# Preferential Trade Agreements, The Metzler Paradox, and Trade Diversion: An Interpretation of the GATT Article XXIV

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## Abstract

Tari¤ Concessions in a Preferential Trade Agreement (PTA) are likely to divert trade from non-participating countries. Consequently, their welfare will deteriorate if the tari¤ rates of the incumbents remain the same. In a general equilibrium framework with multiple goods and multiple regions, this paper clari…es the determinants of the trade diversion. Similarity between the excess supply structures of countries is the key factor in determining the welfare e¤ect on non-participating countries as well as the key condition to precluding the Metzler paradox.

Under a certain similarity condition for the excess supply structures among countries, a PTA will erode the welfare of neighboring non-participating countries unless a participating country is a transit port for the commodity whose tari¤ is reduced. The required tari¤ rate reduction for the export of a non-participant will be determined by the relative size of the regions separated by the tari¤ wall. If a participant in a PTA is a transit port or "entrepôt", then the formation of a PTA will be bene…cial to neighboring countries.

## Key Words

Preferential Trade Agreements, Trade Diversion, the Metzler Paradox, Gross Substitutes, GATT Article XXIV

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## I. Introduction

Regional and preferential trade agreements have become the fashion in the world economy. Many pairs of countries that are not even within a regional neighborhood engage in bilateral preferential agreements. One concern is a procedural one that the world would turn into a spagetti bowl (Bhagwati, 1995) that de…es the future formation of multilateral agreement based upon the genuine principle of the Most Favored Nations (MFN). Another concern with preferential trade agreements (PTAs) is the fact that they may deteriorate the welfare of non-member nations of a PTA, that is, those who are left behind. This paper address the second concern from a general equilibrium viewpoint. We study the following question: Under what conditions and to what extent does a PTA a¤ect the welfare of the countries that do not participate in the agreement?

Article XXIV of the General Agreement on Tari¤s and Trade (GATT) provides an exception of the MFN principle for a series of tari¤ reduction among countries under a PTA. At the same time, it stipulates the conditions on which this exception is granted. A creation of PTA is allowed provided that "the duties and other regulations of commerce imposed at the institution of any such union or interim agreement in respect of trade with contracting parties not parties to such union or agreement shall not on the whole be higher or more restrictive than — prior to the formation of such union or the adoption of such interim agreement" (GATT Article XXIV, Section 5). The Uruguay Round, in its Understanding on the Interpretation of Article XXIV (1994), turned it into a more concrete criterion that the "overall assessment of weighted average tari¤ rates and of customs duties collected" facing the non-member countries should not be raised by the formation of PTA.

For evaluating the e¤ect of PTA, such as Free Trade Agreement (FTA) or Customs Union (CU) on the world economy, it is crucial to ask whether it is trade-diverting or trade-creating. However, as Bhagwati (1993, p.33) deplored concerning the extension of North American Free Trade Area (NAFTA) to Mexico, policy debates seldom

take into consideration explicitly the concept of trade-diverting or trade-creating. Econometric research has recently started to collect evidence that the non-member countries would su¤er from decreasing export price towards PTA member countries. Winters and Chang (2000) estimates that after the accession of Spain to European Communities in 1986, US export price to Spain declined, which reduced US welfare up to $80 million in the markets for …nished manufactures. Chang and Winters (2002) also estimates welfare loss brought to non-MERCOSUR countries by the decrease of export price towards Brazil. The results are loss of $644 million in USA, $236 million in Germany and $59 million in Japan in 1991.

Economic theory, however, is yet short of fully characterizing the determinants of trade creation and trade diversion. Under what conditions will the formation of a free trade area or a preferential trade agreement a¤ect negatively the welfare of the non-member countries outside the agreement? This paper is an attempt to …ll this intellectual gap. We will also argue, as a policy implication of the paper, that the non-member countries will likely lose under the plausible conditions if the rate of the exterior tari¤ imposed on the import from the non-member countries remains constant. The famous Kemp-Wan Theorem (Kemp and Wan, 1976) shows that a PTA will improve the welfare of all countries provided that all the trade ‡ows to the non-member countries are kept intact. Our analysis shows that trade ‡ows cannot remain the same if the tari¤ rates to the nonmember countries remain constant. Therefore, tari¤ reductions are necessary to non-member countries in order to keep the welfare of non-member countries from deteriorating. We present a criterion to determine the required concession in tari¤ rate towards the non-member countries.

Mundell (1964) analyzes the issue by super-imposing the e¤ect of each tari¤ reduction in a PTA utilizing the assumption that the goods traded are gross-substitutes. We follow his lead except that some of our results do not require the gross substitutes assumption. As long as the trade structures of countries are not too far apart, we can obtain clear characteristics of the e¤ects of tari¤ concessions in a general model

with multiple commodities and multiple regions.We shall show that the conditions for "trade diversion" (Viner,1950) is closely related to the conditions for the absence of the Metzler paradox. Also, the concept of gross-substitutability noticed by Metzler (1945) is a useful tool for analyzing relating problems. Under the gross-substitutes assumptions, if the industrial structures expressed by the gross-substitute matrix between trade partners are fairly similar, we can preclude the Metzler Paradox, that is, the phenomenon that the price of a commodity declines when a tari¤ is imposed on the commodity (Metzler, 1949a, 1949b). The similarity of trade structures in terms of the gross-substitution matrix implies that the income e¤ects are moderate.This seems to be one of the reasons that Chipman (1990) considered the Metzler paradox along with the transfer paradox, because the transfer issues are closely related to di¤erent income e¤ects across countries.

