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Nash Equilibrium Tariffs and Illegal Immigration: An Analysis of Preferential Trade Liberalization

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Abstract

We use a version of the small-union Meade model to consider the effects of interdependent import tariffs in the presence illegal immigration. First, we analyze the condition under which illegal immigration is likely to increase (or decrease) in response to reciprocal trade liberalization between the source and host nations (of illegal immigration). Next we describe the Nash equilibrium in tariffs between these nations and discus how a liberalization of tariffs starting from this Nash equilibrium is likely to affect their utility. Finally, we consider the effect of the host nation's liberalization of the import tariff (imposed on its imports from a third nation). We show that strategic considerations regarding the effect of this tariff liberalization on the Nash equilibrium tariffs can modify the traditional (trade creating/diverting) gains from such liberalization.

JEL Classification: F11, F22
Keywords: Preferential Trade Agreement, illegal immigration, second-best tariff

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1. Introduction

Regional trading agreements have become very popular in recent times. Some well known trading blocs are NAFTA, EU, SAARC, and MERCOSUR. However, there are several others which are less prominent. While these agreements strive to eliminate trade barriers within blocs, they typically do not achieve complete free trade (see Baldwin and Venables, 1995). Each member tries to pursue their own interests such as the amount of tariff reduction that they are willing to concede in return for better access to their partners' markets. Also, the issues on the negotiation table are not limited to trade policy alone, but cover a variety of related problems. Illegal immigration is one of the important related issues, especially for PTAs that involve bordering nations.

Illegal immigration has been a serious problem in NAFTA, especially along the US-Mexico border. Recent estimates (see Orrenius 2001) suggest that there are about 3 million undocumented Mexican immigrants in the US in 1997. About 202,000 Mexicans immigrated per year between 1987 and 1996. Tariffs change domestic prices, and cause adjustment between different sectors and indirectly affect the labor market. The resulting change in labor market conditions influence immigration flows. On the other hand, immigration flows due to changes in the source nation or due to policy, directly affect the labor market. Clearly, these two issues, tariff and immigration, are interrelated. Thus trade negotiations have to and do consider these issues simultaneously.[1]

The literature on regional trade agreements has explored a variety of issues (see for example, Ethier and Horn, 1984, Baldwin and Venables, 1995, Bhagwati, Krishna,

[1] NAFTA negotiations/documents discuss both tariff liberalization and ways to control illegal labor flows. Former Attorney General Reno called the Free Trade Agreement with Mexico "..our best hope for reducing illegal immigration over the long haul." http://www.clintonfoundation.org/legacy/101293-fact-sheet-on-nafta-notes.htm

and Panagariya, 1999). Ethier and Horn (1984) have shown that (i) marginal reduction of tariff improves joint welfare of a trade bloc starting from non-discriminatory tariff, and (ii) marginal increase in internal tariff improves joint welfare of trade bloc starting from free intra-trade bloc in a tariff-ridden world. These imply the presence of a positive internal tariff. Panagariya (1999) derives the second best tariff within the context of the Meade Model. In addition to the analysis of marginal changes in tariffs, the literature has explored welfare implications of complete tariff elimination. Panagariya and Krishna (2002) consider circumstances under which an FTA must improve the joint welfare of the bloc.

While the existing literature has deepened our understanding of the nature of second best trade taxes and of welfare implications of regional integration, it has not adequately addressed the issue of illegal immigration. The agenda of this paper is to contribute towards improving our understanding of this issue by complementing the existing literature in four ways. First, we consider how mutual tariff reductions by potential bloc members (who are respectively the host and source nations for illegal immigration) alter the level of illegal immigration. Second, we describe the pre-existing non-cooperative tariff equilibrium for potential bloc members. Third, we analyze the welfare effect of intra-bloc tariff liberalization starting from the Nash equilibrium. Finally, we explore the effect on the host nation (of illegal immigration) of a liberalization of its trade with respect to a third nation (outside of the potential bloc).

The rest of the paper is organized in the following way. Section 2 presents the model and analysis. Section 3 concludes.

2. The Small Union Case

We use the small-union Meade model used in Panagariya (1999) and Bandyopadhyay (2006). There are three nations, *A*, *B*, and *C*. *A* and *B* form a Preferential Trade Agreement (PTA). There are three goods; good-1, 2, and 3. *A* and *B* both produce goods 1 and 2. *A* exports good-1 and imports goods 2 and 3. *B* exports good-2 and imports goods 1 and 3. *C* produces and exports good-3 while it imports goods 1 and 2. We assume *A* and *B* impose import tariffs while *C* pursues free trade. Trade liberalization within the bloc takes place as *A* reduces (or eliminates) import tariff on good-2 and *B* does the same for its import tariff on good-1. These tariffs may be denoted as internal tariffs (internal to the bloc) while the tariffs by *A* and *B* on good-3 are their respective external tariffs. We abstract from strategic interactions in trade policy between the Bloc and the rest of the world, and focus on intra-bloc strategic tariffs, tariff liberalization and how it affects the illegal immigration problem.[2]

