**Chukyo University Institute of Economics**

**Discussion Paper Series**

April 2016

No. 1601

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Kenji Kondoh

# International Immigration via Different Two-type Midstream Countries

**Kenji Kondoh*†**

**Abstract**

Employing the basic model of illegal migration by Bond and Chen (1987) and Yoshida (1993), we studied the recent trends of illegal migrants in Europe. Initially, they cross the border of marginal countries (e.g., Greece or Italy), which are part of a large economic bloc (i.e., the European Union), with the intention of moving within the bloc to find good job opportunities in more developed countries (e.g., Germany); this is facilitated by a lack of passport controls among member countries. Particularly, we focus on the optimal policies of Germany, a highly developed country, as the final destination of immigrants from two different routes (i.e., via Italy with border control, or via Greece without any restriction). We found that under certain conditions, to enhance the domestic wage rate or economic welfare Germany should introduce border controls between Greece and instead, maintaining revenue neutrality, reduce internal enforcement targeted at employed illegal immigrants from not only Greece but also Italy.

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* School of Economics, Chukyo University, 101-2 Yagptphonmachi, Showaku, Nagoya, 4668666, JAPAN. Tel&Fax: +81528357496 email: kkondo@mecl.chukyo-u.ac.jp

† I am grateful to Professor Ngo Van Long for his helpful comments.

## 1. Introduction

In the summer of 2015, a large quantity of refugees from Mideast countries including Syria began to rush toward Europe; EU countries have made efforts to receive them.[1] With the hope of finding better lives, the movement of illegal immigrants from poor Africa and the Mideast to rich European developed countries has been in existence for several decades following the onset of globalization. In reality, there are many economic refugees and it is quite difficult to distinguish genuine refugees from others. Anyway, those immigrants' final destinations are developed countries that are in good economic conditions like Germany, Sweden, and France.[2] These immigrants usually travel by land or sea in order to avoid the air routes because of higher costs and strict border controls. As a result, two ordinary immigration routes have been established. The first is the Mediterranean Sea route, which is from North Africa to Germany via Italy. The second is the Balkan Peninsula route, which is from Mideast and Turkey to Germany via Greece, Serbia, Hungary, and Austria. Since there is no border control between the members of the Schengen agreement, it is almost impossible for final destination countries like Germany to restrict illegal immigrants if they smuggled themselves into the gateway countries, that is, Italy or Greece. Therefore, for Germany, political adjustments and cooperation between those gateway countries are quite important and indispensable.

Generally, the restriction policies for illegal immigrants are classified into two types; namely, border control and internal enforcement. Border control is the policy enacted at the immigration gate. Unfortunate immigrants who are detected when they intend to pass the border sometimes need to pay penalty charges and have to return to their home countries. Therefore, they have no opportunities for employment in the host countries and after return, they will be employed on the same conditions with those left behind in their home countries. On the other hand, internal enforcement is the restriction policy adopted within the host countries. The government detects illegal immigrants when they are employed. They live with the fear of detection throughout

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[1] Accounting to the Washington Post (by Griff Witt, May 18, 2015), the European border-control agency, Frontex, reported that 283,532 illegal border crossings were detected in 2014. Syrians fleeing civil war accounted for the largest group of migrants, or almost one in three. People from sub-Saharan Africa followed. The number of illegal crossings in 2015 was more than double than in the same period a year before.

[2] Accounting to the Washington Post (by Griff Witt, May 18, 2015), the number of migrants seeking asylum in Europe has more than tripled since 2008. Germany, Sweden, Italy, and France together received more than half of all new asylum applications in 2014.

their stay. If detected, they must return to their home country; however, their employers are penalized. Thus, employers pay discounted wage rates to illegal immigrants, considering this risk. Regarding the economic effects of these different two restriction methods of illegal immigration on factor prices and economic welfare, we have several accumulated studies and among all, contributions by Ethier (1986), Bond and Chen (1987), Yoshida (1993), and Kondoh (2000) are important.

We can categorize two types of illegal immigration in Europe depending on the economic situations of the countries that manage the border of the Schengen agreement. The first case is, as we can see at the Balkan Peninsula, the gateway country is at a medium level of development and the economic condition is fairly bad like Greece. In this case, it is quite difficult for illegal immigrants to find job opportunities, and even if they do, the wage rate is much lower than that of neighboring developed countries, which are in better economic condition. Most immigrants do not consider employment in the gateway country and prefer moving to better countries. This gateway country is just a means of transit for global labor flow; therefore, there is no motivation for this gateway country to bear the costs of restricting immigration. This implies that developed countries such as Germany are drowning in a flood of illegal immigration because of the free entry of workers from gate countries and developed countries can only practice the internal enforcement policy. Otherwise, by destroying or suspending the agreement, those countries might possibly introduce border controls between the gateway country. In this case, the developed countries have two political methods simultaneously, border control and internal enforcement.

The second case is, in the Mediterranean Sea, gateway countries are developed, and their economic condition is of a medium level similar to Italy (better than Greece but worse than Germany). Illegal immigrants find employment in such countries but the wage rate is relatively lower than in developed countries. Immigrants choose their country of residence by optimally comparing the expected wage rate in the gateway country with that of the final destination country, considering the possibility of detection by internal enforcement policies. In equilibrium, these two expected wage rates should be equal. The government of the gateway country is motivated to restrict the inflow of illegal immigrants because in equilibrium, some of them prefer to stay in that country, which may cause negative effects on the country's economic welfare. Therefore, the gateway country, which is just a quasi-transit country, adopts border control while the final destination country adopts internal enforcement. They can independently decide on the optimal restriction policies.