Under the assumption of similarity of trade structures among countries, it will be shown that a reduction of a tari¤ by a member of a PTA on a commodity imported from other members will hurt the well-being of the non-member countries that import the same commodity from member countries. Similarly, under the assumption on the similarity of trade structure, a reduction of a tari¤ by a member of the PTA on a commodity imported from other members will hurt the welfare of the countries that export the same commodity without tax privilege to the tari¤- reducing country. Namely, if a member country in a PTA is a "sink", an absorber of import with respect to a commodity, or if a member country in a PTA is a "source" with respect to a commodity, then the rest of the world will be hurt by the creation of a preferential treatment of the commodity by a PTA.

If the industrial structures are exactly similar, we can calculate the magnitude of the deterioration of terms of trade for those countries that import the commodity from the PTA. The magnitude of terms of trade loss is related to the relative size of the areas on the two sides of the original tari¤ wall. The tari¤ wall divides the world into the area connected to the exporter and the area connected to importers. The

tari¤ reduction makes the wall between those areas lower. The ratio of the economic sizes on the two sides decide the e¤ectiveness of the tari¤ reduction. If one side is smaller, then the e¤ect of the tari¤ reduction is larger. In any case, what matters is the relative size of the areas on both sides of the tari¤ wall and not the size of the PTA itself. That means that the trade diversion e¤ect to the rest of the world is quite strong, probably more than commonly conceived.

On the other hand, if a member country that is reducing the tari¤ is a transit port, or entrepôt, that is, if it exports to other members the same commodity it imports from the rest of the world, then the creation of a PTA is bene…cial to the rest of the world. This is presumably another example of the "good" PTA discussed by Frankel et. al. (1995).

Though this model is general in terms of numbers of regions and numbers of countries, this is still a highly abstract and static model. Therefore, we should be careful in drawing policy conclusions directly from this purely theoretical model. At least, however, this analysis shows that trade diversion e¤ects do take place against the non-member countries when a country who is not a transit trader reduces a tari¤ rate. Thus, as a potential policy proposal, we could recommend that the WTO impose a requirement to nations participating in a PTA to reduce its tari¤s against countries outside the PTA by the appropriate calculation suggested by our analysis unless the country is an entrepôt.

## II. Model

### II.1. The Setting of a PTA in the World Economy.

Consider the world economy with n + 1 goods, good 0 being the numéraire. Throughout the paper tari¤s are assumed to be levied in the form of speci…c duties on imports. Export subsidies are not under consideration. Let us draw attention to the two countries (or regions[1]), country B and country C; that engage in mutually preferential tari¤ treatment referred to as a PTA. Country B makes a concession to

[1] For below, countries can be interchanged to regions.

reduce the speci…c tari¤ $t_h^{CB}$ on commodity h, its import from country C, and country C makes a concession to reduce the speci…c tari¤ $t_k^{BC}$ on commodity k, import from country B. Country B is connected to country A by trade, and country C is connected to country D by trade.

If country C imports commodity k from country B and country D, country C is called "a sink with respect to commodity k," and if country B exports commodity k to countries A and C, country B is "a source with respect to commodity k." If country B imports commodity h from country A, country B will be called "a sink with respect to commodity h." If country C exports commodity h to country D, country C will be called "a source with respect to commodity h." On the other hand, if country B imports commodity f from country A and exports to country C, country B will be called "an entrepôt with respect to commodity f." Similarly, if country C imports commodity g from country D and exports to country B, country C is "an entrepôt with respect to commodity g." These model settings are shown in Figure 1.

Following Mundell (1964), we examine …rst the e¤ect of a reduction in the speci…c tari¤ $t_k^{BC}$ imposed by country C on the import good, say k, from B. Then, we can do a similar analysis of a reduction of the speci…c tax $t_h^{CB}$ by country B of an import good h from country C. By superimposing these e¤ects, we can analyze the mutual tari¤ concessions in a PTA consisting countries B and C.

Any countries are allowed to set levels of speci…c tari¤s on all the commodities except for the numéraire, commodity 0, but those tari¤ levels are assumed to be kept constant during our examination of the e¤ects of tari¤ concessions in the PTA. Countries A and B engage in trade with country D for any commodities except for those commodities for which the tari¤ concessions are made in the PTA consisiting of countries B and C. Similarly, countries C and D engage in trade with country A for any commodities except for those commodities for which the tari¤ concessions are made in the PTA. In other words, the commodity whose tari¤ is reduced should not originate as export from a country and reach another with more than two di¤erent

routes. Thus, we pose

Assumption I (Absence of the Con‡uence of Trade across the Regionsin the Commodities under Tari¤ Concession ): For the commodities that are subject to tari¤ reduction in the PTA, the region consiting of A and B ( let us call Region I) engages in trade with the region consisting C and D (let us call Region II) only through the trade channel between B and C. Similarly, for the commodities that are subject to tari¤ reduction in the PTA, the region consiting of C and D engages in trade with the region consisting A and B only through the trade channel between B and C. The commodities that are not the candidates for tari¤ reduction in the PTA can travel anywhere.

This assumption is made in order that the commodity in question, for example, commodity h should not be reimported to country A through country D. If we allowed the multiple routes of trade across region of the goods where tari¤ concessions are given, then such a con‡uence of trade ‡ows would make the analysis highly complex (cf. Lloyd (1982) for the way to avoid this problem for the case of three commodities).