Nation *A* is the host country for illegal immigration, while *B* is the source country. Illegal immigrants send earnings back to *B*, thus *A* does not retain immigrant's factor rewards (for example, Orrenius (2001) states that: "The out-migration of Mexican citizens brings in $4 billion to $7 billion in remittances each year."). Since prices (without tariffs) are given exogenously to the small countries within the bloc, we

[2] Bandyopadhyay (2006) does address tariffs and illegal immigration. However, unlike this paper he ignores the interdependence in trade policy between the bloc members. The role of the latter and how it affects illegal immigration and national welfare is the central focus of this paper. We should note that interdependence in trade policy is discussed (between a trading bloc and the rest of the world) in Bond, Syropoulos, and Winters (2001) and Bond, Riezman, and Syropoulos (2004). Bond, Syropoulos, and Winters (2001) among others shed light on the mutual negotiation process. They examine how formation of customs union with a certain country affects its trade agreements with other countries (multilateral agreements). Their paper derives external tariff response functions of the customs union and the rest of world, and thus provides the conditions under which both a customs union and multilateral trade agreements are sustainable. Our paper differs from the Bond et al. papers in two respects. First, we focus on interdependence in tariffs (pre-union) between bloc members. Secondly, illegal immigration is a major issue in this paper.

normalize them to be unity.[3] Illegal immigrants earn the wage W_I and the level of illegal immigration itself is *I*. Their total earning is $W_I I$, which is repatriated to *B*. This amount must be subtracted from *A*'s revenue and added to *B*'s revenue. The legal wage rates of *A* and *B* are denoted as W^A and W^B, respectively. W^A is assumed to exceed W^B (this may be due to technology differences, tariffs or other reasons) and this creates incentives for immigrants to illegally cross the border. *A* uses internal enforcement and border enforcement to control illegal immigration. The enforcement costs are e_i (internal) and e_b (border), respectively. The tariff on good i by nation j is t_i^j where i = good 1,2, and 3, and j = nations *A* and *B*. The standard expenditure-revenue equations for the three nations are described below. The partial derivatives of expenditure and revenue functions are denoted by subscripts. For instance, E_2^A is the partial derivative of *A*'s expenditure function with respect to price of good-2.

(1) $E^A(1,1+t_2^A,1+t_3^A,u^A) = R^A(1,1+t_2^A,V^A+I) + t_2^A(E_2^A - R_2^A) + t_3^A E_3^A - W_I I - e_i - e_b$

(2) $E^B(1+t_1^B,1,1+t_3^B,u^B) = R^B(1+t_1^B,1,V^B-I) + t_1^B(E_1^B - R_1^B) + t_3^B E_3^B + W_I I$

(3) $E^C(1,1,1,u^C) = R^C(1,V^C)$

We assume that revenue function is strictly concave in endowment, V, such that $R_{VV}^i < 0$ for $i = A, B$. Following Ethier (1986) and Bond and Chen (1987), we use the following assumptions. Firms can hire legal workers and pay W^A or hire illegal workers and pay W_I. However, if firms are detected to be hiring illegal immigrants, they are fined *z* per unit of illegal labor. There is a probability of detection, which depends on the level of internal enforcement. This is denoted as: $p = p(e_i)$, $p' > 0$, $p'' < 0$. The expected fine

[3] Later, we relax this assumption.

per illegal labor unit hired is zp, and on average this is what firms incur above the illegal wage when they hire an illegal immigrant. Competitive firms equate the cost of hiring legal labor to the expected cost of hiring illegal labor.

(4) $W^A = W_I + zp(e_i)$

Potential migrants in B face the risk of being caught by border enforcement. The expected cost may be denoted as $\beta = \beta(e_b)$, $\beta' > 0$. The illegal wage rate, net of this cost is: $W_I - \beta(e_b)$. Assuming risk neutrality, the equilibrium migration condition dictates that the certainty wage in B is equated to the net expected wage from migration:

(5) $W^B = W_I - \beta(e_b)$

2.1. The effect of trade liberalization on the level of illegal immigration

This section considers the effect of trade liberalization on illegal immigration. Notice that: $W^i = R_V^i(.)$ for i = A and B. Thus, equations (4) and (5) imply:

(6) $R_V^B(1+t_1^B, 1, V^B - I) - R_V^A(1, 1+t_2^A, V^A + I) + \rho(e_i, e_b) = 0$

where, $\rho(e_i, e_b) \equiv \beta(e_b) + zp(e_i)$.

