The Global Welfare of Illegal Immigration
in the Presence of Capital Mobility

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Abstract

*Using the Bond and Chen [1987] model on illegal immigration, we newly
examine the effects of internal enforcement by host country's government on
labor-importing country, labor-exporting country and global welfare when cap-
ital is allowed to be internationally mobile between a home and a foreign coun-
tries. The main results we obtain are that an imposition of the enforcement
makes the labor-importing country's welfare better off under some circum-
stances and the labor-exporting country's welfare better off as well, and hence
improves the global welfare. Therefore, we can conclude that the enforcement is
a Pareto-improving-policy. (JEL Classification No.: F 21; F22)*

I. Introduction

The issues on illegal immigration have been addressed in the recent liter-
ature by Ethier [1986], Bond and Chen [1987], Brecher and Choudhri

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[1987] and Yoshida [1993]. Ethier model broke new ground by examining the effects of border and internal enforcement policies using a crime-theoretic analysis ⟨Becker [1968]⟩ in a one-country model. Using this model, Ethier explored how a small country could use the domestic border and internal enforcement policies to achieve domestic policy objectives concerning the level of illegal immigration or the income distribution.

Bond and Chen [1987] extended the Ethier [1986] model by constructing a standard (two-country, one-good, two-factor) model of illegal immigration. In a part of their paper, they examined the effect of an introduction of internal enforcement policy by host country's government on host country's welfare when capital is internationally immobile. They showed that in the absence of capital mobility an imposition of the enforcement may or may not improve the home country's welfare.

Using the Bond and Chen [1987] model, Yoshida [1993] analyzed the effect of introducing the internal enforcement on the foreign country's welfare and the global welfare (which is composed of the domestic and foreign countries' welfare combined), complementing Bond and Chen [1987]. Yoshida [1993] showed that an imposition of the enforcement by the home country's government makes the foreign country's welfare as well as the world as a whole worse off when there is no capital mobility.

However, Bond and Chen [1987] and Yoshida [1993] did not examine the effects of the internal enforcement on the home country, foreign country and two country combined welfare *in the presence of international capital mobility between a home and a foreign countries*. Using Bond and Chen [1987] model, we examine the effects of the enforcement on the host country, foreign country and two country combined welfare when capital is allowed to be internationally mobile between countries.

It is shown that in the presence of capital mobility, the enforcement makes the host country's welfare bettor off under some circumstances and the foreign country's welfare better off as well, and hence improves the global welfare. This result is contrary to that of Yoshida [1993] that an introduction of the enforcement will decrease the global income when there is no capital movement. We can conclude that the internal enforcement by the host country's government is *a Pareto-improving policy* when capital flows exist.

In the next section, we briefly summarize the comparative static analysis

of Bond and Chen [1987], and our results are presented by using their model. Section III offers some concluding remarks.

II. The Model and Main Results

Following Bond and Chen [1987], we introduce a standard (two-country, one-good, two-factor) model of illegal immigration, in which capital is assumed to be internationally mobile. Each firm in both a home and a foreign countries produces a single output using a constant returns to scale technology. Technologies are assumed to be the same in both two countries.

Each output is produced by labor and capital in each country. The production functions of home and foreign firms are, respectively, denoted by $F(L, K)$ and $F^*(L^*, K^*)$ where L, K, L^* and K^* are home labor, home capital, foreign labor and foreign capital employment, respectively. We assume that labor endowment in the home country is more scarce than in the foreign country, so that in the absence of factor mobility the home wage rates w exceed the foreign wage rates w^*. The output is assumed to be the numeraire in this model.

Moreover we assume that there are legal barriers to factor movements. Foreign workers[1] are assumed to be indifferent between working in their native country and illegally working in the host country when they are given the same wage everywhere. The host country's government determines the enforcement level against home firms that employ illegal foreign workers, so that they must pay penalties for the home government if they are found employing those workers from abroad. Also the home country's government levies a tax on home capital exports.

A. Factor Market Equilibrium

Following Bond and Chen [1987], we develop the standard (two-country,

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1. If we assume that the level of the border enforcement is increased by the host country's government, we can suppose that there is a wage differential between illegal work in the home country and legal work in the foreign country. However, we think that there is not the wage differential in our model by excluding the border enforcement since the level of the border enforcement is assumed to be fixed ⟨see Bond and Chen [1987]⟩.

one-good, two-factor) model of illegal immigration, in which foreign labor illegally migrates to the home country and capital is internationally mobile. Technologies are the same between two countries. In autarky, the home country[2] is relatively labor-scarce to the foreign country[3] (*i.e.*, the foreign country is relatively capital-scarce to the home country.). A single good in each country is produced, using labor and capital, under a constant returns to scale technology.