For the criterion of the welfare change of non-member country, say country i, we rely mainly on the terms of trade e¤ects, $x^i dp$, where $x^i$ is the vector of excess supply in country i, while dp is the vector of terms-of-trade for country i[2]. We will illustrate our points graphically with a two-commodity (commodities h and k), three-country (countries A, B and C, in which countries B and C are potential partners of PTA, while country A is non-PTA) example. We abstract from other goods so that the welfare of a country would depend on the "single" terms of trade. We also consider the world economy consisting of three countries, A, B and C. Figure 2 (a) shows the

[2]Exactly speaking, in a tari¤-ridden economy, the welfare e¤ect of PTA consists of two parts, the terms of trade e¤ect and the trade expansion (contraction) e¤ect due to the presence of distortions (Ohyama, 1972). For analytical simplicity, we regard the distortion e¤ect as the e¤ect of secondary importance in our model. Since non-member countries keep their tari¤s constant and remain passive to the change of the terms of trade caused by the formation of PTA, the direction of their welfare is not substantially a¤ected by this e¤ect.

case where country B is "sink," (b) the case where country B is "source," while (c) the case of "entrepôt."

Let us illustrate the situation by a three-country (A, B, C) and two-good (k and h) example, momentarily suppressing country D. In the case of Figure 2 (a), country B imports commodity h from, and exports commodity k to, countries A and C. By Assumption I, countries A and C do not trade with each other. In an initial situation, country B imposes uniform tari¤s on its import both from countries A and C. O¤er curves of countries A, B and C are A, B and C respectively, and combined o¤er curve of countries B and C against country A is BC. Terms of trade before the formation of PTA is Op, and volume of trade for countries A, B and C are determined at point a, b and c, respectively. After the formation of PTA with countries B and C and the elimination of country B's tari¤ levied on import from country C, o¤er curve B moves to $B^0$. However, this preferential tari¤ elimination makes the terms of trade between A and B from those between B and C. In the normal case as indicated in Figure 2, namely, in the absence of Metzler Paradox, the terms of trade between countries B and C, $Op^{BC}$ ameliorate compared to pre-PTA terms of trade, Op, while terms of trade between countries A and B, $Op^{AB}$ deteriorate. The gap between $Op^{AB}$ and $Op^{BC}$ represents remained import tari¤ of country B against country A. This preferential tari¤ reduction makes combined o¤er curve BC shift inward to $B^0C^0$, and the volume of trade for countries A, B and C move to point $a^0$, $b^0$ and $c^0$, respectively. This expresses the decline of country A's welfare as well as the improvement of country C's welfare.

A similar situation happens when country B is a "source." In the case of Figure 2 (b), we consider the case of forming PTA with countries B and C and the elimination of country C's tari¤ levied on commodity k imported from country B. The notation and its meaning are similar to those in Figure 2 (a). After the formation of PTA, o¤er curve C moves to $C^0$, which deteriorates pre-PTA terms of trade Op to post-PTA terms of trade $Op^0$. This preferential tari¤ reduction makes combined o¤er curve BC

shift inward to $B'C'$, and the volume of trade for countries A, B and C move to point $a'$, $b'$ and $c'$, respectively. This expresses the decline of country A's welfare as well as the improvement of country B's welfare.

Lastly, let us consider the case that country B is "entrepôt" with Figure 2 (c). Country B imports commodity f from country A and re-exports to country C. On the other hand, for commodity g, country B imports it from country C and re-exports to country A. O¤er curves of country B against country A and of country C against country B are shown as B and C respectively, and also the o¤er curve of a region composed of countries B and C against country A is shown as BC. The formation of PTA between countries B and C will shift o¤er curve C outward to $C'$, and therefore shift o¤er curve BC outward to $B'C'$. Then, country A's terms of trade ameriolates from Op to $Op'$, and volume of trade between PTA and country A is determined at point $a'$, which indicates the increase of country A's welfare. In the case where country B is entrepôt, the formation of PTA is bene…cial to a non-member country.

### II.2. The Model

Suppose the world consists of four countries, A, B, C and D, and there are $n + 1$ commodities, $i = 0; 1; 2; :::; n$. The non-negative vector of domestic prices for country K is expressed as $p^K = (p_0^K; p_1^K; :::; p_n^K)'$ for $K = A; B$, and C, with $'$ being the symbol for transposition. Good 0 is the numeraire so that $p_0^K = 1$ for all K. Countries A and B form region I, while countries C and D form region II. Countries B and C conclude PTA, since trade between regions I and II only occurred between countries B and C.

Excess supply, export minus import,[3] of those countries and of the world for i'th commodity are de…ned as the functions of domestic prices,

$$x_i^K(p_0^K; p_1^K; :::; p_n^K); \qquad K = A; B; \text{ C and D}, \qquad x_i^W = x_i^A + x_i^B + x_i^C + x_i^D \qquad (1)$$

with price derivatives with the following familiar properties of gross substitutes for

[3] For mere convenience of exposition, I use excess supply instead of excess demand.

n goods except the numéraire. It is ture that $x_{ij}^K$ and $x_{ij}^W$ may be de…ned for all commodities from 0 to n, but $X^K$ and $X^W$ are de…ned for commodities 1 to n, since commodity 0 is numéraire and don't need considering explicitly in the model.

$$X^K = \left[\frac{@x_i^K}{@p_j}\right] = \left[x_{ij}^K\right] \qquad i; j = 1; :::; n \tag{2}$$

$$X^W = \left[\frac{@x_i^W}{@p_j}\right] = \left[x_{ij}^W\right] \qquad i; j = 1; :::; n$$

Here we introduce the concept of gross substitutability.