Relation-(6) implicitly defines the level of illegal immigration as:

(7) $I = I(t_1^B, t_2^A, \rho)$

Let $D \equiv R_{VV}^A + R_{VV}^B$, ($D < 0$). Using (6) and (7), the effects of each policy instrument on immigration are:

(8) $I_1 \equiv \dfrac{\partial I}{\partial t_1^B} = \dfrac{R_{V1}^B}{D}$, $I_2 \equiv \dfrac{\partial I}{\partial t_2^A} = -\dfrac{R_{V2}^A}{D}$, $I_\rho \equiv \dfrac{\partial I}{\partial \rho} = \dfrac{1}{D}$

Tariffs change the domestic import prices and hence the wage rates. These in turn affect the incentive for illegal immigration. We show below that the precise effect of the tariff on the immigration flow depends on the characteristics of the labor markets of both nations (host and the source). The parameter ρ captures enforcement policy, and we suppress it (for now) to focus on the effect of tariff changes on illegal immigration. Using (7):

$$(9) \quad dI = \frac{\partial I}{\partial t_1^B} dt_1^B + \frac{\partial I}{\partial t_2^A} dt_2^A$$

Lemma 1. Suppose under the Preferential Trade Agreement, *A* and *B* reduce the internal tariff by the same amount while *A* maintains a given enforcement policy. Illegal immigration increases with trade liberalization if and only if $R_{V1}^B > R_{V2}^A$ (i.e., $\frac{\partial w^B}{\partial p_1} > \frac{\partial w^A}{\partial p_2}$).

Proof:

$$(10) \quad dt_1^B = dt_2^A = dt < 0$$

Then, from (8) and (9),

$$(11) \quad \frac{dI}{dt} = \frac{R_{V1}^B - R_{V2}^A}{D}$$

Note that: $\frac{dI}{dt} < 0$, if and only if: $R_{V1}^B > R_{V2}^A$, i.e., if and only if: $\frac{\partial w^B}{\partial p_1} > \frac{\partial w^A}{\partial p_2}$. ■

Lemma 1 lays down the condition under which trade liberalization (for equal tariff cuts) may raise (or reduce) illegal immigration. Consider the US-Mexico situation. It is not clear whether reciprocal trade liberalization in this context raises or reduces illegal immigration. While Mexico may be described as a relatively more labor abundant nation, it is also true that its agriculture uses unskilled labor and suffers from comparative disadvantage compared to the US agriculture. Trade liberalization may lead to a greater inflow of US agricultural products into Mexico and may shrink that sector. Employment reduction in that sector may reduce Mexican wages and raise illegal immigration. On the other hand, if the trade liberalization raises Mexican wages through a greater demand for its relatively low skilled manufacturing sector, the effect of illegal immigration is likely to be opposite. Characteristics of the different sectors (in terms of their relative factor intensities etc.) and the pattern of trade (between a source and a host nation) will determine how trade liberalization will (in practice) affect illegal immigration. Lemma 1 provides a useful benchmark for analysis.

2.2. The Pre-Agreement Nash Tariff Equilibrium

Here we describe the utility maximizing Nash tariffs of nations *A* and *B* on imports from each other (given their respective tariffs on good-3 which is imported from *C*). *A* chooses its utility maximizing tariff on import of good-2 (t_2^A), under the Nash assumption that t_1^B is unaffected by this choice. Also, t_3^A is assumed to be exogenous to this choice. Given a positive t_3^A, and its associated trade distortion, the utility maximizing tariff is a "second-best" tariff. As in the existing literature, such a second best tariff partially offsets distortions created in the other sector (by $t_3^A > 0$). But there is another factor that is central to this paper. As we have shown in the previous sub-section, tariffs of both the *A* and *B* (along with *A*'s enforcement choice) affect the level of illegal immigration. In turn, this affects the choice of second best tariffs for both nations. This factor also makes the utility functions of the two nations interdependent on each other's tariffs. Thus the second best tariff for say *A* has to be chosen under some strategic assumption that it makes about *B*'s choice of tariffs. We make the traditional simultaneous Nash move assumption that *A* assumes that when it adjusts its tariff, B's tariff is not be affected. We first derive the Nash reaction functions for each nation's second best tariffs. Next we explore the conditions that determine the slope of these reaction functions (i.e., whether the tariffs are strategic substitutes or complements). Finally, we describe the Nash second-best tariff equilibrium. From (1) and (4), we obtain:

$$(12)\quad E^A(1,1+t_2^A,1+t_3^A,u^A)=R^A(1,1+t_2^A,V^A+I)+t_2^A(E_2^A-R_2^A)+t_3^A E_3^A$$
$$-IR_V^A(1,1+t_2^A,V^A+I)+Izp(e_i)-e_i-e_b$$

This implicitly defines:

$$(13)\quad u^A=u^A(t_2^A,t_3^A,I,e_i,e_b)=u^A(t_2^A,t_3^A,I(t_1^B,t_2^A,\rho),e_i,e_b)$$

B's tariff enters into *A*'s utility function through *I (.)*. The change in *A*'s utility is:

$$(14)\quad du^A=\left(\frac{\partial u^A}{\partial t_2^A}\right)_{|I}dt_2^A+\frac{\partial u^A}{\partial I}dI+\frac{\partial u^A}{\partial t_3^A}dt_3^A+\frac{\partial u^A}{\partial e_b}de_b+\frac{\partial u^A}{\partial e_i}de_i$$

Using the expenditure – revenue identity (1):

$$(15)\quad \frac{\partial u^A}{\partial I}=\frac{zp-t_2^A R_{2V}^A-IR_{VV}^A}{D_u}\text{, where, } D_u\equiv E_u^A-t_2^A E_{2u}^A-t_3^A E_{3u}^A=E_{1u}^A+E_{2u}^A+E_{3u}^A>0\text{,}$$

assuming normality of all goods.

