{z} L(z)^{1-z}, \qquad (1)$$

where a Cobb-Douglas function with homogeneous of degree one in capital and labor is assumed to facilitate the discussion below. The coefficient A in the functional form measures the degree of factor-neutral technological progress. The coefficient z representing the factor share in the production can also denote the degree of relative capital intensity. It will be convenient to work with the dual unit-cost function, which is

$$\begin{aligned} c(w, r, z) &= \min\{wL(z) + rK(z) \mid f[L(z), K(z)] \geq 1\} \\ &= \frac{B(z)}{A} r^z w^{1-z}, \end{aligned} \tag{2}$$

where B(z) denotes the cost factor associated with good z that is independent of the influence of capital rental (r) and wage (w), and is shorthanded for

$$B(z) = \left(\frac{1-z}{z}\right)^z + \left(\frac{z}{1-z}\right)^{1-z}. \tag{3}$$

We let $a_k(w,r,z) \equiv \frac{\partial c(w,r,z)}{\partial r} = \frac{z\boldsymbol{B}(\boldsymbol{z})}{A}\left(\frac{r}{w}\right)^{z-1}$ and $a_L(w,r,z) \equiv \frac{\partial c(w,r,z)}{\partial w} = \frac{(1-z)\boldsymbol{B}(\boldsymbol{z})}{A}\left(\frac{r}{w}\right)^{z}$ denote the amount of capital and labor needed to produce one unit of y(z). These will depend on the factor prices. Since the capital-labor intensity ratio of good z, i.e., $\frac{a_K(w,r,z)}{a_L(w,r,z)} = \frac{z}{1-z} \cdot \frac{w}{r}$, is non-decreasing in z, the ordering of z also represents the degree of capital intensity.

In the beginning we consider the home country under autarky. Demand is assumed to come from a Cobb-Douglas utility function whose logarithm form can be written as :

$$\ln U = \int_0^1 \alpha(z) \ln y(z) dz, \text{ with } \int_0^1 \alpha(z) dz = 1. \tag{4}$$

Thus, a constant share of income $\alpha(z)$ is spent on each final good y(z). Then, under autarky, the expenditure on each final good at home would be $\alpha(z)(wL + rK)$, where L and K are the factor endowments of home country, with equilibrium prices w and r..

Let us now introduce a multilateral free trade zone with three countries for simplicity and denoted by 1, 2 and 3 in the subscription respectively. These three countries are assumed to have identical technology and tastes. The key issue for trade is to determine which goods are produced in each country. The equilibrium prices will be determined by

$$p(z) = \min\{c(w_1, r_1, z), c(w_2, r_2, z), c(w_3, r_3 z)\}. \tag{5}$$

In general, each country will produce and export those goods with lower unit-costs than the other countries in the free trade zone. Thus, to determine the trade pattern, we need to compare unit-cost across countries.

We suppose that the three countries are ranked according to their relative abundance of endowment in labor versus capital with country one the most labor abundant and country three the most capital abundant. To fix ideas, we let country two be the home country with its labor-capital endowment ratio located between country one and country three. As a result, the wage/rental ratios for the three countries would be $\frac{w_1}{r_1} < \frac{w_2}{r_2} < \frac{w_3}{r_3}$. With this assumption, we can graphically illustrate the problem of choosing the minimum cost location for each good.

The unit-cost as a function of z can have any shape whatsoever. The impact of the factor intensity index z on the unit-cost function is primarily determined by the term of v = $r^z w^{1-z}$. For convenience, we ignore the impact of z on B(z) below[6]. Consequently, $\frac{\partial c(w,r,z)}{\partial z} \approx \frac{B(z)}{A}\frac{\partial v}{\partial z} = \frac{B(z)}{A} w \left(\frac{r}{w}\right)^z ln\frac{r}{w}$. By differentiating the slope of v with respect to r/w, we get $\frac{\partial(\partial v/\partial z)}{\partial(r/w)} = w\left(\frac{r}{w}\right)^{z-1}\left[zln\frac{r}{w}+1\right]$. Depending on the relative size of capital rental with respect to wage, we have the following two cases:

(i) When r > w, the unit-cost function is positively sloped with respect to z. In addition, a country with a greater r/w will come up with a greater slope of unit-cost function. To ensure the full-employment condition for the three countries, the three unit-cost curves as shown in Figure 1 would intersect at least twice as shown. We therefore expect that $c(w_1, r_1, z) < c(w_2, r_2, z) < c(w_3, r_3, z)$, for $z < z_1$. Similarly, $c(w_3, r_3, z) < c(w_2, r_2, z) < c(w_1, r_1, z)$, for $z > z_2$. When z is located between z_1 and z_2, we would have $c(w_2, r_2, z) < c(w_1, r_1, z)$ and $c(w_2, r_2, z) < c(w_3, r_3, z)$.