Several studies on immigration control policies apply to a two-country model;

however, few studies consider the interaction between more than three countries. We consider two types of gateway countries which stand midstream in international labor flow, and play the role of just a transit or quasi-transit country. Kondoh (2014) is one of the few examples that focused on the optimal economic policies of the midstream countries. However, Kondoh (2014) focused on the optimal policies of countries such as Thailand, which is confronted simultaneously with both illegal unskilled immigrants from much less developed neighboring countries and skilled workers brain drain to much developed countries. Kondoh's main interest is different from our study. On the other hand, there are other studies about the migrants' choice of destinations such as Giordani and Ruta (2013). They focused on the standard of restriction policies by the cooperation of multiple countries compared with the optimal level. Coniglio and Kondoh (2015) also adopted a three-country model where the immigration restriction concepts held by the two host countries are different, one country is quality-based while the other is quantity-based. They studied the liberalization of the labor market between two host countries.

In this study, we focus on a final destination developed country that is confronted with illegal immigration via two different types of midstream country. In Section 2, we present the basic model. In Section 3, we show the effects on factor prices, national income and the number of illegal immigrants, and the level of internal enforcement that satisfies the revenue-neutrality condition caused by an increase in illegal immigration to two different gateway countries. Moreover, we also studied the effects caused by stricter restriction policies in developed countries. We find that to enhance the wage rate of domestic workers and to reduce the possible negative social effects of increasing illegal immigrants, the final destination developed country should introduce border enforcement to free labor inflow from the gateway countries and, due to the revenue-neutrality constraint, the cost of this border enforcement is met by reducing the level of internal enforcement measures. Section 4 is devoted to the concluding remarks.

## 2. The Model

We develop a simple two-country model of international illegal migration, following Bond and Chen (1987) and Yoshida (1993). Both countries are developed and the existing firms produce a single manufactured good using constant returns to scale technology. The production functions of the two countries, Countries D and I, are $F(L,K)$ and $F^*(L^*,K^*)$, where $L$ and $L^*$ denote labor inputs, $K$ and $K^*$

denote capital inputs. The price of the good is assumed the numeraire. Technologies could differ between countries. The primary factors of production are labor and capital. We assume that Country D is the highly developed country and because of accumulated capital endowment, this country is relatively capital abundant. On the other hand, Country I is also developed but relatively labor abundant compared with Country D. In the absence of factor mobility, the wage rate of Country D, $w$, is higher than that of Country I's, $w^*$; the rental price of capital in Country D, $r$, is lower than that of Country I's, $w^*$.

Both developed countries, D and I, are members of large economic blocs like the European Union where all markets of goods and factors are integrated. Although a perfectly free border is realized between the members of this bloc, like the Schengen agreement, there exist factor price differences, $w > w^*$ and $r < r^*$; we assume no factor movement between two countries. The reason for this prudence is moving costs. The manufacturing industry needs large magnitude capital investments to set up the necessary machines and establish factory operations. This implies the existence of huge extra costs on scrap and build in the case of capital movement between two countries, which makes capital in Country D give up to move. In a similar fashion, we can also consider domestic workers' moving costs, which consists of basic trip and additional set-up costs. In international migration, workers must dispose of their assets, make special efforts to find new houses, job opportunities, and good schools for their children. This additional cost tends to be larger for the residents in the more developed countries. Therefore, in autarky, we assume that there is no motivation for domestic factor movement under the existence of a factor price gap.

Now we consider that the economic bloc of developed rich countries is confronted with the inflow of international immigration from developing countries. Generically, we name them Country S. We assume that Country I locates the border of the economic bloc, which is just next to Country S. Thus, workers immigrate to Country I at first. As opposed to domestic workers, there is no set-up cost for immigrants from developing countries. Those just entered in Country I are eager to move to Country D because of its higher wage rate especially if the basic trip cost is sufficiently small. In other words, Country D is the final destination for foreign immigrants and Country I is just the gateway.

Countries D and I know that introducing immigrants enhance GDP or national income, as shown by Wong (1995). In order to protect the domestic workers' income, those countries have the intention to introduce restriction policies. In country D, immigration from Country S is illegal. Since Country D does not share borders with Country S, and

free mobility for illegal immigrants is guaranteed by the no-passport control within integrated developed countries, the only available option is internal enforcement policies to control the number of immigrants. If firms employing such workers are detected, they must pay penalty costs and immigrants are deported to their home country.[3] Penalty fees should finance the cost of this restriction policy, that is, financial balances should be satisfied through policy sustainability. On the other hand, the immigration control by Country I, which shares borders with Country S, is border enforcement. We assume border restrictions require public expenditure while it is almost impossible to collect penalty fees from detected and repulsed workers who have no money, as they are not employed in Country I yet.