The second term in (14) captures the utility effect of a unit rise in the illegal immigration level. The rise in $I(.)$ has three effects: (a). it raises the government's expected fine collections; (b). it leads to expansion (or contraction) of domestic production of good 2 through the Rybczynski effect and this affects import duty collections; and, (c). it reduces the legal wage in *A* (through an expanded labor supply) leading to a lower wage payment to illegal labor. The latter is a terms of trade gain for a labor importing nation.

Relations (14) and (15) implicitly define *A*'s second best Nash tariff reaction function:

$$(16) \quad t_2^A = t_2^A(t_1^B, t_3^A, e_i, e_b)$$

Also, *A* optimally chooses e_b and e_i by setting $\frac{\partial u^A}{\partial e_b} = 0$ and $\frac{\partial u^A}{\partial e_i} = 0$. These two first order conditions (relating to enforcement) yield:

$$(17) \quad \beta'(e_b)(-t_2^A R_{2V}^A - IR_{VV}^A + zp(e_i)) = D$$

$$(18) \quad zp'(e_i)[R_{VV}^B I - t_2^A R_{2V}^A + zp(e_i)] = D$$

Using (15) in (14) and setting $dt_3^A = 0$ and noting $\frac{\partial u^A}{\partial e_b} = 0$ and $\frac{\partial u^A}{\partial e_i} = 0$, we get the first order condition for the choice of t_2^A as:

$$(19a) \quad t_2^A\left[(E_{22}^A - R_{22}^A) + \frac{(R_{2V}^A)^2}{D}\right] + t_3^A E_{32}^A - \frac{R_{2V}^A}{D}\left[IR_{VV}^B + zp\right] = 0 .$$

Using (17), (19a) can be simplified to yield the following expression *A*'s Nash second-best tariff:

$$(19b) \quad t_2^A = \frac{R_{V2}^A(1 + I\beta') - \beta' t_3^A E_{32}^A}{\beta'(E_{22}^A - R_{22}^A)} > 0 \text{, if and only if } t_3^A E_{32}^A > \frac{(1 + I\beta')}{\beta'} R_{V2}^A .$$

From (19b) it is clear that there is no guarantee that the Nash utility maximizing tariff for *A* is positive. It is clear that if good-2 is a complement for good-3 (i.e., if $E_{32}^A < 0$), then this effect by itself will call for a negative (second best) tariff on good-2 (given $t_3 > 0$). This is because a reduction in the price of good-2 will raise the demand for good-3 under complemantarity. The latter reduces the distortion caused by the tariff on good-3. The other effect on the second best tariff is similar to that explained in Bandyopadhyay (2006). If $R^A_{V2} > 0$, then a fall in the price of good-2 reduces the wage in *A*. The wage reduction in the host nation will reduce illegal immigration through the equilibrium migration condition. Therefore, there is an incentive for *A* to reduce t_2 to get a reduction in illegal immigration. Therefore, if $R^A_{V2} > 0$, and also if $E^A_{32} < 0$, then (19b) suggest that it is optimal to impose a negative tariff. Along the same lines, one can explore the conditions that will justify a positive second best tariff.

Relation-(19a) [or (19b)] implicitly defines the Nash tariff reaction function for *A*. The slope of *A*'s reaction function is:

$$(20)\quad \left.\frac{\partial t^A_2}{\partial t^B_1}\right|_{Nash-A} = \frac{R^B_{VV} R^A_{V2} R^B_{V1} / D^2}{(E^A_{22} - R^A_{22}) + (R^A_{2V})^2 (R^A_{VV} + 2R^B_{VV}) / D^2} > 0 \text{ if and only if } R^A_{V2} R^B_{V1} > 0\,.$$

Similarly, we obtain *B*'s reaction function:

$$(21a)\quad t^B_1 \left[(E^B_{11} - R^B_{11}) + \frac{R^B_{V1} R^B_{V1}}{D} \right] + t^B_3 E^B_{31} + \frac{\beta R^B_{V1}}{D} + \frac{IR^B_{V1} R^A_{VV}}{D} = 0$$

Alternately, the (Nash) second best tariff for *B* may be expressed as:

$$(21b)\quad t^B_1 = -\frac{R^B_{1V}(\beta + IR^A_{VV}) + t^B_3 E^B_{31} D}{(E^B_{11} - R^B_{11})D + (R^B_{1V})^2} > 0 \text{ if and only if } t^B_3 E^B_{31} D < -R^B_{1V}(\beta + IR^A_{VV})$$

$$\Rightarrow t^B_1 > 0 \text{ if and only if } t^B_3 E^B_{31} > \frac{R^B_{1V}(\beta + IR^A_{VV})}{(-D)}\,.$$