De…nition (Gross Sustitutability: GS): The goods are called gross substitutes if and only if

$$x_{ij}^K < 0; \quad x_{ij}^W < 0:$$

These conditions imply, as well known, that

$$x_{ii}^K > 0; \quad x_{ii}^W > 0:$$

Assumption II (Gross Substitute): All the goods are gross substitutes.

According to studies by Arrow-Hurwicz (1958), Hahn (1958), and Negishi (1958), matrices $X^K$ and $X^W$ are non-singular and their inverses are with all positive elements. We call this property "positively invertible." We depend upon this Gross Substitutability Assumption in Section V, and in other sections we proceed our discussions on a weaker condition as follows. Needless to say, Assumption II implies Assumption III.

Assumption III (Invertibility of $X^W$): $X^W$ is non-singular.

For simplicity, we assume either that the transportation costs are negligible, and consider the world where the speci…c duties are used as tari¤s. One can easily see that this analysis is extendable to the world where transportation costs are constant, where subsidies exist, or where the tari¤s take the ad valorem tari¤s. The tari¤

vector of country L levied on its imported commodity from country K is de…ned as $t^{KL} = (0; t_1^{KL}; t_2^{KL}; :::; t_n^{KL})'$. In the pre-union situation, each country levies the same value of tari¤ on the same commidity imported from etither country. International price vector of country L in pre-union situation is $p^L = (p_0^L; p_1^L; :::; p_n^L)'$. In the post-union situation, a country reduces its import tari¤ only for the union-partner country.

In order to keep the world market in equilibrium, one takes the e¤ect of price changes to excess demand as

$$X^A dp^A + X^B dp^B + X^C dp^C + X^D dp^D = 0 \tag{3}$$

Or, considering region I and region II, with noticing that $dp^I$ is common between countries A and B, and $dp^{II}$ is common between countries C and D[4], then

$$X^I dp^I + X^{II} dp^{II} = 0 \tag{4}$$

## III. The Case with Identical Substitute Structure

Before the formation of a PTA, countries may have di¤erent speci…c tari¤s and accordingly di¤erent domestic price levels. After the formation of a PTA, country B and country C exchange tari¤ concessions. We examine the e¤ects of tari¤ reductions by super-imposing the e¤ects of a tari¤ reduction of a country to those of a tari¤ reduction of the other, as initiated by Mundell (1964).

Consider the commodity k being exported from country B to country C, and suppose only the tari¤ on good k from country B to country C is changed. An element k of $t^{BC}$ is changed. Let $dt^{BC}$ indicate the change in speci…c tari¤s on goods imported from counrty B to country C. Speci…cally, we concentrate on the kth commodity on which the tari¤ rate is reduced. $dt^{BC} = \left(0; ¢¢¢; 0; dt_k^{BC}; 0; ¢¢¢; 0\right)'$. In the two regions we are considering, by the introduction of tari¤ concession, a wedge is introduced between the change of good k between region I and region II.

[4] The price level itself may be di¤erent between countries in a region. However, the change of prices is identical in both countries in the same region.

$dp_k^C = dp_k^B + dt_k^{BC}$ always holds, then noting $dp^A = dp^B = dp^I$ and $dp^C = dp^D = dp^{II}$, equation (4) implies

$$X^W dp^{II} = X^I dt^{BC} \tag{5}$$

or,

$$X^W dp^I = - X^{II} dt^{BC} \tag{6}$$

If $X^I$ and $X^{II}$ are propotionate, the comparative statics of the model are very simple. Assume $X^A = \alpha X^W$, $X^B = \beta X^W$, $X^C = \gamma X^W$, $X^D = \delta X^W$, $\sigma^I = \alpha + \beta$, $\sigma^{II} = \gamma + \delta$, $\sigma^I + \sigma^{II} = 1$. Then, equations (5) and (6) equal to, respectively,

$$dp^{II} = (\alpha + \beta) dt^{BC} = \sigma^I dt^{BC} \tag{7}$$

$$dp^I = - (\gamma + \delta) dt^{BC} = - \sigma^{II} dt^{BC} \tag{8}$$

This means $\frac{dp_k^{II}}{dt_k^{BC}} = \alpha + \beta = \sigma^I$, and $\frac{dp_i^{II}}{dt_k^{BC}} = 0$ for $i \neq k$. When $\sigma^I$ is close to 1, that is, the region I is large, region I plays as a large country while region II being small, and the decrease of import tariff on commodity k decreases its domestic price in region II by almost the same amount. The same story goes for the case of $\frac{dp_k^I}{dt_k^{BC}} = - (\gamma + \delta) = - \sigma^{II}$, and $\frac{dp_i^I}{dt_k^{BC}} = 0$ for $i \neq k$. This characteristic of the results for the case of the identical excess supply among countries is curious, since the change of tariff on commodity k does not affect the price of other commodities. Moreover, what is needed is not the exact similarity of the exccess supply structure of each country, but the exact similarity of the excess supply structure between the two regions. It is also worth noting what matters is not the relative scale of the FTA in the world, but the relative scale of the region including the tariff-conceeding country and its hinterland. The wedge between the price changes is between region I and region II, and the relative economic size (in terms of the demand structure expressed by X

matrix) is on the two sides across the wedge. This will have a signi…cant implication for the interpretation of the GATT Article XXIV.