Following Bond and Chen (1987) and Yoshida (1993), illegal immigrants are assumed to be indifferent between working in Country I (after successfully breaking through the border) and working illegally in Country D, provided that they are given the same expected wage. We consider two different ways for illegal immigrants to enter the economic bloc. The first way is, as mentioned before, via Country I. In equilibrium, some of the immigrants who successfully entered the bloc are employed in Country I and others are employed in Country D with the same expected wage rate. Another way is via the third country, Country G. This country is also one of the bloc's members but because of low capital accumulation and high unemployment rate caused by poor economic policies, we assume the expected wage rate of this country, $w^{**}$, is lower than that of Country I's, $w^{*}$. This relation implies that no immigrants will stay in Country G to find job opportunities, that is, Country G is just a transit country for immigrants and all immigrants can go straight to Country D without any border control because Country G is also the member of border free agreement. Let $H$ denote the number of illegal immigrants in Country D via Country G and let $M$ denote the number of illegal immigrants to Country D via Country I. Note that even with a low wage rate, workers in domestic Country G do not try to migrate because of the existing set-up costs.

The firm in Country D is risk neutral, and is indifferent between domestic and illegal workers from two different routes. The cost of employing an illegal immigrant consists of the worker's wage and the expected value of the penalty fine if the authorities detect illegal employment. In equilibrium, the following equation is satisfied:

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

[3] The illegal immigrants detected must return to Country I; however, the same numbers of immigrants return and we have the exact same equilibrium in the next period.

where $p(E, M+H)$ is the probability that illegal immigrants are detected, with $p(0,H)=0, p \le 1, p^1 \equiv \partial p/\partial E > 0, p^{11} \equiv \partial^2 p/\partial E^2 < 0, p^2 \equiv \partial p/\partial (M+H) < 0$ , and $p^{22} \equiv \partial^2 p/\partial (M+H)^2 < 0$; $z$ is the fine which firms pay for each illegal worker caught by the government's internal enforcement policy and $E$ is the level of enforcement.

Additionally, following Yoshida (1993), the production function of a firm in Country D can be rewritten as $F(L,K) = Kf(\lambda)$, where $\lambda = L/K$ and $f' > 0, f'' < 0$. Under perfect competition, the first order conditions for a firm's profit maximizing condition yields

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

$$f(\lambda) - \lambda f'(\lambda) = r. \tag{3}$$

From (3), we easily obtain

$$\lambda = \lambda(w), \quad \lambda' = 1/f'' < 0. \tag{4}$$

Similarly the production functions of a firm in Country I can be rewritten by $F^*(L^*, K^*) = K^* f^*(\lambda^*)$, where $\lambda^* = L^*/K^*$ and $f^{*\prime} > 0, f^{*\prime\prime} < 0$.

Let us examine the equilibrium condition in the factor markets. In the market of Country D, we have

$$\lambda(w^* + p(E, M+H)z)\bar{K} = \bar{L} + M + H, \tag{5}$$

where $\bar{K}$ and $\bar{L}$ are the initial factor endowments of Country D and $M$ is the number of illegal immigrants from Country I.

In Country I, the following condition holds in equilibrium:

$$\lambda^*(w^*)\bar{K}^* = \bar{L}^* + N - M, \tag{6}$$

where $\bar{K}^*$ and $\bar{L}^*$ are the initial domestic factor endowments of Country I before migration to D. We need to remark that in Country I, there exist illegal immigrants who had already come outside from the economic bloc. $N$ denotes those illegal immigrants from Country S. Again, we need to remark that the national income of Country I only includes domestic capital and labor incomes.

We assume that the enforcement policy of Country D is endogenously

determined to satisfy the revenue-neutrality condition.[4] Let $v$ denote the cost associated with returning illegal immigrants to Country I and collecting fines from firms caught hiring them. Additionally, let us assume that the level of enforcement $E$ is also the cost of catching illegal immigrants, which implies that the additional expenditure to detect illegal immigrants will linearly enhance the enforcement level. Thus, the financial balance condition that implies that the government's net income from restriction policy is null, can be expressed as

$$\Psi \equiv (z-v)\,p(E, M+H)[M+H]-E=0\,. \tag{7}$$

By totally differentiating (1), (2), and (3), we have

$$dr=-\lambda dw=-\lambda(dw^*+z\,dp)\,. \tag{8}$$

The effect of increasing exogenous variables on $r$ is opposite to its effect on $w$. Similarly, we obtain the equations for Country I as follows:

$$\lambda^*=\lambda^*(w^*),\quad d\lambda^*/dw^*=1/f^{*\prime\prime}<0\,. \tag{9}$$

Additionally, the relationship between the effects on factor prices of Country I are derived as follows:

$$dr^*=-\lambda^* dw^*\,. \tag{10}$$

From (10), it is clear that the effect of changing exogenous variables on $r^*$ is opposite to its effect on $w^*$, as was the case in Country D.

Now we have three equations, (5), (6), and (7), and the three endogenous variables, $w^*$, $M$, and $E$ will be determined if $\overline{K}, \overline{L}, \overline{K^*}, \overline{L^*}, z, v, N$, and $H$ are

[4] The level of enforcement is usually determined considering several complex factors. Maximizing national welfare or income of the host country seems the most reasonable. In the usual case, national welfare includes the term of social safety or stability, which is considered a decreasing function of the number of illegal immigrants. This is the reason why host countries restrict immigration, which causes negative effects on national income. Moreover, concerning international harmony or global welfare, this self-complacent policy, which usually obtains profits from detecting illegal immigrants, might not be favored by foreign countries. Here, instead, we introduce financial balance as a more acceptable and sustainable restriction policy target.

exogenously given.