The term involving E^B_{31} in the Nash second best tariff for *B* has a similar interpretation to the case for *A*, which we have already explained. The other term in the numerator involves R^B_{1V}, which captures the effect of *B*'s tariff on its wage. Notice that if *B* raises its tariff on good-1, it will raise its wage when: $R_{1V}^{B} = \dfrac{\partial w^{B}}{\partial p_{1}} > 0$. In this case, the incentive to migrate to *A* falls. Given that: $R_{VV}^{A} = \dfrac{\partial w^{A}}{\partial V} < 0$, the supply reduction of illegal labor will raise the wage in *A*. In turn, given enforcement, this raises $W_{I} = W^{A} - zp$. This is a terms of trade gain for *B* in the factor market. Consequently, in this case, *B* can exploit its monopolistic power (as a seller of illegal labor) by imposing a positive tariff on good-1. Notice that even if $E_{31}^{B} = 0$, a positive tariff is optimal because of this reason if R_{1V}^{B} is positive and β is sufficiently small such that: $\beta + IR_{VV}^{A} < 0$.

The (inverse of) slope of *B*'s reaction function is:

$$(22) \quad \frac{\partial t_{2}^{A}}{\partial t_{1}^{B}}_{|Nash-B} = \frac{(E_{11}^{B} - R_{11}^{B}) + (2R_{VV}^{A} + R_{VV}^{B})/D^{2}}{R_{V2}^{A}R_{V1}^{B}R_{VV}^{A}/D^{2}} > 0 \text{ if and only if } R_{V2}^{A}R_{V1}^{B} > 0.$$

It is clear from (20) and (22) that the sign of the two reaction functions must be the same. If the signs of R_{V2}^{A} and R_{V1}^{B} are the same (positive or negative), the reaction functions must be positively sloped, otherwise they are negatively sloped.

Relations (17), (18), (19) and (21) can be simultaneously solved to obtain the Nash equilibrium tariff rates for *A* and *B*, as well as the optimal enforcement levels e_{i} and e_{b} for nation-*A*. The Nash tariff equilibrium for negatively sloped reaction functions is demonstrated in figure-1.

[graph 1] *around here.*

2.3. The effect of a Preferential Trade Liberalization at the Nash Equilibrium

In this section, we analyze how the national welfare levels of A and B are affected if both nations agree to reduce tariffs starting from the initial Nash tariff equilibrium. The literature on second best tariffs (in the absence of illegal immigration considerations) suggests that liberalization may or may not raise welfare in an already distorted economy.[4] We explore how illegal immigration affects this conclusion and identify conditions under which liberalization will be welfare improving. The following proposition formally states our findings.

Proposition 1. At the Nash equilibrium, the host nation *A* gains from a tariff liberalization by the source nation *B* if and only if *B*'s wage rate is positively related to the price of good-1 (i.e., $R^B_{1V} > 0$). In this latter case, assuming that *B*'s Nash tariff on good-1 is positive, a sufficient condition for *B* to gain from *A*'s liberalization (of tariff on good-2) is that *A*'s wage rate is negatively related to the price of good-2 (i.e., $R^A_{2V} < 0$)

Proof:

Evaluating the derivatives at the Nash equilibrium and using A's first order conditions for the choices of t_2^A, e_i and e_b, we get:

$$(23a) \quad du^A{}_{|Nash} = \frac{\partial u^A}{\partial I}\frac{\partial I}{\partial t_1^B} dt_1^B .$$

Using the (Nash) first order condition for the choice of t_2^A, e_i and e_b, (23a) can be reduced to:

[4] The Kemp-Wan proposition discussed in Ethier and Horn (1984) suggests that the adjustment of the external tariff makes the complete elimination of internal tariff under customs unions welfare improving without harming the rest of the world. Panagariya and Krishna (2002) extends this to the case of an FTA. Throughout the analysis we hold the external tariff constant leaving the examination of the Kemp-Wan type of trade liberalization with the presence of illegal immigration to future research.

(23b) $\left(\dfrac{du^A}{dt_1^B}\right)_{|Nash} = -\dfrac{R_{1V}^B}{\beta' D_u} < 0$ if and only if $R_{1V}^B = \dfrac{\partial w^B}{\partial p_1} > 0$.

(23b) proves the first part of the proposition. Notice that the condition requires that *B*'s wage falls as price of good-1 is reduced. A fall in *B*'s wage is a terms of trade gain for *A* (the importer of labor). Therefore, only when tariff liberalization by B reduces its wage, *A* gains from it [the other gains for *A* have already been internalized by the choice of its Nash utility maximizing combination of (t_2^A, e_i, e_b)]. Similarly, analyzing the effect of a change in *A*'s liberalization on *B*'s utility (evaluated at the Nash equilibrium), we obtain:

$$(24) \quad \left(\frac{du^B}{dt_2^A}\right)_{|Nash} = -\frac{R_{2V}^A\,(t_1^B R_{1V}^B + \beta - IR_{VV}^B)}{DD_u^B} < 0 \;\text{ iff }\; R_{2V}^A\,(t_1^B R_{1V}^B + \beta - IR_{VV}^B) < 0$$

where, $D_u^B \equiv E_u^B - t_1^B E_{1u}^B - t_3^B E_{3u}^B = E_{1u}^B + E_{2u}^B + E_{3u}^B > 0$.