Home firms are indifferent between employing home labor and employing illegal foreign labor.[4] The cost of employing illegal workers is composed of these workers' wage and expected value of fine. Hence, in equilibrium[5] we have:

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2 From the assumption of the same technology between two countries, we find that in the absence of international factor mobility the wage (rental price) of home capital-abundant country is higher (lower) than of foreign labor-abundant country.

3. In our model, home workers do not have incentives to legally or illegally migrate to the foreign country because from the assumption the home wage rate w exceeds the foreign wage rate w in the absence of factor mobility. The foreign country's government may not need to introduce both the border and internal enforcement policies. Therefore, the expenditure levels on those enforcement policies are zero.

4. If the home country's government puts the border enforcement into force, the foreign illegally-attempted migrants are suffered from the penalties, k when they are caught at the border between two countries. If we assume that the probability of detection at the border is expressed as $g(B)$ where B is the expenditure of the border enforcement by the host country's government, $g(0) = 0$, $g' > 0$, $g'' < 0$ and $g < 1$, the risk neutral illegal migrants adjust themselves so as to equate the expected reward from migration to the local wage, w^*:

$$(w^* - k)g + w^l (1 - g) = w^*, \tag{i}$$

where w^l is the wage that the illegal workers who succeed in moving into the home country earn by working illegally in the home country's firm.

   The equation (i) is rewritten as:

$$w^l = w^* + k[g(B)/(1 - g(B))]. \tag{ii}$$

Thus, when the home country's government carries out the border enforcement, the foreign illegal migrants who are exempted from its enforcement earn the wage, w^l more than the foreign country's wage, w^*.

   We can ignore $k[g(B)/(1 - g(B))]$ in the right-hand side of equation (ii) since we assume that the level of border enforcement is constant throughout the paper. Therefore, there is no wage differential between illegal working in the host country and legal working in the foreign country; $w^l = w^*$ ⟨see Bond and Chen [1987]⟩.

5. The number of illegal immigration, $I(>0)$ is determined so that (1) is satisfied. If

$$w = w^* + p(E)z, \tag{1}$$

where $p(E)$ is the probability of detection, with $p(0) = 0$, $p \le 1$, $p' > 0$ and $p'' < 0$, and z is the fine which home firms pay for each illegal worker caught by the enforcement of host country's government. E is the level of enforcement. We exclude the possibility of $E = 0$ (see footnote 7 on some reason for it).

The production function for home firm is expressed as $F(L, K) = Kf(\lambda)$, where $\lambda = L/K$ and $f' > 0$, $f'' < 0$. Therefore the first-order conditions of the cost-minimization for the domestic firms facing given wage rates w and capital rental rates r are:

$$f'(\lambda) = w, \tag{2a}$$

$$f(\lambda) - \lambda w = r. \tag{2b}$$

From (2a) it is clear that

$$\lambda = \lambda(w), \quad \lambda' = 1/f'' < 0. \tag{3}$$

The total differentiation of (1) and (2b) gives the effects of the enforcement E of w, r and w^*:

$$dr = -\lambda dw, \tag{4}$$

$$= -\lambda(dw^* + p'zdE), \tag{5}$$

where λ is assumed to be chosen optimally.

In the foreign country, the foreign firms minimize total costs given foreign wage and rental rates w^* and r^*, with respect to labor and capital. Hence, similar relations to (3), (4) and (5) are obtained:

$w > w^* + p(E)z$ for any $E > 0$, the home firm is willing to hire foreign illegal workers rather than home workers, and hence (1) holds. On the other hand, if it is not the case, the domestic firm would like to employ relatively more home workers than foreign workers, so (1) is satisfied. Therefore, in equilibrium (1) holds and thus $I(> 0)$ is determined from (1).