## 3. Analysis

Under constant domestic labor in Country D, total differentiation of (5), (6), and (7) yield

$$\begin{bmatrix} \lambda'\bar{K}p^2z-1 & \lambda'\bar{K} & \lambda'p^1z\bar{K} \\ 1 & \lambda^{*\prime}\bar{K}^* & 0 \\ \partial\Psi/\partial M & 0 & \partial\Psi/\partial E \end{bmatrix}\begin{bmatrix} dM \\ dw^* \\ dE \end{bmatrix}=\begin{bmatrix} 1-\lambda'p^2z\bar{K} \\ 0 \\ -\partial\Psi/\partial H \end{bmatrix}dH+\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}dN, \tag{11}$$

where by the assumption of the existence of the financial balance level of enforcement and $p^{11}\equiv\partial^2 p/\partial E^2<0$, we can assert $\partial\Psi/dE=(z-v)p^1(M+H)-1<0$. We also can assert that $\partial\Psi/dM=\partial\Psi/dH=(z-v)[p+p^2(M+H)]>0$ because increasing the number of immigrants usually reduce the probability of detection for each immigrant but it will enhance the number of detected immigrants in total.

The determinant of LHS matrix of (11) is

$$\Delta=\lambda^{*\prime}\bar{K}^*\Theta-(\partial\Psi/\partial E)\lambda'\bar{K}<0, \tag{12}$$

where

$\Theta\equiv(\lambda'\bar{K}p^2z-1)(\partial\Psi/\partial E)-\lambda'\bar{K}p^1z(\partial\Psi/\partial M)=-(\partial\Psi/\partial E)-[(z-v)pp^1+p^2]\lambda'\bar{K}z>0$.

### 3.1 Effects of an Increase in Illegal Immigration via Country G

From (11), we obtain

$$\Delta[dw^*/dH]=\Theta>0,, \tag{13}$$

$$\Delta[dM/dH]=-\lambda^{*\prime}\bar{K}^*\Theta>0, \tag{14}$$

$$\Delta[dE/dH]=(\partial\Psi/\partial M)\lambda'\bar{K}<0, \tag{15}$$

which implies $dw^*/dH<0$, $dr^*/dH>0$, $dM/dH<0$ and $dE/dH>0$. From (8), we also have

$$\begin{aligned}\Delta[dw/dH] &= \Delta\{dw^*/dH + p^1 z(dE/dH) + p^2 z[1+(dM/dH)]\} \\ &= -(\partial\Psi/\partial E)[1+\lambda^{*\prime}\bar{K}^* p^2 z] > 0.\end{aligned} \tag{16}$$

This implies that $dw/dH < 0$ and $dr/dH > 0$.

GDP or the national income of Countries D and I can be expressed as $Y = w\bar{L} + r\bar{K}$ and $Y^* = w^*\bar{L}^* + r^*\bar{K}^* - B$, respectively, where $B$ denotes the costs of border enforcement of Country I. Therefore, we can obtain

$$\begin{aligned}dY/dH &= \bar{L}(dw/dH) + \bar{K}(dr/dH) \\ &= (\bar{L} - \lambda\bar{K})(dw/dH) \\ &= -(M+H)(dw/dH) > 0,\end{aligned} \tag{17}$$

$$\begin{aligned}dY^*/dH &= L^*(dw^*/dH) + \bar{K}^*(dr^*/dH) \\ &= (L^* - \lambda^*\bar{K}^*)(dw^*/dH) \\ &= -(N-M)(dw^*/dH) > 0,\end{aligned} \tag{18}$$

where we need to remark that $M < N$, which implies that not all illegal immigrants from Country S to I migrate to Country D.

Finally, we need to consider national welfare. It is widely known that introducing foreign workers usually causes positive effect on national income. However, most of the developed countries intend to restrict the inflow of foreign workers. This is because the existence of negative externalities by those immigrants, such as social instability and a lack of safety or the generation of necessary social costs like education. Now we introduce welfare functions of Countries D and I, respectively, $W(M+H) = Y(M+H) - \zeta(M+H)$ and $W^*(N-M) = Y^*(N-M) - \zeta^*(N-M)$, where $\zeta$ denotes the negative externalities caused by immigrants. We have $Y' > 0$ and $Y'' < 0$ while we reasonably assume that the property of the negative externality function as $\zeta' > 0$ and $\zeta'' > 0$. Let us assume that at the initial equilibrium, both $W' < 0$ and $W^{*\prime} < 0$ are satisfied, which justifies the stricter restriction policies by Countries D and I as intended.

Now we have the following results, which follows our intuition: increasing illegal immigrants via Country G will reduce the amount of illegal immigrants in Country D from Country I, reduce the wage rates and national welfare while enhancing the rental prices of capital and national incomes of both Countries D and I. The wage rate of Country I decreases because increased labor endowment caused by immigration

from Country G to D reduces the wage rate of Country D, and from (1), this leads to negative effects on the wage rate of Country I. Decreasing wage rate in Country I implies increased labor/capital ratio in that country, which means decreased illegal migration from Country I to D.