If t_1^B and R_{1V}^B are positive, then: $(t_1^B R_{1V}^B + \beta - IR_{VV}^B) > 0$. In this case, (24) must be satisfied if $R_{2V}^A = \dfrac{\partial w^A}{\partial p_2} < 0$. This proves the second part of the proposition above. It is intuitive that liberalization by *A* (that reduces its internal price of good-2) confers a terms of trade benefit to *B* (the exporter of labor) when the wage in *A* rises. This happens when $R_{2V}^A < 0$. ■

2.4. The Effect of *A*'s Pre-commitment to Liberalize Tariff on Good-3: A Two-Stage Analysis

The analysis above assumed that the tariffs on good-3 for the two nations are given exogenously. Here we consider the situation where A may alter its tariff on good-3 at a stage prior to the stage where the two nations choose their respective Nash equilibrium tariffs (on goods 1 and 2) and the enforcement levels. If t_3^A is chosen is stage-1 and the other choice variables for both nations in stage-2, then the analysis for the previous section is unaffected (because as far as stage-2 is concerned, t_3^A is still exogenous).[5]

First, we see how the reaction function of *A* is affected by the reduction of the tariff on good 3. Second, we examine how this will affect the Nash equilibrium tariff of *B*. Finally, we explore how this affects *A*'s utility .[6] From (20) and (22), the slopes of the reaction functions do not change in response to the change in the tariff on good on 3. Denoting the left hand side of (19a) as Φ^A,

$$(25)\quad \frac{\partial t_2^A}{\partial t_3^A} = -\frac{E_{32}^A}{\partial \Phi^A / \partial t_2^A}$$

The denominator of (25) must be negative from the second order condition of *A*'s choice of the Nash second best tariff. Thus, if good 2 and 3 are substitutes (i.e., $E_{32}^A > 0$), the reduction in t_3^A will shift *A*'s reaction function down, as described in the graph 2 (which assumes that the reaction functions are negatively sloped). On the other hand, if $E_{32}^A < 0$, *A*'s reaction function shifts up.

[graph 2] *around here*

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[5] For simplicity, let us assume that *B*'s tariff on good-3 is still exogenously given for this two stage model.

[6] Bond, Syropoulos, and Winters (2001) discuss how trade liberalization in a customs union affects the multilateral trading process. They find that intra-bloc trade liberalization which requires the reduction of the external tariff is negatively associated with the elasticity of substitution between member and nonmember goods.

Let us consider the case where the goods are substitutes. Given *B*'s reaction function, if A pre-commits to a lower t_3^A, it would lead to an increase in t_1^B (i.e., $\frac{dt_1^B}{dt_3^A} < 0$). Using (13), and the first order conditions for *A*'s choice of stage-2 variables, the effect on *A*'s utility is:

$$(26a) \quad \frac{du^A}{dt_3^A} = \frac{\partial u^A}{\partial t_3^A} + \frac{\partial u^A}{\partial I}\frac{\partial I}{\partial t_1^B}\frac{dt_1^B}{dt_3^A}$$

Using (23b), (26a) reduces to:

$$(26b) \quad \frac{du^A}{dt_3^A} = \frac{\partial u^A}{\partial t_3^A} - \left(\frac{R_{1V}^B}{\beta' D_u}\right)\left(\frac{dt_1^B}{dt_3^A}\right).$$

The second term on the right hand side of (26b) will be positive if $\frac{dt_1^B}{dt_3^A} < 0$ and if $R_{1V}^B > 0$. The latter was discussed in proposition-1. This means that *A* has to balance the direct potential gains from tariff reduction [i.e., the term $\frac{\partial u^A}{\partial t_3^A}$], with the loss that will occur through the strategic effect captured by the second term. Under strategic substitutability (the case that obtains when $R_{1V}^B > 0$ and $R_{2V}^A < 0$), the reduction in t_2^A (following the cut in t_3^A) will raise t_1^B. Given $R_{1V}^B > 0$, this will raise the wage in *B*. The latter is a terms of trade loss for *A* and will deter *A* from liberalizing its tariff on good-3.

Proposition 2. Reduction of *A*'s tariff on good-3 leads to a higher Nash equilibrium tariff on good-1 by *B* when goods 2 and 3 are Hicksian substitutes (for *A*) and when the tariff reaction functions are downward sloping (i.e., tariffs on goods 1 and 2 are strategic substitutes for each other). The strategic effect moderates *A*'s potential gains from tariff liberalization on good-3.

Proof: The text preceding the proposition constitutes the proof. ■

3. Conclusion

The paper focuses on the interdependence of second best tariffs for potential members of a preferential trading bloc in the presence of illegal immigration between them. We identify conditions that determine the effect of such tariff liberalization on illegal immigration. We also describe the Nash equilibrium tariffs that exist in the absence of any agreement and use them as a benchmark to discuss potential utility gains from intra-bloc liberalization. Finally, we consider how the host nation's incentives to liberalize its trade with a non-member may be affected by strategic considerations that pertain to tariffs imposed by the source nation for illegal immigration. ■

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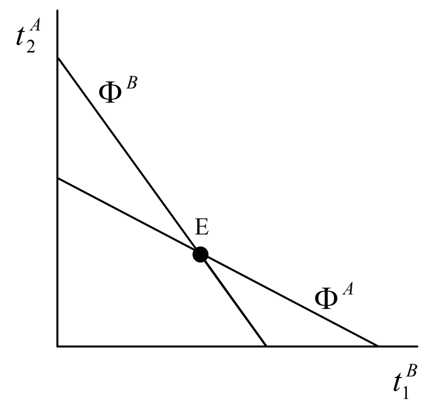
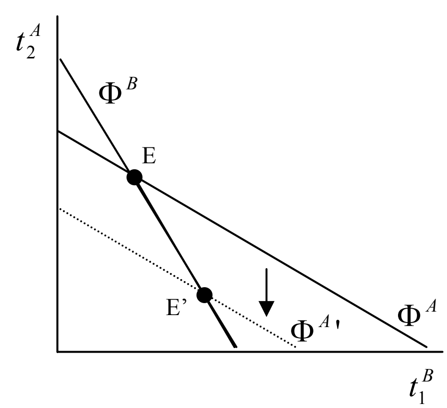
Graph 1 The internal Nash tariff Equilibrium



Φ^A : A's Reaction function
Φ^B : B's Reaction function
E : Nash Equilibrium

Graph 2 The effect of the external tariff reduction



$\Phi^{A\prime}$: A's Reaction function after reduction in t_3^A
E' : new Nash Equilibrium

Appendix

1. *Deriving A's Second Best Nash Tariff Reaction Function:*

(14) $du^A = \left(\dfrac{\partial u^A}{\partial t_2^A}\right)_{|I} dt_2^A + \dfrac{\partial u^A}{\partial I} dI + \dfrac{\partial u^A}{\partial t_3^A} dt_3^A + \dfrac{\partial u^A}{\partial e_b} de_b + \dfrac{\partial u^A}{\partial e_i} de_i$

Given t_3^A and at optimal e_i and e_b, the utility maximizing choice of t_2^A requires:

$$(A1) \quad \frac{du^A}{dt_2^A} = \frac{\partial u^A}{\partial t_{2\,|I}^A} + I_2 \frac{\partial u^A}{\partial I} = 0$$

$$\frac{\partial u^A}{\partial t_{2\,|I}^A} = \frac{t_2^A (E_{22}^A - R_{22}^A) + t_3^A E_{32}^A - IR_{V2}^A}{D_u^A}$$

where $D_u^A \equiv E_u^A - t_2^A E_{2u}^A - t_3^A E_{3u}^A = E_{1u}^A + E_{2u}^A + E_{3u}^A > 0$

Combined with (15), (A1) can be rewritten

$$(A2) \quad t_2^A \left[(E_{22}^A - R_{22}^A) + \frac{(R_{V2}^A)^2}{D} \right] + t_3^A E_{32}^A - IR_{V2}^A - \frac{R_{V2}^A}{D}(zp - IR_{VV}^A) = 0$$

$\Rightarrow t_2^A \left[(E_{22}^A - R_{22}^A) + \dfrac{(R_{V2}^A)^2}{D} \right] + t_3^A E_{32}^A - R_{V2}^A \left[I + \dfrac{1}{D}(zp - IR_{VV}^A) \right] = 0$. Noting that $D = R_{VV}^A + R_{VV}^B$, and using it in the last equality in (*A2*) above, we get (19a) of the text.

Furthermore, using (17), we have $zp - IR_{VV}^A = \dfrac{D}{\beta'} + t_2^A R_{V2}^A$. We substitute this in (A2) and obtain (19b).

2. *Deriving B's Second Best Nash Tariff Reaction Function:*

Totally differentiating (2), and using (5), $W_I = R_V^B + \beta$, we obtain

$$(A3) \quad D_u^B du^B = (\beta + t_1^B R_{1V}^B - IR_{VV}^B) dI + \left[t_1^B (E_{11}^B - R_{11}^B) + t_3^B E_{31}^B + IR_{1V}^B \right] dt_1^B$$

Where $D_u^B \equiv E_u^B - t_1^B E_{1u}^B - t_3^B E_{3u}^B = E_{1u}^B + E_{2u}^B + E_{3u}^B > 0$

Given t_2^A, $dI = I_1 dt_1^B = \dfrac{R_{V1}^B}{D}$. Therefore, (A3) can be rewritten as

$$(A3a) \quad D_u^B \frac{du^B}{dt_1^B} = (\beta + t_1^B R_{1V}^B - IR_{VV}^B)\frac{R_{V1}^B}{D} + t_1^B (E_{11}^B - R_{11}^B) + t_3^B E_{31}^B + IR_{1V}^B$$

Set (A3a) zero, we obtain B's reaction function: [ref: (21a)].