Proposition I: Suppose the excess supply structure of each region is identical. Then, under Assumption I (non-con‡uence with respect to commodity k) and Assumption III (invertibility of world trade structure matrix), one unit of tari¤ reduction for a commodity by a member of a FTA located in region II will decrease the price of the commodity in region II by the relative weight region I, $\gamma_I$, and increase its price in region I by the relative weight of region II, $\gamma_{II}$.

The welfare consequences of Proposition 1 is clear. If country C reduces tari¤ for commodity k from country B, then $p_k^A = p_k^B = p_k^I$ will rise and $p_k^C = p_k^D = p_k^{II}$ will fall. Accordingly, if country B is a source with respect to commodity k, country A will certainly lose by increasing the price of its importing commodity k from country B. If country C is a sink with respect to commodity k, then country D will lose by decreasing the price of its exporting commodity k to country C. These cases show that the formation of FTA will degrade non-member countries' welfare if member countries are sink and/or source of commodities in which non-member countries trade with them. If country B is a transit or a entrepôt of commodity k, however, country A will gain by increasing the price of its exporting commodity k to country C via country B.

## IV. The E¤ects on the Country outside the PTA in an Assymmetry Case

Next, we will extend our analysis to the case where trade structure X is not similar, with employing an approximation. Consider the e¤ect of forming a PTA on terms of trade for outside country A without the assumption of proportionate substitution matrix employed in section III. From equation (7), it can be written as

$$\begin{aligned} dp^I &= i(X^W)^{i1} X^{II} dt^{BC} \\ &= i(X^W)^{i1} \left[ \gamma_{II} X^W + \left( X^{II} i \gamma_{II} X^W \right) \right] dt^{BC}; \end{aligned} \tag{9}$$

where $\gamma_{II} = \text{augmin}_\gamma \left\| X^{II} i \gamma X^W \right\|$. The norm of square matrix $A_{ij} = (a_{ij})$ of order

$n \pounds n$, and the norm of a vector p with n-element are de…ned in this paper as (See, Bellman, 1960, p. 165)

$$\begin{aligned} kAk &= n \cdot \max_{i;j} (ja_{ij}j); \\ kpk &= \max_{j} (jp_j j): \end{aligned}$$

This de…nition of the norm is easily shown to satisfy regular triangle inequalities attached to the norm[5]. Then, equation (9) is rewritten as

$$dp^I + \gamma^{II} dt^{BC} = -(X^W)^{-1}(X^{II} - \gamma^{II} X^W) dt^{BC}: \tag{10}$$

Considering the norm of equation (10),

$$\left\| dp^I + \gamma^{II} dt^{BC} \right\| \leq \left\| (X^W)^{-1} \right\| \left\| (X^{II} - \gamma^{II} X^W) \right\| \left\| dt^{BC} \right\|. \tag{11}$$

Here we introduce Similarity Condition I.

Similarity Condition I: $\left\| (X^{II} - \gamma^{II} X^W) \right\| \leq \varepsilon = \left\| (X^W)^{-1} \right\| \leq \varepsilon = n(\max x^{\alpha}_{ij})$, where $x^{\alpha}_{ij}$ is the $(i;j)$ element of $(X^W)^{-1}$ for a positive value of $\varepsilon$.

Then, if Similarity Condition I is satis…ed, equation (11) equals to

$$\left\| dp^I + \gamma^{II} dt^{BC} \right\| \leq \varepsilon \left\| dt^{BC} \right\|.$$

When only $t^{BC}_k$ is changed, namely

$$dt^{BC} = \left(0; \cdots; 0; dt^{BC}_k; 0; \cdots; 0\right)';$$

then, $\eta^I_{ik} = \frac{dp^I_i}{dt^{BC}_k}$ is expressed as follows.

$$\begin{aligned} \eta^I_{kk} &= \frac{dp^I_k}{dt^{BC}_k} = -\gamma^{II} + 1 \\ \eta^I_{ik} &= \frac{dp^I_i}{dt^{BC}_k} = 1 \qquad \text{for } i \neq k; \end{aligned}$$

[5] In particular, $kA + Bk \cdot kAk + kBk$ and $kABk \cdot kAkkBk$.

where $\gamma^{II}$ is a positive value not exceeding unity and defined by $\gamma^{II} = \text{augmin}_{\gamma} \left\| X^{II} - \gamma X^{W} \right\|$, and $\tau$ can take either sign, but limited by $|\tau| < \varepsilon$. The range of $\eta^{I}_{kk}$ is $(-\gamma^{II} - \varepsilon; -\gamma^{II} + \varepsilon)$, and the range of $\eta^{I}_{ik}$ is $(-\varepsilon; \varepsilon)$ (see Figure 3). Similary, for region II,

$$\eta^{II}_{kk} = \frac{dp^{II}_{k}}{dt^{BC}_{k}} = \gamma^{I} + \tau$$

$$\eta^{II}_{ik} = \frac{dp^{II}_{i}}{dt^{BC}_{k}} = \tau \qquad \text{for } i \neq k;$$

where $\gamma^{I} + \gamma^{II} = 1$. As long as $\tau$ is constrained by $\varepsilon$, that is smaller than $\gamma^{I}$, then $\frac{dp^{II}_{k}}{dt^{BC}_{k}} > 0$. This is exactly the condition that excludes the Metzler Paradox. The range of $\eta^{II}_{kk}$ is $(\gamma^{I} - \varepsilon; \gamma^{I} + \varepsilon)$, and the range of $\eta^{II}_{ik}$ is $(-\varepsilon; \varepsilon)$.