## 3.2 Effects of an Increase in Illegal Immigrants in Country I

The number of illegal immigrants in Country I depends on the border control policy imposed by the government. Usually, as shown by Wong (1995) for example, immigration is beneficial for the host country and border control cost dominates the penalty fees, which are collected by detected immigrants without enough assets. Therefore, the main economic purpose of the restriction of immigrants for Country I is to protect domestic workers' income under the insufficient public income redistribution system.

Let us consider the case that Country I is confronted with the larger number of illegal labor inflow. Then total labor endowment should increase without the introduction of a higher level border enforcement. From (11), we have:

$$\Delta[dw^*/dN] = \Theta > 0, \tag{19}$$

$$\Delta[dM/dN] = -\lambda'\bar{K}(\partial\Psi/\partial E) < 0, \tag{20}$$

$$\Delta[dE/dN] = (\partial\Psi/\partial M)\lambda'\bar{K} < 0, \tag{21}$$

$$\begin{aligned}\Delta[dw/dN] &= \Delta[dw^*/dN + p^1 z(dE/dN) + p^2 z(dM/dN)] \\ &= -(\partial\Psi/\partial E)[1 + (\lambda'\bar{K} + \lambda^{*\prime}\bar{K}^*)p^2 z)] - z\lambda'\bar{K}p^2 z\lambda^{*\prime}\bar{K}^* \\ &> 0,\end{aligned} \tag{22}$$

where from (19) to (22) implies $dw/dN < 0$, $dr/dN > 0$, $dw^*/dN < 0$, $dr^*/dN > 0$, $dM/dN > 0$, and $dE/dN > 0$.

Moreover, we also have

$$\begin{aligned}dY/dN &= \bar{L}(dw/dN) + \bar{K}(dr/dN) \\ &= (\bar{L} - \lambda\bar{K})(dw/dN) \\ &= -(M + H)(dw/dN) > 0.\end{aligned} \tag{23}$$

$$\begin{aligned}dY^*/dN &= L^*(dw^*/dN) + \bar{K}^*(dr^*/dN) \\ &= (L^* - \lambda^*\bar{K}^*)(dw^*/dN) \\ &= -(N - M)(dw^*/dN) > 0.\end{aligned} \tag{24}$$

Now we have the following results: increasing illegal immigrants to Country I will enhance the number of illegal immigrants in Country D from Country I, reduce the wage rates and national welfare, while enhancing the prices of capital and national incomes of both Countries D and I.

We need to remark that comparing the two immigration cases, an increase in $H$ and $N$, the effects on factor prices, the national income of Country I, and the financial balanced enforcement level of Country D are exactly the same in sign and magnitude, that is, $dw^*/dH = dw^*/dN < 0$, $dr^*/dH = dr^*/dN > 0$, $dY^*/dH = dY^*/dN > 0$, and $dE/dH = dE/dN > 0$. On the other hand, the effects on the number of illegal immigrants from Country I to D, factor prices, and the national income of Country D are not the same. Regarding illegal immigrants from Country I to D, we have $dM/dH < 0$, $dM/dN > 0$, and $|dM/dH| \neq |dM/dN|$. Moreover, from (16) and (22), we have $dw/dN < dw/dH < 0$, and therefore, $dr/dN > dr/dH > 0$ and $dY/dN > dY/dH > 0$, which implies that the magnitude of the positive effect on national income and the negative effect on domestic wage rate caused by the marginal increase in illegal immigrants from Country S to I should be larger than those with a marginal increase in illegal immigrants from Country S to G. This is because in the former case, additional immigration encourages existing illegal immigration from I to D, while it does not in the latter case.

Now we have the following proposition:

**Proposition 1**: The magnitude of the positive effect on national income and the negative effect on domestic wage rate caused by marginal increase in illegal immigrants from Country S to I are larger than those with a marginal increase in illegal immigrants from Country S to G.

### 3.3 Choice of Optimal Routes

We now in turn focus on the border enforcement policy by Country I and the optimal choice of migration routes by potential migrants in Country S. Let us consider that all potential migrants in Country S are uniformly distributed in the territory, which spans a large area and is located next to both Countries I and G. Each country has only

one possible gate. A potential migrant must pay trip cost, which depends on the distance between his residence area and the entrance gate. Let us define the distance between the two gates in terms of units, and assume $L_S$ as the number of potential migrants living in every continuous spot between the two gates. Remember that Country I enforces border control. Therefore, some migrants can fail to enter. To simplify our analysis and adopt a realistic assumption, we ignore penalty charges imposed on detected illegal immigrants at the border. Let $\alpha$ denote the probability of success to enter Country I illegally; $\mu$ denotes the necessary unit one-way trip cost; and $\underline{w}$ denotes the wage rate of Country S.

The expected income for a potential migrant traveling the distance $t$ from his home to the gate of Country I can be expressed as $\alpha w^* + (1-\alpha)\underline{w} - t\mu$ if he intends to migrate to Country I. We assume that a potential immigrant who is not successful in crossing the border will find his job opportunities at the border town of Country S. Thus, he does not return to his home town. On the other hand, his residence is located $(1-t)$ far from Country G's gate. Since there is no border control at this gate, and he straightforwardly can move to Country D; thus, the expected income in this case can be expressed as $w^* - (1-t)\mu$. Let us define $\tilde{t}$ as the point that satisfies

$$\alpha w^* + (1-\alpha)\underline{w} - \tilde{t}\mu = w^* - (1-\tilde{t})\mu , \tag{25}$$

where at the residence $\tilde{t}$, potential workers' expected income from illegal migration to Country I is just equal to that of Country D via Country G. From (25), we have

$$\tilde{t} = \frac{1}{2} - \frac{(1-\alpha)(w^* - \underline{w})}{2\mu}, \tag{26}$$

and we easily recognize that $\tilde{t}$ is an increasing function of $\alpha$.[5] Workers whose residence area is less (larger) than $\tilde{t}$ optimally choose to migrate to Country I (G), respectively.

## 3.4 Stricter Border Enforcement Policy by Country I

Let us assume that Country I starts to adopt stricter border enforcement that

[5] We assume that (26) is positive in sign. If (26) is negative, all potential migrants in Country S move to the gate of Country G.

results in decreasing $\alpha$.[6] We need to remark that immigrants from Country S, can now be expressed as $H = (1-\tilde{t})L_S$ and $N = \alpha\tilde{t}L_S$. We also need to remark that stricter border enforcement will cost more, that is, $B(\alpha) < 0$. Totally differentiating (5), (6), (7), and (25), we have the following equation system which endogenously determines $w^*, M, E,$ and $\tilde{t}$ under the political choice of $\alpha$.

$$\begin{bmatrix} \lambda'\bar{K}p^2z-1 & \lambda'\bar{K} & \lambda' p^1 z\bar{K} & -(\lambda'\bar{K}p^2z-1)L_S \\ 1 & \lambda^{*\prime}\bar{K}^* & 0 & -\alpha L_S \\ \partial\Psi/\partial M & 0 & \partial\Psi/\partial E & -(\partial\Psi/\partial M)L_S \\ 0 & 1-\alpha & 0 & 2\mu \end{bmatrix} \begin{bmatrix} dM \\ dw^* \\ dE \\ d\tilde{t} \end{bmatrix} = \begin{bmatrix} 0 \\ \tilde{t}L_S \\ 0 \\ (w^*-\underline{w}) \end{bmatrix} d\alpha \,. \tag{27}$$

The determinant of the LHS matrix of (27) is $\Delta' = 2\mu\Delta - (1-\alpha)^2 L_S\Theta < 0$. By simple calculation, we have

$$\begin{aligned} dM/d\alpha = (\Delta')^{-1}\{&[-\tilde{t}(1-\alpha)L_S + (w^*-\underline{w})\lambda^{*\prime}\bar{K}^*]\Theta L_S \\ &-(\partial\Psi/\partial E)\lambda'\bar{K}L_S[2\mu\tilde{t} - \alpha(w^*-\underline{w})]\} > 0, \end{aligned} \tag{28}$$

$$dw^*/d\alpha = (\Delta')^{-1}[-\mu(1-4\tilde{t})(1-\alpha)L_S\Theta], \tag{29}$$

$$dE/d\alpha = (\Delta')^{-1}[-\mu(1-4\tilde{t})](\partial\Psi/\partial M)\lambda'\bar{K}L_S, \tag{30}$$

$$\begin{aligned} d\tilde{t}/d\alpha = (\Delta')^{-1}\{&[-\tilde{t}(1-\alpha)L_S + (w^*-\underline{w})\lambda^{*\prime}\bar{K}^*]\Theta \\ &-(\partial\Psi/\partial E)\lambda'\bar{K}(w^*-\underline{w})\} > 0. \end{aligned} \tag{31}$$

The above results show that if Country I adopts stricter border enforcement policy, then the number of illegal immigrants from S to I and I to D, denoted by $N$ and $M$ respectively, will decrease, while illegal immigrants from G to D denoted by $H$ will increase. The sign of (29) and (30) depends on the degree of initial border enforcement of Country I. If Country I adopted a sufficiently strict enforcement to satisfy $\tilde{t} < 1/4$ or $2(1-\alpha)(w^*-\underline{w}) > \mu$, we conclude that $dw^*/d\alpha > 0$ and $dE/d\alpha < 0$. This implies that additional and stricter border enforcement policy by Country I will reduce its wage rate (implying that the reduction of $N$ is dominated by reduction of $M$ and

[6] As we do not consider the penalty charge which should be paid by the illegal immigrants detected at the border, there is no revenue-neutrality constraint of Country I. Country I determines the level of $B$ or $\alpha$ exogenously to fit political target.

surprisingly, regardless of stricter immigration policy, total labor endowment in Country I will increase) and enhance the internal enforcement effort by Country D (which is necessary to realize the reduction of $M$ ). On the other hand, if Country I's border enforcement is not too strict and satisfies $\tilde{t} > 1/4$ or $2(1-\alpha)(w^* - \underline{w}) < \mu$, we conclude $dw^*/d\alpha < 0$ and $dE/d\alpha > 0$, which implies that stricter border enforcement policy by Country I will reduce its wage rate (this means that the reduction of $N$ is not dominated by the reduction of $M$ and the total labor endowment in Country I will decrease) and reduce the internal enforcement effort by Country D.

From (10), we also have $dr^*/d\alpha < (>)0$ if $\tilde{t} < (>)1/4$ and in a similar fashion by deriving (18) and (24), we also can obtain $dY^*/d\alpha > 0$ if $\tilde{t} > 1/4$. It is necessary to remark that even in case that $\tilde{t} < 1/4$, as stricter border enforcement implies higher cost, $B$, we cannot conclude $dY^*/d\alpha < 0$ straightforwardly. Moreover, under the assumption of $W^{*\prime} < 0$, we also can conclude that $dW^*/d\alpha < 0$ if $\tilde{t} > 1/4$.

Concerning Country D, we have

$$\begin{aligned} dw/d\alpha &= K^{-1} f''[(dM/d\alpha) - L_S(d\tilde{t}/d\alpha)] \\ &= K^{-1} f''(\Delta')^{-1}\{(\partial\Psi/\partial E)\lambda'\bar{K}L_S[2(1-\alpha)(w^* - \underline{w}) - \mu], \end{aligned} \tag{32}$$

which implies that $dw/d\alpha > (<)0$ if $\tilde{t} < (>)1/4$ and similar to that of Country I, also $dr/d\alpha < (>)0$, $dY/d\alpha < (>)0$ and $dW/d\alpha > (<)0$ if $\tilde{t} < (>)1/4$. If the initial border enforcement is high, additional stricter immigration reduces illegal immigration from I to D, denoted by $M$ but this effect is dominated by the increased number of illegal immigrants from G to D, denoted by $H$ caused by reduction in $\tilde{t}$. Therefore, the wage rate in Country D as well as that of Country I will decrease in this case. The above results imply that if Country D continues to depend on and encourage the border enforcement policy by Country I, the accumulated stricter restriction will harm the economic welfare of Country D in due course.

Now we establish the following Proposition.

**Proposition 2**: 1). Introduction of stricter border enforcement by Country I will reduce the wage rate and national welfare, while it will enhance the rental price of capital and national income of each Country, I and D, if the initial level of border enforcement by Country I is not so strict to satisfy $\tilde{t} > 1/4$, that is, if a unit trip cost is sufficiently small to satisfy $2(1-\alpha)(w^* - \underline{w}) > \mu$.

2) Introduction of stricter border enforcement by Country I will enhance the wage rate

while it will reduce the rental price of capital of each Country, I and D, and it also will reduce national income but will enhance national welfare of Country D, if the initial level of border enforcement by Country I is sufficiently strict to satisfy $\tilde{t} < 1/4$, that is, if a unit trip cost is sufficiently large to satisfy $2(1-\alpha)(w^* - \underline{w}) < \mu$.

3) Introduction of the stricter border enforcement by Country I will reduce the number of illegal immigrants from Country I to D.

## 3.5 Introduction of Border Control between Countries D and G

Finally, let us consider the case where Country D starts to introduce border control between Country G to reduce the inflow of illegal immigrants from Country S via Country G.[7] Let $\beta$ denote the probability of success to enter Country D from G illegally. All the failed workers must go back to Country G and their wage rate is that of Country G, $w^{**}$. Now let us define $\hat{t}$ as the point that satisfies

$$\alpha w^* + (1-\alpha)\underline{w} - \hat{t}\mu = \beta w^* + (1-\beta)w^{**} - (1-\hat{t})\mu, \tag{33}$$

where at residence $\hat{t}$, the potential workers' expected income from illegal migration to Country I is just equal to that of Country D via Country G. We note that immigrants from Country S can be expressed as $H = \beta(1-\hat{t})L_S$ and $N = \alpha\hat{t}L_S$. The revenue-neutrality constraint for Country D can be rewritten as

$$\Phi \equiv (z-v)p(E, M+H)[M+H] - E - J(\beta) = 0, \tag{34}$$

where $J$ denotes the cost of border enforcement and $J'(\beta) < 0$.

Let us consider the case of decreasing $\beta$. Total differentiation of (5), (6), (34), and (33) results in the following:

[7] In 2016, Sweden temporarily introduced border control with Denmark to prevent the free inflow of refugees already inside the Schengen area.

$$\begin{bmatrix} \lambda'\bar{K}p^2z-1 & \lambda'\bar{K} & \lambda'p^1z\bar{K} & -(\lambda'\bar{K}p^2z-1)L_S \\ 1 & \lambda^{*\prime}\bar{K}^* & 0 & -\alpha L_S \\ \partial\Phi/\partial M & 0 & \partial\Phi/\partial E & -(\partial\Phi/\partial M)L_S \\ 0 & \beta-\alpha & 0 & 2\mu \end{bmatrix}\begin{bmatrix} dM \\ dw^* \\ dE \\ d\hat{t} \end{bmatrix} = \begin{bmatrix} -(\lambda'\bar{K}p^2z-1)(1-\hat{t})L_S \\ 0 \\ J'-(\partial\Phi/\partial M)(1-\hat{t})L_S \\ -(w^*-w^{**}) \end{bmatrix} d\beta. \tag{35}$$

As $\partial\Phi/\partial M = \partial\Psi/\partial M = \partial\Phi/\partial H = \partial\Psi/\partial H$, we can conclude that the determinant of the LHS matrix of (34), $\Delta''$, is negative in sign under the assumption that $\beta > \alpha$.

By simple calculation, we have,

$$\begin{aligned} dM/d\beta = (\Delta'')^{-1}\{&[2\mu\lambda^{*\prime}\bar{K}^* + (\beta-\alpha)\alpha L_S][-(1-\hat{t})\Theta L_S - J'\lambda'p^1z\bar{K}] \\ &+ (w^*-w^{**})[-\lambda^{*\prime}\bar{K}^*\beta L_S\Theta + (\partial\Psi/\partial E)\alpha L_S\lambda'\bar{K}]\}, \end{aligned} \tag{36}$$

$$\begin{aligned} dw^*/d\beta = (\Delta'')^{-1}\{&[-\Theta - J'\lambda'p^1z\bar{K}] \\ -(w^*-w^{**})L_S[&-\alpha\Theta + (\partial\Phi/\partial M)\lambda'p^1z\bar{K} - (\lambda'p^2z\bar{K}-1)(J'-(\partial\Phi/\partial M)(1-\hat{t})L_S]\} < 0, \end{aligned} \tag{37}$$

$$\begin{aligned} dE/d\beta = (\Delta'')^{-1}\{&2\mu[(\lambda'p^2z\bar{K}-1)\lambda^{*\prime}\bar{K}^*J' - \lambda'\bar{K}(J'-(\partial\Phi/\partial M)(1-\hat{t})L_S)] \\ &+ (w^*-w^{**})[(\partial\Psi/\partial M)(1-\alpha)\lambda'\bar{K}L_S] \\ &- J'(\beta-\alpha)(1-\alpha)(\lambda'p^2z\bar{K}-1)L_S\} > 0, \end{aligned} \tag{38}$$

$$\begin{aligned} d\hat{t}/d\beta = (\Delta'')^{-1}\{&(w^*-w^{**})[-(\partial\Psi/\partial E)\lambda'\bar{K} + \lambda^{*\prime}\bar{K}^*\Theta] \\ &-(\beta-\alpha)[\lambda'p^1z\bar{K}J' + \Theta(1-\hat{t})L_S]. \end{aligned} \tag{39}$$

Here we consider the case that Country D adopts border enforcement policy between Country G. The above results show that keeping the financial balance, the stricter border enforcement of Country D will reduce the effort of internal enforcement, that is, policy conversion without additional public spending. The wage rate of Country I will increase, which also implies that $dr^*/d\beta > 0$, $dY^*/d\beta > 0$ and $dW^*/d\beta < 0$. From (36) and (39), we obtain $dM/d\beta < 0$ and $d\hat{t}/d\beta < 0$ if $\beta$ is not much larger than $\alpha$ ($\beta \gtrapprox \alpha$).

Concerning Country D, we have

$$
\begin{aligned}
dw/d\beta &= K^{-1} f''[(dM/d\beta) - \beta L_S (d\tilde{t}/d\beta) + (1-\hat{t})L_S] \\
&= K^{-1} f''(\Delta'')^{-1}\{(\partial\Psi/\partial E)\lambda'\bar{K}[-(\beta-\alpha)(w^*-w^{**}) - 2\mu L_S] \\
&+(1-\hat{t})L_S{}^2\Theta[(\beta-\alpha)^2 - (1-\alpha)^2] + J'\lambda' p^1 z\bar{K}[-2\mu\lambda^{*\prime}\bar{K}^* + (\beta-\alpha)^2 L_S]\},
\end{aligned}
\tag{40}
$$

and the sign of (40) should be negative if $J'$ is sufficiently small, that is, additional border enforcement for Country D does not cost a lot. In the above situation, we have $dw/d\beta < 0$, $dr/d\beta > 0$, $dY/d\beta > 0$, and $dW/d\beta < 0$. We need to remark that these results do not depend on the level of border enforcement by Country D.

Now we establish the following Proposition.

**Proposition 3**: Consider that Country D started to convert immigration policies from internal enforcement to border enforcement while satisfying the revenue-neutrality constraint. Thus, if border control is still weaker than that of Country I and additional costs of border enforcement are sufficiently small, introducing stricter border control for illegal immigrants from Country G will enhance the wage rates and national welfare, while reducing internal enforcement expense, rental prices of capital, and national incomes of both Countries D and I.

We need to remark that if Country D intends to enhance domestic workers' wage rate or national welfare, then introducing border enforcement between Country G and restricting the inflow of illegal immigrants that partially substitutes for the previous internal enforcement policy, will cause a positive effect under certain conditions due to this stronger control. These political targets can be attained by maintaining financial balance; additionally, not only can Countries D enjoy positive results, but also members of the same economic bloc of developed countries, Country I. On the other hand, if Country D does not introduce border enforcement and continues to depend on the border enforcement policy by Country I, accumulated stricter restriction will harm the economic welfare of Country D after a while.

## 4. Concluding Remarks

We show the effects on factor prices, national income and welfare, the number of illegal immigrants, and the level of internal enforcement caused by an increase in illegal

immigration to two different gateway countries. Moreover, we also studied the effects caused by the introduction of stricter restriction policies by two developed countries. We find that to enhance the wage rate of domestic workers and national welfare, under certain conditions, the final destination developed country should introduce border enforcement to the free labor inflow from the gateway countries and should be partially substituted for the previous internal enforcement policy.

This study still has several topics for further extension. First, we need to consider that the final destination country, Country D, maximizes welfare while ignoring revenue-neutrality constraint. Second, we can also consider the cooperation of two developed countries taking into account aggregate welfare maximization. Third, we need to consider international capital movement, the direction of which is opposite to international migration.

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