$$(A4) \quad t_1^B \left[(E_{11}^B - R_{11}^B) + \frac{(R_{V1}^B)^2}{D} \right] = (IR_{VV}^B - \beta)\frac{R_{V1}^B}{D} - t_3^B E_{31}^B - IR_{1V}^B$$

Noting $D = R_{VV}^A + R_{VV}^B$, the right hand side of (A4) becomes

$$(IR_{VV}^B - \beta)\frac{R_{V1}^B}{D} - t_3^B E_{31}^B - IR_{1V}^B = (IR_{VV}^B - \beta)\frac{R_{V1}^B}{D} - t_3^B E_{31}^B - \frac{IR_{1V}^B (R_{VV}^A + R_{VV}^B)}{D}$$
$$= -\frac{R_{V1}^B}{D}(\beta + IR_{VV}^A) - t_3^B E_{31}^B$$

Plug this back in (A4), we solve for B's second best tariff in (21b).

3. *The effect of A's tariff reduction on B's utility: (Proposition 1 part a)*

Based on (A3), and given the optimal enforcement (e_i, e_b), and $dI = I_1 dt_1^B + I_2 dt_2^A$,

$$(A5) \quad D_u^B du^B = \left[(\beta + t_1^B R_{1V}^B - IR_{VV}^B)I_1 + t_1^B (E_{11}^B - R_{11}^B) + t_3^B E_{31}^B + IR_{1V}^B\right] dt_1^B + (\beta + t_1^B R_{1V}^B - IR_{VV}^B) I_2 dt_2^A$$

Evaluating at the second best t_1^B [$\dfrac{du^B}{dt_1^B} = 0$ or (21a)],

$$(A6) \quad D_u^B \frac{du^B}{dt_2^A} = (\beta + t_1^B R_{1V}^B - IR_{VV}^B) I_2$$

Using the F.O.C. of the second best t_1^B,

$$(A7) \quad (\beta + t_1^B R_{1V}^B - IR_{VV}^B) = -\frac{t_1^B(E_{11}^B - R_{11}^B) + t_3^B E_{31}^B + IR_{V1}^B}{I_1}$$

Plug this into (A6), we obtain

$$(A8) \quad D_u^B \frac{du^B}{dt_2^A} = -\frac{I_2}{I_1}\left[t_1^B(E_{11}^B - R_{11}^B) + t_3^B E_{31}^B + IR_{V1}^B\right]$$

Using (21a), $t_1^B(E_{11}^B - R_{11}^B) + t_3^B E_{31}^B = -\frac{R_{1V}^B}{D}\left[t_1^B R_{1V}^B + \beta + IR_{VV}^A\right]$ and substitute (8), (A8) can be rewritten as

$$(A9) \quad D_u^B \frac{du^B}{dt_2^A} = -\frac{R_{V2}^A}{D}\left[t_1^B R_{V1}^B + \beta - IR_{VV}^B\right]$$

Therefore,

$$\frac{du^B}{dt_2^A} \underset{\le}{\ge} 0 \text{ as } R_{V2}^A\left[t_1^B R_{V1}^B + \beta - IR_{VV}^B\right] \underset{\le}{\ge} 0$$

4. *The effect of B's tariff reduction on A's utility: (Proposition 1 part b)*

$$(A10) \quad du^A = \left[\frac{\partial u^A}{\partial t_{2\,|I}^A} + \frac{\partial u^A}{\partial I} I_2\right] dt_2^A + \frac{\partial u^A}{\partial I} I_1 dt_1^B$$

At the second best t_2^A,

$$(A10a) \quad \frac{du^A}{dt_1^B} = \frac{\partial u^A}{\partial I} I_1$$

Meanwhile, F.O.C. for t_2^A is:

$$(A10b) \quad \frac{\partial u^A}{\partial t_{2\,|I}^A} + \frac{\partial u^A}{\partial I} I_2 = 0$$

Rearrange it and we obtain,

$$(A10c) \quad \frac{\partial u^A}{\partial I} = -\frac{\left(\dfrac{\partial u^A}{\partial t^A_{2\,|I}}\right)}{I_2}$$

Using (1), we also obtain

$$(A11) \quad \frac{\partial u^A}{\partial t^A_{2\,|I}} = -\frac{t^A_2(E^A_{22} - R^A_{22}) + t^A_3 E^A_{32} - IR^A_{V2}}{D_u}$$

Substitute (A10c) and (A11) into (A10a), we have

$$(A12) \quad \frac{du^A}{dt^B_1} = \left(\frac{I_1}{I_2}\right)\frac{t^A_2(E^A_{22} - R^A_{22}) + t^A_3 E^A_{32} - IR^A_{V2}}{D_u}$$

Using (19a) and (8), (A12) can be rewritten as:

$$(A13) \quad \frac{du^A}{dt^B_1} = -\frac{R^B_{V1}}{\beta' D_u}$$

Therefore,

$$\frac{du^A}{dt^B_1} \mathrel{\substack{\geq \\ \leq}} 0 \text{ as } R^B_{V1} = \frac{\partial w^B}{\partial p_1} \mathrel{\substack{\leq \\ \geq}} 0$$