Proposition II: Under assumptions I, III and Similarity Condition I with $\varepsilon$ smaller than $\gamma^{II}$, the Metzler Paradox does not occur.

The results above indicate the importance of the similarity of excess supply patterns in assessing the loss or benefit of non-members. Also, the importance of the relative size of regions as well as the importance of the network pattern of trade, that is, the question if a country is a sink, source, or an entrepôt. If the trade structure is similar enough to give a small $\varepsilon$, one can neglect the effect of tariff reduction to a commodity on the price of other commodities. Except when a country is an entrepôt, tariff reductions in a PTA will exert negative effects on neighboring non-member countries. The required tariff reduction to the non-member countries is calculated by the relative size of the two regions divided by the tariff wall that is being reduced.

## V. Gross Substitutability and the Absence of the Metzler Paradox

In this section, we will introduce an alternative condition under the gross substitutability that would guarantee the absence of the Metzler Paradox. The Metzler Paradox is a surprising situation such that a tariff reduction by a country raises the domestic price of import. We consider a two-region version of equation (4).

In this section, the proof that Gross Substitutability (GS hereafter) and Similarity Condition II (explained as follows) implies the absence of the Metzler Paradox goes

intuitively as follows. GS implies that the absolute value of o¤-diagonal column-sum of price derivatives of excess supply matrix $X^W = X^I + X^{II}$ is less than the value of diagonal element of that column. This can be derived along the reasoning by Hahn (1958)[6] from the Warlas law $p^0 X^W > 0$ for international price p. By the well-known theorem of Debreu and Herstein, the inverse matrix of matrix $X^W$ is positive, and the world market satis…es a stability condition. We introduce the following.

Assumption IV: (Similarity Condition II of gross substitutes between regions I and II) Both $p^0 X^I > 0$ and $p^0 X^{II} > 0$.

Why do we name it a "similarity" condition? For the world as a whole, the Warlas law ensures

$$\bar{p}^0 \bar{x}^W = 0;$$

if we write the international n+1 dimensional price vector as $\bar{p}$ including the numéraire, and the augmented demand of n + 1 dimension as $\bar{x}^W$. This implies, as Hahn (1958) showed in terms of the n £ n substitution matrix $(X_{ij})$, $i; j = 1; :::; n$,

$$p^0 X^W > 0:$$

Taking advantage of the fact that in equilibrium the excess supply equals zero, i.e.,

$$\bar{x}^W = 0:$$

What we are evaluating is the excess supply of a region (or a country) by international price vector. If a region is similar in terms of excess supply responses, then probably Assumption IV will hold. One may call Assumption IV the "extended Hahn condition."[7]

[6] Rigrously, the reasoning is due to Takayama's (1974) interpretation of Hahn's method.

[7] >From other angles, this condition holds if income e¤ects are not strong and if $p^I$ or $p^{II}$ is not far from p. For by zero'th homogeneity of $x_i(p_0; p_1; :::; p_n)$ (Negishi, 1958),

Proposition III: Gross Substitutability and Similality Condition II implie the absence of the Metzler Paradox

Step I:

$x_i^W$ in Warlas law $\sum_{i=0}^{n} p_i x_i^W = 0$ is homogenious. Then, by Euler's equation, $\sum_{i=0}^{n} x_{ji}^W p_i = 0; \quad j = 0; \cdots; n$. Good 0 is numeraire and $p_0 = 1$, then $\sum_{i=1}^{n} x_{ji}^W p_i = i\, x_{j0}^W > 0$, or

$$x_{jj}^W p_j = \sum_{j \neq i} \bar{x}_{ji}^W \bar{p}_i, \qquad \text{for } i; j = 1; \cdots; n \tag{12}$$

Define $Y^W = PX^W$ and $Y^K = PX^K$, where $P$ is a diagonal matrix whose diagonal elements correspond to the element of international price vector $p$. Then, equation (12) is rewritten as

$$y_{jj}^W = \sum_{j \neq i} \bar{y}_{ji}^W, \qquad \text{for } i; j = 1; \cdots; n \tag{13}$$

It is also assumed that regions I's and II's gross-substitute matrix for excess supply $X^I$ and $X^{II}$ has the same price-weighted column-sum conditions.

$$y_{ii}^I = \sum_{j \neq i} \bar{y}_{ji}^I, \qquad y_{ii}^{II} = \sum_{j \neq i} \bar{y}_{ji}^{II}, \qquad \text{for } i; j = 1; \cdots; n \tag{14}$$

We will argue below that the diagonal elements of $\{X^I + X^{II}\}^{-1} X^{II}$ are all positive from the lemma below.

Step II: Lemma

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$$X^I p^I > 0.$$

If $p^I$ is near $p$ and $X^I$ is close to a symmetric matrix, then it is more likely that

$$p^0 X^I > 0$$

holds as well.

If $Y^W = \left[ y_{ij}^W \right]$ is a matrix $y_{ii}^W > 0$, $y_{ij}^W < 0$ $(i \neq j)$, $y_{ii}^W > \sum_{i \neq j} \left| y_{ij}^W \right|$ (or $\sum_{i=1}^{n} y_{ij}^W > 0$), for all i, then $Y^W$ is non-negatively invertible, i.e. $(Y^W)^{-1} = Y^{W*} = \left[ y_{ij}^{W*} \right] > 0$, where the asterisk indicates the elements of the inverse matrix. And each non-diagonal element of any low is smaller than its diagonal element, that is, $y_{ii}^{W*} > y_{ij}^{W*}$ for $i \neq j$.