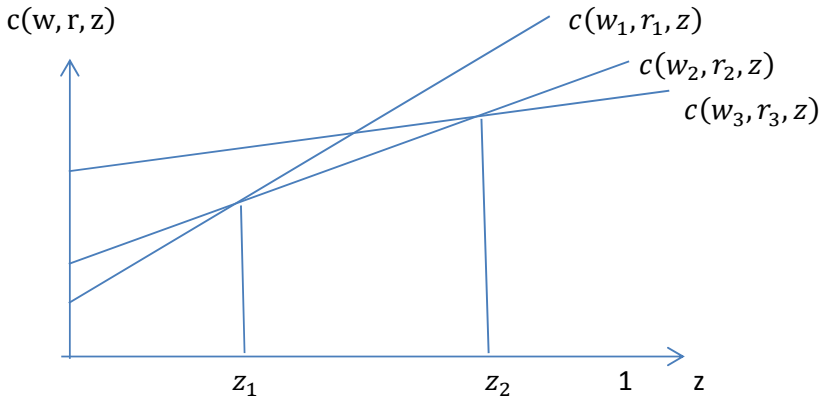

Figure 1

(ii) When r < w, the unit-cost function is negatively sloped with respect to z. As long

[6] The impact of z on the first term of B(z), i.e., $\left(\frac{1-z}{z}\right)^z$, would be roughly offset by its impact on the second term, i.e., $\left(\frac{z}{1-z}\right)^{1-z}$.

as the ratio of wage to capital rental is not too large, more specifically when$1 < \frac{w}{r} < e^{1/z}$, it is clear that the slope of unit-cost function becomes flatter as r/w is getting large. Therefore we derive the Figure 2 below:

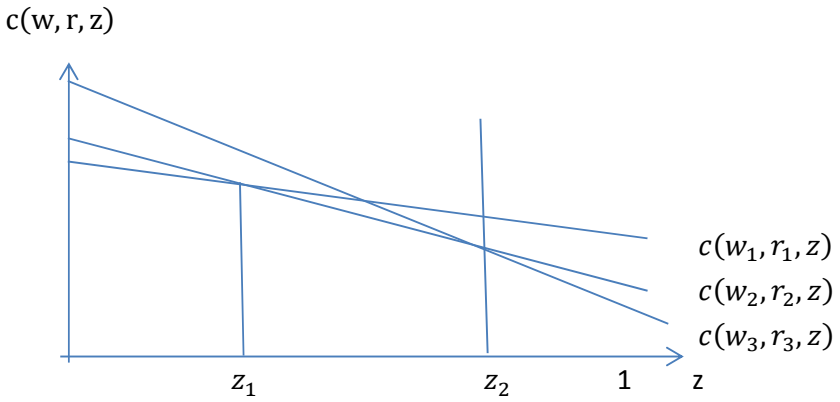

Figure 2

Given the intersection of the three unit-cost curves in Figures 1 and 2, we can see that country one will specialize in the products $[0, z_1)$, country two (i.e., the country we are particularly interested in) in the products (z_1, z_2) and country three in the products $(z_2, 1]$. Thus, the outputs in each country are determined by

$$y(z) = \frac{\alpha(z)[(w_1L_1+r_1K_1)+(w_2L_2+r_2K_2)+(w_3L_3+r_3K_3)]}{c(w_1,r_1,z)},$$

$$\text{for } z \in [0, z_1) \qquad (6.1)$$

$$y(z) = \frac{\alpha(z)[(w_1L_1+r_1K_1)+(w_2L_2+r_2K_2)+(w_3L_3+r_3K_3)]}{c(w_2,r_2,z)},$$