When the level of internal enforcement, E, becomes sufficiently high, the level of illegal immigration, I is more eliminated. Hence, it is possible that for $\exists$ large E, the number of illegal immigration becomes zero; there is a corner solution with regard to labor mobility. However, we only assume the existence of interior solution on labor movement for $\forall E$.

$$\lambda^{*} = \lambda^{*}(w^{*}), \quad \lambda^{*\prime} = 1/f^{*\prime\prime} < 0, \tag{6}$$

$$dw^{*} = -dr^{*}/\lambda^{*}. \tag{7}$$

If there were no barriers to capital mobility, the home capital would shift to the foreign country until returns were the same everywhere; $r = r^{*}$. From the assumption of the same technology between two countries, this would cause the home and foreign wages to equalize in our model; $w = w^{*}$, and hence there would be no illegal immigration. Therefore, we assume that the home country's government levies a tax on home capital located in the foreign country, K_F, so that the net return to home capital in the foreign country is $r^{*}(1 - t)$, where t is the tax rate which is the open interval in $(0, 1)$. Note that there are both capital and illegal labor flows in equilibrium. Home capital[6] shifts to the foreign country until the rental rates of home capital located in the home country equal to after-tax returns of home capital K_F located in the foreign country:

$$r = r^{*}(1 - t), \tag{8}$$

where t is included in $(0, 1)$.

Let us examine the equilibrium condition in factor markets.[7] This condition for the home market is

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6. If a tax on home capital exports is very high; $r > r^{*}(1 - t)$ for $\exists$ high t, then the levels of capital exports may be probably zero; $K_F = 0$. Therefore, there is a corner solution for capital mobility. But the existence of an interior solution on capital movement is only assumed in our model.

7. There is a possibility that $w = w^{*}$ from (1) when the level of internal enforcement is zero; $E = 0$ (and a tax, t (which is involved in $(0, 1)$) is imposed on the returns of home capital located in the foreign country), and hence the rental price of home capital, r becomes equal to that of foreign capital, r^{*}. This implies that it may be possible for factor price equalization to occur, and hence *the level of illegal immigration, I, is independent of the enforcement level, E.*

However, we assume that the level of internal enforcement, E is *initially* set at some minimum level, E_{min} (> 0). In short, we do not consider that the expenditure level of enforcement is zero; $E = 0$ since we exclude the possibility of factor price equalization from consideration. Thus, there are two-way factor movements in equilibrium for any defined E (> 0) and t.

I am very grateful to the two anonymous referees for informing me that the factor price equalization can occur when $E = 0$, and giving me such some appropriate prescriptions on this serious problem as above mentioned.

$$(\overline{K} - K_F)(1-a)\lambda(w^* + p(E)z) = \overline{L}, \tag{9}$$

where $\overline{K}$ and $\overline{L}$, respectively, are the initial capital and labor endowments of the home country, and a is defined as $I/(\overline{L}+I)$, where I is the level of illegal immigration. Also in the foreign market equilibrium we have

$$(\overline{K}^* + K_F)\lambda^*(w^*) + (\overline{K} - K_F)a\lambda(w^* + p(E)z) = \overline{L}^*, \tag{10}$$

where $\overline{L}^*$ and $\overline{K}^*$, respectively, are the initial labor and capital endowments in the foreign country. The three equations of (8), (9) and (10) determine w^*, a and K_F.

By totally differentiating (8) and making use of (5) and (7), we can obtain the following equation:

$$[\lambda^*(w^*)(1-t) - \lambda(w^* + p(E)z)]\,dw^* = r^* d(1-t) + \lambda(w^* + p(E)z)p'z dE. \tag{11}$$

It is said from (11) that a rise in the tax rate on home capital decreases the wages of foreign workers if $(\lambda^*(1-t) - \lambda) > 0$. Following Bond and Chen [1987], we assume that the sign of $(\lambda^*(1-t) - \lambda)$ is positive ⟨see Neary [1978] on the reason for assuming this condition⟩.

Total differentiation of (8), (9) and (10) yields the following three-equation system, eliminating dw using (1):

$$\begin{bmatrix} \lambda^*(1-t) - \lambda & 0 & 0 \\ (\overline{K} - K_F)(1-a)\lambda' & -(\overline{K} - K_F)\lambda & -(1-a)\lambda \\ (\overline{K}^* + K_F)\lambda^{*\prime} + a\lambda(\overline{K} - K_F) & (\overline{K} - K_F)\lambda & \lambda^* - a\lambda \end{bmatrix} \begin{bmatrix} dw^* \\ da \\ dK_F \end{bmatrix}$$

$$= \begin{bmatrix} -r^* dt + \lambda p' z dE \\ -(\overline{K} - K_F)(1-a)\lambda' p' z dE \\ -(\overline{K} - K_F)a\lambda' p' z dE \end{bmatrix}. \tag{12}$$

The determinant of system (12) is

$$D = (\lambda^*(1-t) - \lambda)((\overline{K} - K_F)(\lambda - \lambda^*)\lambda),$$

where the sign of D is negative because the sign of $(\lambda^*(1-t) - \lambda)$ is assumed to be positive.

We can, from (12), obtain the effects of E on w^*, a and K_F:

$$dw^* / dE = \lambda p' z / (\lambda^*(1-t) - \lambda) > 0, \tag{13a}$$

$$da / dE = p'z[-\lambda^{*2}(1-t)(1-a)(\overline{K} - K_F)\lambda'$$
$$- \lambda^2(1-a)(\overline{K}^* + K_F)\lambda^{*'}]/D < 0, \tag{13b}[8]$$

$$dK_F / dE = p'z[\lambda\lambda^*(1-t)(\overline{K} - K_F)^2\lambda'$$
$$+ (\overline{K} - K_F)(\overline{K}^* + K_F)\lambda^2\lambda^{*'}]/D > 0. \tag{13c}$$

Next from (4), (5) and (13a) the effect of E on w is:

$$dw / dE = dw^* / dE + p'z = \lambda^*(1-t)p'z/(\lambda^*(1-t) - \lambda) > 0. \tag{14}$$

The effects of E on r and r^* are obtained from (4), (7), (13a) and (14):

$$dr/dE = -\lambda\lambda^*(1-t)p'z/(\lambda^*(1-t) - \lambda) < 0, \tag{15}$$

and

$$dr^*/dE = -\lambda^*\lambda p'z/(\lambda^*(1-t) - \lambda) < 0. \tag{16}$$

With these comparative static results, Bond and Chen [1987] showed that with capital mobility the enforcement policy brings about adverse effects to home and foreign capital, whereas it does favorable effects to home and foreign labor.

Although the effects on the six endogenous variables, the factor prices in both locations, the number of illegal immigration and capital exports were derived, we cannot analyze the effects of internal enforcement on the home country, foreign country and two country combined welfare from only those effects since each effect is different from another. In subsection II.B, we examine the effects of enforcement on the home country, foreign country and global welfare.

B. Welfare Effects

In this subsection we examine the effects of internal enforcement by the home country's government on the home country, foreign country and two country combined welfare.

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8. From the definition of a and (13b), the effect of enforcement on the level of illegal immigration, I, is negative:

$$dI/dE = [(1 - a)/(\overline{L} + I)]\cdot[da/dE] < 0.$$

First we consider the labor-importing country's income:

$$Y = w\bar{L} + r\bar{K} + p(E)(z - v)I + (r^* - r)K_F - E, \tag{17}$$

where v denotes the costs associated with the return of illegal workers to their native country and the collection of fines from firms, and E is the cost of arresting illegal workers incurred to the home country's government. Y is composed of factor expenditures $(w\bar{L} + r\bar{K})$ and the home government surplus $[p(E)(z - v)I + (r^* - r)K_F - E]$.

We examine the effect of E on the home country's welfare. Differentiating (17) with respect to E is:

$$dY/dE = \bar{L}dw/dE + \bar{K}dr/dE + p'(z - v)I + p(z - v)dI/dE$$
$$+ K_F(dr^*/dE - dr/dE) + (r^* - r)dK_F/dE - 1. \tag{18}$$

By making use of (1), (4), (5) and (7) and noticing $\lambda = (\bar{L}+I)/(\bar{K} - K_F)$, (18) is rewritten as:

$$dY/dE = (r^* - r)dK_F/dE - Idw^*/dE - \lambda^* K_F dw^*/dE$$
$$+ p(z - v)dI/dE - (vp'I + 1). \tag{19}$$

We assume that $z = v$; the fine that the home firm pays for each caught illegal worker is equal to the cost associated with the return of each illegal worker to his native country and the collection of fine from the penalized firm. From the assumption, (19) is rewritten as:

$$dY/dE = (r^* - r)dK_F/dE - Idw^*/dE - \lambda^* K_F dw^*/dE - (vp'I + 1). \tag{20}$$

We find from (13a) and (13c) that the sign of (20) is indeterminate. However, it is clear from (13a) and (13c) that the sign of (20) is positive if the condition[9] (C-1): $(r^* - r)dK_F/dE > Idw^*/dE + \lambda^* K_F dw^*/dE + (vp'I + 1)$ is satisfied for any defined $E(> 0)$ and t. This necessary condition implies that the marginal tax on revenue of home capital outflows from an imposition of the enforcement, $(r^* - r)dK_F/dE$ outweighs the effect of the enforcement on foreign labor's wage, $Idw^*/dE + \lambda^* K_F dw^*/dE$ and the marginal costs of the enforcement, $(vp'I + 1)$.

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9. Notice that (C-1) is the necessary condition for the level of optimal enforcement policy to be positive.

Proposition 1: *The host country's income will increase under (C-1) when the internal enforcement by the host country's government is carried out.*

Second, we consider the effect of internal enforcement on the foreign country's income. The foreign country's welfare is expressed as:

$$Y^* = w^* \lambda^* (w^*) (\bar{K}^* + K_F) + r^* \bar{K}^* + Iw^*. \tag{21}$$

Y^* consists of factor expenditures $[w^* \lambda^* (w^*) (\bar{K}^* + K_F) + r^* \bar{K}^*]$ and immigrant earnings Iw^*. By differentiating (21) with respect to E and using (7), the following equation is obtained:

$$dY^*/dE = Idw^*/dE + \lambda^* K_F dw^*/dE > 0. \tag{22}$$

The sign of (22) is unambiguously positive from (13a). Y^* will rise when the level of enforcement increases.

Proposition 2: *The welfare of labor-exporting country will rise when the host country puts the internal enforcement into force.*

This result is contrary to that of Yoshida [1993] that 'the welfare of labor-exporting country will decline when the enforcement policy is introduced in the home country'.

Third, we consider the effect of enforcement on global welfare $(Y+Y^*)$. The global income, $(Y + Y^*)$ is derived from (17) and (21):

$$(Y + Y^*) = [w\bar{L} + r\bar{K} + p(E)(z - v)I + (r^* - r)K_F - E]$$
$$+ [w^* \lambda^* (w^*) (\bar{K}^* + K_F) + r^* \bar{K}^* + Iw^*], \tag{23}$$

where Y and Y^* are expressed by the first and second brackets in the right-hand side of (23), respectively. The differentiation of (23) with respect to E is derived from (19) and (22):

$$d(Y+Y^*)/dE = (r^* - r)dK_F/dE + p(z - v)dI/dE - (vp'I + 1). \tag{24}$$

By considering the assumption, $z = v$, (24) is rewritten as follows:

$$d(Y+Y^*)/dE = (r^* - r)dK_F/dE - (vp'I + 1). \tag{25}$$

It is clear that the sign of (25) is positive if the condition (C-1) is satisfied for any defined $E(> 0)$ and t. In short, the effect of enforcement on

$(Y+Y^*)$ is positive when the marginal tax-revenue on home capital outflows, $(r^*- r)dK_F/dE$ outweighs the marginal costs of the enforcement, $(vp'I + 1)$. This result is contrary to that of Yoshida [1993] that 'the global income will decline when an enforcement policy by the government of host country is introduced.

Proposition 3: *The internal enforcement by the home country's government will cause the global income to be better off under (C-1).*

It is shown from our welfare analysis that the internal enforcement by the host country's government makes the home country's welfare better off under $(C$-1) and the foreign country's welfare better off, and hence improves the global welfare. Therefore, we can conclude that under some circumstances the internal enforcement is *a Pareto-improving policy.*

III. Concluding Remarks

In this paper, using the Bond and Chen [1987] model, we examined the effects of internal enforcement by the host country's government on the home country, foreign country and global welfare when capital is allowed to be internationally mobile between two countries. We showed that an imposition of the enforcement makes the home country's welfare better off under some circumstances and the foreign country's welfare better off, and hence improves the global welfare. Therefore, the enforcement by the host country's government may be *a Pareto-improving policy.* The result is contrary to that of Yoshida [1993] that an introduction of the enforcement will reduce the global welfare when capital is not allowed to be internationally mobile.

In accordance with the very intelligible comments of an anonymous referee,[10] we state some economic interpretations of our results by comparing them with those of Yoshida [1993]. The comments following Proposition 2 could be expanded to indicate why the results differ from those of Yoshida [1993]. In the paper, capital is immobile between countries, so an increase in the enforcement reduces the wage rate in the foreign country. With capi-

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10. I thank an anonymous referee very much for his giving me the clearly understandable comments concerning my welfare analysis on the enforcement.

tal mobility, an increase in the enforcement raises the wage rate in the labor-exporting country. Thus, it is the fact that the terms of trade move in the opposite direction in the two cases that generates the difference in results. When capital is immobile, the enforcement introduces a distortion into a previously Pareto optimal world economy and will thus reduce the world welfare. When there are capital mobility and a capital export tax, the initial situation involves a distortion. The introduction of a second distortion, the enforcement policy, could raise the world welfare for the standard second-best reasons (see the comments below (25)).

We can generally regard the real world as the distorted economy developed in our model. Hence, an imposition of internal enforcement based on immigration law by the host country (*e.g.*, United States) can be justified in view of economic welfare.

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