The first condition on the column sum is generally known as the collumn-sum condition as a special case of the dominant diagonal. The second condition that the diagonal of the matrix is larger than each off-diagonal matirix is less well known. We may call it the condition of superior diagonal.

Proof of the Lemma

We prove this lemma by partitioned multiplication of the matrix. Since the gross substitutability ensures the existence of a positive inverse $Y_{n-1}^{W*}$ of $Y_{n-1}^W$

$$Y^{W*} = \begin{bmatrix} & & y_{1n}^{W*} \\ Y_{n-1}^{W*} & & \vdots \\ & & y_{n-1;n}^{W*} \\ y_{n1}^{W*} \quad \cdots & y_{n;n-1}^{W*} & y_{nn}^{W*} \end{bmatrix} = \begin{bmatrix} & & \\ Y_{n-1}^{W*} & & y_n^{W*+} \\ & & \\ y_n^{W*} & & y_{nn}^{W*} \end{bmatrix} \tag{15}$$

where $y_n^{W*} = \left( y_{n1}^{W*}, \cdots, y_{n;n-1}^{W*} \right)$ and $y_n^{W*+} = \left( y_{1n}^{W*}, \cdots, y_{n-1;n}^{W*} \right)'$. Then, $Y^{W*} Y^W = I$, or,

$$\begin{bmatrix} & & & & \\ Y_{n-1}^{W*} & & y_n^{W*+} & Y_{n-1}^W & y_n^{W+} \\ & & & & \\ y_n^{W*} & & y_{nn}^{W*} & y_n^W & y_{nn}^W \end{bmatrix} = \begin{bmatrix} & & \\ I & & 0 \\ & & \\ 0 & & 1 \end{bmatrix} \tag{16}$$

where $Y_{n-1}^W$ is partitioned matrix. $y_n^{W*} = -y_{nn}^{W*} y_n^W \left( Y_{n-1}^W \right)^{-1}$:

$$-y_n^W \left( Y_{n-1}^W \right)^{-1} = -\left( y_{n1}^W, y_{n2}^W, \cdots, y_{n;n-1}^W \right) \begin{bmatrix} y_{11}^W & y_{12}^W & \cdots & y_{1;n-1}^W \\ y_{21}^W & y_{22}^W & \cdots & y_{2;n-1}^W \\ \vdots & \vdots & \ddots & \vdots \\ y_{n-1;1}^W & y_{n-1;2}^W & \cdots & y_{n-1;n-1}^W \end{bmatrix}^{-1}$$

$$< \left( \sum_{k=1}^{n-1} y_{k1}^W, \sum_{k=1}^{n-1} y_{k2}^W, \cdots, \sum_{k=1}^{n-1} y_{k,n-1}^W \right) \begin{bmatrix} y_{11}^W & y_{12}^W & \cdots & y_{1,n-1}^W \\ y_{21}^W & y_{22}^W & \cdots & y_{2,n-1}^W \\ \vdots & \vdots & \ddots & \vdots \\ y_{n-1,1}^W & y_{n-1,2}^W & \cdots & y_{n-1,n-1}^W \end{bmatrix} = (1, 1, \cdots, 1) \tag{17}$$

Therefore, $y_{nn}^W > y_{nj}^W$ for $n \neq j$. (Q.D.E.)

Step III:

We would like to show that the diagonal element of the matrix

$$\left[ X^I + X^{II} \right] (X^W)^{-1} X^I = (X^W)^{-1} X^I \tag{18}$$

is positive. Because of the Lemma, $(Y^W)^{-1}$ has a superior diagonal such that $y_{ii}^W > y_{ij}^W$ for $i \neq j$. Then we show that the increase in tariff rate in country A produces the increase in domestic price in country A. Let $dt^{BC} = [0, \cdots, 0, dt_k^{BC}, 0, \cdots, 0]'$, $dp^{II} = (X^W)^{-1} X^I \cdot dt^{BC} = (Y^W)^{-1} Y^I \cdot dt^{BC}$.

$$(Y^W)^{-1} = Y^W = \left[ y_{ij}^W \right] \tag{19}$$

$$Y^I = \left[ y_{ij}^I \right] \tag{20}$$

$$k\text{'th column of } (Y^W)^{-1} Y^I = \begin{bmatrix} y_{k1}^W & y_{k2}^W & \cdots & y_{kn}^W \end{bmatrix} \begin{bmatrix} y_{1k}^I \\ y_{2k}^I \\ \vdots \\ y_{nk}^I \end{bmatrix} = y_{kk}^W y_{kk}^I + \sum_{i=1; i \neq k} y_{ki}^W y_{ik}^I =$$

$$y_{kk}^W y_{kk}^I + y_{kk}^W \sum_{i=1; i \neq k} y_{ik}^I > 0$$

This implies $\frac{dp_k^{II}}{dt_k^{BC}} > 0$, that is, the Metzler Paradox does not occur. The next proposition will naturally follow.

Proposition IV: As long as the effect through the price of the goods on which tariff is reduced, absence of the Metzler paradox implies that the effect of a formation of

a PTA will deteriorate for a non-member trading partner that competes with incumbents. The conclusion will be reversed for the case of "entrepôt."