$$\text{for } z \in (z_1, z_2) \qquad (6.2)$$

$$y(z) = \frac{\alpha(z)[(w_1L_1+r_1K_1)+(w_2L_2+r_2K_2)+(w_3L_3+r_3K_3)]}{c(w_3,r_3,z)},$$

$$\text{for } z \in (z_2, 1] \qquad (6.3)$$

The equality of relative demand and supply for labor versus capital for the three countries can be shown below:

$$\frac{L_1}{K_1} = \frac{\int_0^{z_1} a_L(w_1,r_1,z)y(z)dz}{\int_0^{z_1} a_K(w_1,r_1,z)y(z)dz}, \qquad (7.1)$$

$$\frac{L_2}{K_2} = \frac{\int_{z_1}^{z_2} a_L(w_2,r_2,z)y(z)dz}{\int_{z_1}^{z_2} a_K(w_2,r_2,z)y(z)dz} \qquad (7.2)$$

$$\frac{L_3}{K_3} = \frac{\int_{z_2}^{1} a_L(w_3,r_3,z)y(z)dz}{\int_{z_2}^{1} a_K(w_3,r_3,z)y(z)dz} \qquad (7.3)$$

The right side of equations above is the relative demand for labor versus capital for

each country, depending on the relative wage-rental ratio of the country. These must equal the relative endowment L/K for the country.

The three-country equilibrium is determined by conditions (6.1), (6.2), (6.3) and (7.1), (7.2), (7.3), combined with $c(w_1, r_1, z_1) = c(w_2, r_2, z_1)$ and $c(w_2, r_2, z_2) = c(w_3, r_3, z_2)$, and also trade balance conditions for each country:

$$\int_0^{z_1} \alpha(z)[(w_2L_2 + r_2K_2) + (w_3L_3 + r_3K_3)]dz = \int_{z_1}^1 \alpha(z)(w_1L_1 + r_1K_1)dz \quad (8.1)$$

$$\int_{z_1}^{z_2} \alpha(z)[(w_1L_1 + r_1K_1) + (w_3L_3 + r_3K_3)]dz = \int_0^{z_1} \alpha(z)(w_2L_2 + r_2K_2)dz + \int_{z_2}^1 \alpha(z)(w_2L_2 + r_2K_2)dz \quad (8.2)$$

$$\int_{z_2}^1 \alpha(z)[(w_1L_1 + r_1K_1) + (w_2L_2 + r_2K_2)]dz = \int_0^{z_2} \alpha(z)(w_3L_3 + r_3K_3)dz \quad (8.3)$$

The left side of equations above is the value of export while the right side the value of import for country 1, 2 and 3 respectively. It is noted that the equations of (8.1), (8.2) and (8.3) are correlated among one another. By adding (8.1) to (8.2) we get (8.3). Therefore only two of the three trade balancing conditions are independent. Substituting (6.1), (6.2) and (6.3) into (7.1), (7.2) and (7.3), we then have seven independent equations (i.e., (7.1), (7.2), (7.3), two of (8.1), (8.2) and (8.3), and two threshold conditions $c(w_1, r_1, z_1) = c(w_2, r_2, z_1)$, $c(w_2, r_2, z_2) = c(w_3, r_3, z_2)$) to determine threshold points z_1 and z_2 and five of the six factor prices $(w_1, r_1), (w_2, r_2), (w_3, r_3)$ (one of the six factor prices is treated as numeraire).

III. Model Implications

To simplify the discussion below we assume that the product preference as well as the income share spent on each good, i.e., $\alpha(z)$, are equal among z and identical among the three countries. In other words, $\alpha(z)=1$ is assumed below for the sake of easy interpretation.

According to the specification of output y(z) for each country (i.e., equations (6.1), (6.2) and (6.3)), the unit-cost function $c(w, r, z)$ (equation (2)) and the factor inputs for the unit product output (i.e., $a_k(w, r, z)$and $a_L(w, r, z)$), we can rewrite the factor market equilibrium equations (7.1), (7.2) and (7.3) as

$$\frac{L_1}{K_1} = \left[\frac{2}{Z_1} - 1\right] \times \frac{r_1}{w_1} \quad (7.1)'$$

$$\frac{L_2}{K_2} = \left[\frac{2}{z_1+z_2} - 1\right] \times \frac{r_2}{w_2} \quad (7.2)'$$

$$\frac{L_3}{K_3} = \frac{1-z_2}{1+z_2} \times \frac{r_3}{w_3} \quad (7.3)'$$

Likewise, we can simplify the three trade balance conditions (8.1), (8.2) and (8.3) as follows:

$(z_1 - 1)(w_1L_1 + r_1K_1) + z_1(w_2L_2 + r_2K_2) + z_1(w_3L_3 + r_3K_3) = 0$ (8.1)'

$(z_2 - z_1)(w_1L_1 + r_1K_1) + (z_2 - z_1 - 1)(w_2L_2 + r_2K_2) + (z_2 - z_1)(w_3L_3 + r_3K_3) = 0$ (8.2)'

$(1 - z_2)(w_1L_1 + r_1K_1) + (1 - z_2)(w_2L_2 + r_2K_2) - z_2(w_3L_3 + r_3K_3) = 0$ (8.3)'

Moreover, the two threshold conditions can be restated as

$r_1^{z_1}w_1^{1-z_1} = r_2^{z_1}w_2^{1-z_1}$ (9.1)

$r_2^{z_2}w_2^{1-z_2} = r_3^{z_2}w_3^{1-z_2}$ (9.2)

We broadly classify the countries in the MFTA into three groups. Those countries which are relatively more capital abundant and obtain comparative advantage in the production of those goods located above the second factor intensity threshold (z_2) are categorized as the "capital rich countries"; those countries specializing in the production of those goods below the first factor intensity threshold (z_1) are called as the "labor rich countries". The rest countries in this multilateral free trade association are labeled as "factor neutral countries". We start with the examination of the product specialization range for factor neutral countries, i.e., $z_2 - z_1$. As for the impact on the specialization zone for capital and labor rich countries, we then look into the variation of $1 - z_2$ and z_1 specifically. In the following, we examine $z_2 - z_1$ in two ways.

First, from equations (7.1)' and (7.3)' we can derive the thresholds z_1 *and* z_2 as

$$z_1 = \frac{2}{\frac{L_1w_1}{r_1K_1}+1} \quad (10.1)$$

and

$$z_2 = \frac{2}{\frac{L_3w_3}{r_3K_3}+1} - 1. \quad (10.2)^7$$

From the factor market equilibrium conditions of capital rich as well as labor rich countries, the product range of specialization $z_2 - z_1$ is related to the factor income ratios of these countries. According to equations (10.1) and (10.2) we can readily obtain the following lemma:

Lemma 1: *An improvement of capital versus labor income ratio in the capital rich countries (i.e., an increase in* $\frac{r_3K_3}{w_3L_3}$*) leads to an increase in the capital intensity of the*

[7] It is evident that $z_2 < 1$. To assure that $z_2 > 0$ *and* $z_1 < 1$, $\frac{L_1w_1}{K_1r_1} > 1 > \frac{L_3w_3}{K_3r_3}$ must be satisfied in equilibrium. In other words, the relative labor to capital income must be greater (smaller) than 1 in the labor (capital) abundance country. Moreover, in order for $z_2$to be greater than z_1 we need to impose two another conditions. The first one is $\frac{L_1w_1}{K_1r_1} > 1 + 2 \times \frac{L_2w_2}{K_2r_2}$ which is obtained by comparing $z_2 = \frac{2}{\frac{L_2w_2}{r_2K_2}+1} - z_1$ (from (7.2)') with (10.1). The second one is $\frac{L_1w_1}{K_1r_1} - \frac{L_3w_3}{K_3r_3} > \frac{L_3w_3}{K_3r_3}\left(2 + \frac{L_1w_1}{K_1r_1}\right) + 1$ by comparing eq. (10.1) to (10.2).

products to be specialized (i.e., an increase in z_2*)and reduces their product range of specialization (i.e.,* $1 - z_2$ *becomes smaller). Similarly, an improvement of labor versus capital income ratio in the labor rich countries (i.e., an increase in* $\frac{w_1 L_1}{r_1 K_1}$*) leads to an enhancement of labor intensity in their specialized products (i.e., a decrease in* z_1*), narrowing the product specialization range. Either of the above cases (i.e., an increase in* $\frac{r_3 K_3}{w_3 L_3}$ *or* $\frac{w_1 L_1}{r_1 K_1}$*) will unequivocally shore up the product range of specialization for this factor neutral country* (i. e., $z_2 - z_1$ *becomes larger).*

The second way to examine the product specialization range (i.e., $z_2 - z_1$) for this particular member country of the MFTA is to compare its gross domestic product (GDP) with those of capital rich and labor rich countries. Since we assume income share spent on each good, α(z), is equal among z and identical among the three countries, it results that the length of specialization range for each country must equal its GDP share in the MFTA given the balance of payments condition. As can be seen from the equation (8.2)' the range of production specialization for the factor neutral country is:

$$z_2 - z_1 = \frac{w_2 L_2 + r_2 K_2}{(w_1 L_1 + r_1 K_1) + (w_2 L_2 + r_2 K_2) + (w_3 L_3 + r_3 K_3)}$$

$$= \frac{1}{\frac{w_1 L_1 + r_1 K_1}{w_2 L_2 + r_2 K_2} + \frac{w_3 L_3 + r_3 K_3}{w_2 L_2 + r_2 K_2} + 1}$$

Let $GDP_1 \equiv w_1 L_1 + r_1 K_1, GDP_2 \equiv w_2 L_2 + r_2 K_2, GDP_3 \equiv w_3 L_3 + r_3 K_3$. We can derive the following lemma:

Lemma 2: *The factor neutral country's product specialization zone in the MFTA,* $z_2 - z_1$*, is positively related to its share of gross domestic product in the MFTA. An increase in its GDP relative to the capital rich countries or labor rich countries (i.e., an increase in either* $\frac{GDP_2}{GDP_3}$ *or* $\frac{GDP_2}{GDP_1}$*) is associated with an expanded specialization zone of* $z_2 - z_1$*. The same conclusion can be similarly derived for capital rich and labor rich countries.*

IV. Welfare Analysis of the Admission of a New Country in the MFTA

When a new country considers an admission into the MFTA, it needs to evaluate the welfare implication of abolishing various degree or form of trade barriers with some or all of the incumbents of the MFTA. Therefore we have to establish a model with the imposition of some trade barrier between this newcomer and the incumbents of the MFTA initially. To facilitate and simplify our analysis below we assume a flat

tariff rate *t* be imposed between the newcomer and the incumbents prior to the entry (like the case in customs union). The following changes are needed for the preceding basic model to accommodate the adoption of this trade barrier.

Firstly, the GDPs for either the newcomer or the incumbent countries should include the tariff revenues. More specifically, the GDP of the factor neutral country becomes $w_2L_2 + r_2K_2 + R_2$,where R_2 denotes the tariff revenue for the newcomer and equals $\frac{(1-z_2+z_1)}{z_2-z_1+1/t} \times (w_2L_2 + r_2K_2)$. It is because for each import good, i.e., $z \in [0, z_1) \cup [z_2, 1]$, the gross expenditure (including tariff) is $\alpha(z)(w_2L_2 + r_2K_2 + R_2)$. Therefore, the tariff revenue from each import good would be $[\alpha(z)(w_2L_2 + r_2K_2 + R_2)] \times \frac{t}{1+t}$. Let $\alpha(z) = 1$ for simplicity. We can solve R_2 from the definition equation that $R_2 = (w_2L_2 + r_2K_2 + R_2) \times \frac{t}{1+t} \times (1 - z_2 + z_1)$, which implies that $R_2 = \frac{(1-z_2+z_1)}{z_2-z_1+1/t} \times (w_2L_2 + r_2K_2)$. An increase in tariff rate *t* or the reduction in the newcomer's product specialization range $z_2 - z_1$ will lead to an increase in the country's tariff revenue.

Likewise, we can solve the tariff revenue accrue to the labor rich country from the definition equation that $R_1 = (w_1L_1 + r_1K_1 + R_1) \times \frac{t}{1+t} \times (z_2 - z_1)$ which implies $R_1 = \frac{t(z_2-z_1)}{1+t-t(z_2-z_1)} \times (w_1L_1 + r_1K_1)$. Similarly, the tariff revenue accrue to the capital rich country becomes $R_3 = \frac{t(z_2-z_1)}{1+t-t(z_2-z_1)} \times (w_3L_3 + r_3K_3)$.

Secondly, the equilibrium conditions for the outputs in each country (i.e., (6.1), (6.2) and (6.3)) would then be revised as:

$$y(z) = \frac{\alpha(z)[(w_1L_1+r_1K_1+R_1)+(w_2L_2+r_2K_2+R_2)/(1+t)+(w_3L_3+r_3K_3+R_3)]}{c(w_1,r_1,z)}$$

$$\text{for } z \in [0, z_1). \qquad \widetilde{(6.1)}$$

$$y(z) = \frac{\alpha(z)[(w_1L_1+r_1K_1+R_1)/(1+t)+(w_2L_2+r_2K_2+R_2)+(w_3L_3+r_3K_3+R_3)/(1+t)]}{c(w_2,r_2,z)},$$

$$\text{for } z \in (z_1, z_2). \qquad \widetilde{(6.2)}$$

$$y(z) = \frac{\alpha(z)[(w_1L_1+r_1K_1+R_1)+(w_2L_2+r_2K_2+R_2)/(1+t)+(w_3L_3+r_3K_3+R_3)]}{c(w_3,r_3,z)}$$

$$\text{for } z \in (z_2, 1]. \qquad \widetilde{(6.3)}$$

After substituting the above three equations into the equilibrium conditions for

the factor markets (7.1), (7.2) and (7.3), we obtain the same factor market equilibrium equations as before, i.e., (7.1)', (7.2)' and (7.3)' still hold even with the imposition of tariff here. Nevertheless, the trade balance conditions for the model with tariff would now be revised as

$$-\left[\frac{z_2-z_1}{1+t}+(1-z_2)\right](w_1L_1+r_1K_1+R_1)+\frac{z_1}{1+t}(w_2L_2+r_2K_2+R_2)+\ z_1(w_3L_3+$$

$$r_3K_3+R_3)=0 \qquad \widetilde{(8.1)}$$

$$(z_2-z_1)(w_1L_1+r_1K_1+R_1)+(z_2-z_1-1)(w_2L_2+r_2K_2+R_2)+(z_2-$$

$$z_1)(w_3L_3+r_3K_3+R_3)=0 \qquad \widetilde{(8.2)}$$

$$(1-z_2)(w_1L_1+r_1K_1+R_1)+\frac{1-z_2}{1+t}(w_2L_2+r_2K_2+R_2)\text{-}[z_1+\frac{z_2-z_1}{1+t}](w_3L_3+$$

$$r_3K_3+R_3)=0 \qquad \widetilde{(8.3)}$$

It is noted that equations $\widetilde{(8.1)}$ and $\widetilde{(8.3)}$ imply equation $\widetilde{(8.2)}$.

Moreover, the imposition of tariff would create a gap for the newcomer's import goods, i.e., for $z \in [0, z_1)$ and $z \in [z_2, 1]$, between the newcomer's domestic prices and the incumbents' export prices. Therefore, the threshold conditions would become

$$(1+t)r_1^{z_1}w_1^{1-z_1}=r_2^{z_1}w_2^{1-z_1} \qquad \widetilde{(9.1)}$$

And

$$r_2^{z_2}w_2^{1-z_2}=(1+t)r_3^{z_2}w_3^{1-z_2}. \qquad \widetilde{(9.2)}$$

As long as we redefining $GDP_1 \equiv w_1L_1+r_1K_1+R_1$, $GDP_2 \equiv w_2L_2+r_2K_2+R_2$, and $GDP_3 \equiv w_3L_3+r_3K_3+R_3$, lemma 2 above still holds with the imposition of tariff between the factor neutral country (i.e., the newcomer) and the incumbent countries. Lemma 1 remains valid except for the revision of factor prices for either the labor or the rich countries after the imposition of tariff. We now examine how the tariff affects the range of product specialization zone for the newcomer and incumbents of the MFTA.

After inserting the definition of tariff revenues of R_1, R_2 and R_3 into equation $\widetilde{(8.2)}$, we can rephrase $\widetilde{(8.2)}$ as follows:

$\mu(1+\mathrm{t}\mu)[(w_1L_1+r_1K_1)+(w_3L_3+r_3K_3)]=(1-\mu)(w_2L_2+r_2K_2)\times(1+t-t\mu)$,

where μ stands for z_2-z_1. The above equation can be rewritten as

$$\mathrm{t}=\frac{\frac{\mu[(w_1L_1+r_1K_1)+(w_3L_3+r_3K_3)]}{(1-\mu)(w_2L_2+r_2K_2)}-1}{(1-\mu)-\frac{\mu^2[(w_1L_1+r_1K_1)+(w_3L_3+r_3K_3)]}{(1-\mu)(w_2L_2+r_2K_2)}} \qquad (11)$$

A country's GDP amount is not necessarily in a direct proportion to the size of its specialization zone in the MFTA. For the sake of easy interpretation we define the ratio of the new country's share of product specialization area among the MFTA

countries with respect to its GDP share in the MFTA as δ. In other words, $\delta \equiv \frac{\mu[(w_1L_1+r_1K_1)+(w_3L_3+r_3K_3)]}{(1-\mu)(w_2L_2+r_2K_2)}$. The relation between tariff rate *t* and the size of product specialization zone for the newcomer (i.e., the equation (11) above) can be further simplified as

$$\mathrm{t} = \frac{\delta-1}{1-\mu-\delta\mu} \qquad (11)'$$

When $\delta > 1$, $\delta\mu$ must be less than $1-\mu$ to assure a nonnegative tariff rate *t*. Similarly, $\delta < 1$ implies $\delta\ \mu > 1-\mu$.

From the equation (11)' we can readily obtain the result that an increase in *t* leads to an increase in μ $(\frac{d\mu}{dt} > 0)$ when $\delta > 1$. However, when $\delta < 1$, an increased *t* results in a decrease in μ $(\frac{d\mu}{dt} < 0)$. Once the country is admitted into the MFTA, its tariff rate will reduce to zero. We hence derive the proposition below:

Proposition 1: *When a country's GDP commands a greater proportion among the MFTA member countries than its share of the range of product specialization zone (i.e.,*$\delta < 1$*), the admission of the country into the MFTA will broaden its product specialization zone while the incumbents of the MFTA will truncate their specialization zone. Otherwise (when* $\delta > 1$*), the admission of this country into the MFTA will narrow its specialization zone while the MFTA incumbents will benefit from the expansion of their specialization zone.*

According to lemma 2 which remains true even with the imposition of tariff, an enlarged specialization zone for the newcomer (i.e., in case of $\delta < 1$) will improve the country's GDP relative to those of labor rich and capital rich countries. On the other hand, when $\delta > 1$ the newcomer's specialization zone will shrink after entering the MFTA and cause a reduction of its GDP relative to the levels of the incumbent countries.

According to equations (10.1) and (10.2), the capital rich countries will enhance their capital rental-wage ratios (r_3/w_3) while the labor countries will beef up their wage-capital rental ratios (w_1/r_1) from the entry of this newcomer whenever $\delta < 1$. When $\delta > 1$, the capital rich countries will reduce their capital rental-wage ratios while the labor countries reduce their wage-capital rental ratios after the entry of this newcomer.

We summarize the result in the following proposition:

Proposition 2: *When a country's product specialization share is less than its share of GDP (i.e.,* $\delta < 1$*), the admission of this country into the MFTA will beef up the capital rental-wage ratio for the capital rich countries and the wage-capital rental ratio for the labor rich countries. As for the welfare impact for this newly admitted country, its GDP will improve relative to the incumbent countries after the entry into the MFTA. When a country has a relatively large share of product specialization than its GDP share, the admission of this country into the MFTA will dampen the capital rental-wage ratio for the capital rich countries and the wage-capital rental ratio for the labor rich countries, and undercut the GDP for the newly admitted country.*

The ratio of a country's specialization share with respect to its GDP share (i.e., δ) is virtually a measure of the country's openness in the global trade market. If a country is widely open toward the global environment, the competition driven by the international trade will force this country to be subjected to a high degree of specialization. In consequence, the product range in which this country obtains comparative advantage will be relatively narrow as compared with its economic size in the world. The proposition 2 provides a criterion to ascertain the gain from the MFTA. When a country is open enough so that its $\delta < 1$, the entry to the MFTA will bring in a favorable outcome in terms of widening product specialization zone, raising factor prices and enhancing employment opportunity. Moreover, the admission of this new country will drive the capital rich countries of the MFTA to be more specialized in their comparatively advantageous sectors, beefing up their capital rental relative to wage while the labor rich countries will become more specialized toward the labor intensive products and push up their wage relative to capital rental. However, when a country is highly isolated so that $\delta > 1$, the results above will be totally reverse.

We can also examine the impact of changes in tariff rate on the new entrant's welfare by the following expression: $\frac{\mathrm{dW}}{\mathrm{dt}} \equiv \frac{\mathrm{d}GDP_2}{\mathrm{dt}} = \mathrm{d}(w_2L_2 + r_2K_2 + R_2)/\mathrm{dt}$. As a matter of fact, the impact of *t* on $w_2L_2 + r_2K_2$ reflects the terms of trade effect while its impact on R_2 denotes the efficiency effect according to Grinols and Wong (1991) or Ju and Krishna (2000). By substituting $R_2 = \frac{(1-z_2+z_1)}{z_2-z_1+1/t} \times (w_2L_2 + r_2K_2) = \frac{t(1-\mu)}{1+t\mu} \times (w_2L_2 + r_2K_2)$ we can derive $\frac{\mathrm{dW}}{\mathrm{dt}} = \frac{d(w_2L_2+r_2K_2)}{dt} \times \frac{1+t}{1+t\mu} + (w_2L_2 + r_2K_2) \times \frac{d\left[\frac{1+t}{1+t\mu}\right]}{dt}$, where

$$\frac{d\left[\frac{1+t}{1+t\mu}\right]}{dt} = \frac{1+t\mu-(\mu+t\times\frac{d\mu}{dt})\times(1+t)}{(1+t\mu)^2} = \frac{1-\mu-\frac{d\mu}{dt}\times t(1+t)}{(1+t\mu)^2}.$$

The term of $\frac{d(w_2L_2+r_2K_2)}{dt}$ captures the impact from the terms of trade effect. When $\delta < 1$ According to proposition 2 the ultimate welfare impact for this new entrant hinges on whether $\delta > 1$ or not. When $\delta < 1$, the joining MFTA for the newcomer (its tariff rate is eliminated) will bring in an expansion of its specialization zone and an improvement in its GDP relative to incumbent countries. This implies that the favorable term of trade effect should sufficiently offset the unfavorable efficiency effect ($\frac{d\left[\frac{1+t}{1+t\mu}\right]}{dt} > 0$) in such a way that the overall welfare impact is positive. When $\delta > 1$, the shrinkage of the newcomer's specialization zone from its entry into the MFTA will cause a substantial worsening in its terms of trade effect so that the ultimate welfare will deteriorate.

V. Conclusions

This study builds up a multilateral free trade model with three member countries categorized by their relative abundance of endowments. We examine the product range of specialization for each country, especially the one that has a middle relative abundance. Moreover, we investigate whether it is welfare improving for this "factor-neutral country" in joining the free trade zone.

If the "factor neutral country" has not traded with the capital and labor-rich country (which form a bilateral free trade agreement), the admission into the multilateral free trade zone will enhance its GDP relative to the incumbent countries. The owners of the relatively abundant factor in incumbent countries benefit from the newcomer; wage versus capital rental ratio increases for the labor rich country and decreases for the capital rich one.

However, if the "factor neutral country" has traded with the capital and labor-rich country subject to some trade barriers such as tariff taxes, the admission into the multilateral free trade zone is not necessarily beneficial. We find that the entry to the MFTA will widen the newcomer's specialization zone and uplift its relative GDP only when it has been quite open toward the global market such that its product specialization share is less than its share of GDP. Otherwise the newcomer's specialization zone shrinks and the relative GDP decreases once it joins the free trade agreement. We argue that unless a country has been determined to pursue an open trade policy with a sufficient specialization in its employment of labor and the allocation of capital among domestic industries, the entry into the MFTA may bring in a great amount of job losses and capital misallocation in the short run due to the shrinkage of the range of comparative advantageous sector from the stiffer competition in the free trade environment. The empirical research based on the

implication of this paper merits further studies.

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