## VI. Simple Illustrations of Actual PTAs

Now we present some actual data related to the theoretical analyses developed above. Since gross substitutability of each country is difficult to estimate, we present each country's values of trade as indicators of demand-supply structures. Table 1 shows the values of export for ten largest export countries/area as in 1998. Table 1 shows between which countries PTAs are concluded.

First, we see the recent virtual agreement for the Japan-Mexico PTA (March, 2004) as an example where Japan reacts as a non-member against the North American Free Trade Agreement (NAFTA). After the formation of NAFTA (which came into force in April, 1994) and the enlargement of EU member countries (January 1995), Japanese industrial circles started to advocate PTAs explicitly, which Japan had not yet concluded at that time, and started to urge the Japanese government to conclude them, especially with some Asia-Pacific countries. After Mexico concluded the PTA with the European Union (July 2000), Japanese industrial circles worried that their business situations in Mexico would be deteriorated compared to those in other countries, and concentrated their political influences in favor of a PTA with Mexico. That may be the main reason why the Japanese government has placed high priority on the PTA negotiation with Mexico. Mexico will become the second partner of the PTA, following Singapore.

Japan's conclusion of the PTA with Mexico can be explained well from our theoretical model. By the formation of NAFTA, Japan has suffered from the deterioration of its terms of trade against Canada, USA and Mexico. We can see from Table 1 that Mexico's presence in the world market is not the outstanding one. However, Mexico's additional conclusion of a PTA with EU, the second largest world trade market, would make Japan's terms of trade with Mexico deteriorate much more than the

terms of trade with Canada and USA[8]. It is not the scale of the country of a partner in a PTA, but the scale of the market with "hinterland" that a PTA brings through the partner. Japan has faced one major obstacle to conclude PTA with Mexico: Agriculture, of which Japan is less reluctant to liberalize trade, but Japan-Mexico trade contains a high volume of agriculture. However, the resistance to liberalizing agricultural trade was overwhelmed by the Japanese industry circles' fret of worsening business environment vis-à-vis North American and European countries in the Mexican market[9].

Second, we take into consideration the PTAs of Singapore and Hong Kong as the cases of entrepôt. After 2001, Singapore concluded four FTA with New Zealand (January, 2001), Japan (November, 2002), European Free Trade Association (January, 2003) and Australia (July, 2003). In light of our theoretical model, a formation of a PTA with entrepôt by other countries is bene…cial for non-member countries, Singapore's new and positive attitude toward forming PTAs is to be welcome for the world economy. The same holds for Hong Kong, an entrepôt toward China. Hong Kong and China concluded Closer Economic Partnership Arrangement (January, 2004), which implies the widening of commerce between China and the rest of the world. This will be bene…cial to the world economy as well.

## VII. Conclusion

We have shown that the creation of a preferential trade area by a combination of concessions on tari¤s will exert a substantial impact on those countries outside the area. If a commodity on which a tari¤ concession is made is competitively supplied by an non-member country to the tari¤-reducing country, then the welfare of the non-member country will deteriorate. Similarly, an outside country will lose if it imports from a member country a commodity for which tari¤ is reduced by a member country.

[8] Besides with NAFTA and EU, Mexico conclude FTA under GATT article XXIV with Chile, Israel and European Free Trade Association, and also conclude PTA under the Enabling Clause with about 50 developping countries.

[9] Of course, Japan puts some agricultural products on the list of exceptions for trade liberalization.

The only exception is the case of an entrepôt.

The degree of the loss depends on the relative size of the areas between which prices change di¤erently after the tari¤ concession. For example, if only a small non-member country (consider country A in our analysis) is exporting to the NAFTA a commodity that is under the tari¤ concession within the NAFTA, and if the part of the NAFTA that is importing the commodity is relatively small, then the loss to the small non-member country can be large. If one can regard Singapore as an entrepôt, a PTA between Singapore and Japan, for example, may bene…t the supplier of a good that is exported to Singapore.

Therefore, we suggest to the reader as a proposal a more strict interpretation of the GATT Article XXIV in such a way that PTA members be obligated to reduce their outside duties by a certain percentage of the internal mutual reduction of tari¤s. The percentage can be calculated by the ratio between the two regions described in our model.

More than a half century has passed since Metzler discovered his paradox as well as the nature of the gross substitutes, and since Viner paid attention to the trade diversion e¤ect of a custom union. Gross substitutes played an important role in the general equilibrium analysis by Arrow-Hurwicz, Hahn and Negishi. In this paper we presented another way of integrating these analytical concepts to understand the e¤ects of tari¤ reductions in a PTA under fairly general conditions in a model of a world economy with many regions and many goods.

The legacy of Metzler and Viner, and the insight from the new development in the general equilibrium analysis in the 1950s are still well alive. Their merit is not restricted just to theoretical curiosity. The practically important issues of the interpretation of the GATT Article XXIV are crucially dependent on the nature of substitution matrix of excess supply behavior.

Investment and other dynamic issues are abstracted, since our intention is to present a frame of reference under the simplest setting for the e¤ect of tari¤ con-

cessions within a PTA to non–member countries[10]. Some may wonder why we are bothered by complicated algebra when simulation results are now readily available. Our answer is that this type of theoretical analysis will serve as guideposts for interpreting various calibration results which can only give case-by-case answers to the problem.

[10] For alternative formulation with explicit production function under constant and increasing returns to scale, see, for example, Srinivasan (1997) and Goto and Hamada (1998, 1999).

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Figure 1: