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Abstract

This paper examines the efficacy of internal and external enforcement policy to combat illegal immigration. The model features search-theoretic unemployment and policy interdependency among multiple destination countries. With one destination country, internal and external enforcement policy have similar effects. With multiple destination countries, we consider prototypal geographical configurations. In one, all destinations are contiguous with the source country, while in the other only one destination country is contiguous with the source country. In both cases the equilibrium external enforcement policy level is lower than the joint optimum, calling for supranational authorities to implement immigration policy. In the absence of such policy, we consider the effect of delegating border control policy to one destination country and find that delegation of authorities to the largest country can improve each destination country's welfare relative to the Nash equilibrium level.

Keywords: illegal immigration, immigration policy, multiple destinations, job search

JEL classification: F22, F66, H77, J61, J64

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1 Introduction

Illegal immigration is a perennial problem facing many developed countries. Every year, an estimated half a million immigrants enter the United States illegally. Across the Atlantic, there were more than 276,000 illegally entries into the European Union in 2014, a figure which is likely to climb in the coming years. Given such large flows of illegal immigrants, it is hardly surprising that illegal immigration has attracted much attention from economists. While much of the literature is empirical, Ethier (1986) developed a formal framework of illegal immigration and examined the efficacy of border control (external enforcement) and employer sanctions (internal enforcement) from the host country's perspective. His model has since been extended to examine various immigration-related issues; see, e.g., Bond and Chen (1987), and Yoshida and Woodland (2005), among others.

In this paper we reconsider the immigration policy in a new environment. First, there seems more demand for immigration control when the economy has high rates of unemployment. To model unemployment, Ethier (1986) and subsequent writers have assumed unemployment due to wage rigidity (e.g., wages set by minimum wage legislation or by labor unions) in the tradition of the Harris and Todaro (1970) model. In this paper we replace the rigid-wage model with the search-theoretic model of unemployment developed by Pissarides (2000); see also Rogerson, Shimer and Wright (2005).

Second, and more importantly, Ethier (1986) and subsequent writers have analyzed the setting with one destination country. In contrast, our model has multiple destination countries. Multiplicity of destinations highlights potential policy conflict among destination countries. To understand the nature of such conflict we focus on two prototypal geographical configurations. One has when all destination countries bordering the source country so that immigrants first cross the border where enforcement is the weakest and then move to the destinations of their preferences. As this is the configuration that applies to some U.S. states contiguous with Mexico, we call it the American (or common-border) case.

The other prototypal geographical configuration has only one destination country bordering the source country so that all immigrants must enter that country first before moving on to other destinations. As this setup is a more suitable in analysis of policy conflict between, say, Greece, which serves as the main point of entry to Europe, and Germany, the eventual destination of most immigrants to the European Union, we call this configuration the European (or single-border) case.

We now outline our paper. We start with the baseline model, where there is one small destination country. Its main objective is to incorporate illegal immigration into the standard model of equilibrium unemployment. In this model all active firms randomly experience idiosyncratic adverse shocks that cause job separations. Firms employing illegal immigrants face an additional risk of job separations when employer sanctions programs are in effect. This model shows that tighter border control raises wages and reduce unemployment rates for both native and immigrant workers while stemming immigration flows. Employer sanctions have similar effects.

We next consider the cases with multiple destination countries. We begin with the American case, where all destination countries (or states) simultaneously and independently choose levels of border control policy. Since the country with the weakest border control determines flows of immigration into all the destination countries, the model is an application of Hirshleifer's weakest-link model (Hirshleifer 1983, 1985). As such, the model yields a continuum of Nash equilibria the in external enforcement policy game. Further, if all destination countries are symmetric, the equilibrium policy includes the joint optimum. If the countries are asymmetric, however, the jointly optimum border control policy is not in the set of Nash equilibria, giving rise to real policy conflict among the destination countries.

In the European case, the simultaneous policy game yields the unique equilibrium in which the border country implementing its first best policy while all the other destination countries implementing internal enforcement policy efficiently. However, since the border country fails to take into account the effect of its immigration policy on the other destination countries, the equilibrium level of border control falls short of the joint optimum. In fact, the jointly optimal border control level exceeds that any destination country prefers.

Although we observe inefficient outcomes in both the American and the European case, the inefficiencies arise for different reasons: in the American case, border control enforcement is akin to a public good, and the built-in weakest-link structure leads to underprovision of the public good. By contrast, the inefficiency in the European case is ascribed to the standard externalities; the unique border country fails to take into account the other destinations' welfare when implementing its external enforcement policy. In contrast, in both scenarios, internal enforcement policy suffers no externalities and so can be implemented efficiently in each country (given the equilibrium border control policy).

We now relate this paper to the recent literature. Giordani and Ruta (2013) consider what we call the American case. They show the existence of continuous Nash equilibria and highlight border policy coordination failures among symmetric multiple destination countries. However, there are some notable differences between their analysis and ours. First, their analysis is limited to border control policy in the American case with symmetric destination countries. Second, their model is more abstract, and so is not suited to study the effects of immigration policy on the domestic economy. Equilibrium unemployment is featured in the immigration model of Chassanboulli and Palivos (2014). In contrast to the present work, these authors consider legal immigration in a two-country setting so there are no discussion of policy conflict among destination countries.

The remainder of the paper proceeds as follows. Section 2 provides the baseline equilibrium unemployment model with a single destination country. Section 3 examines the properties of immigration policies in the baseline model. Section 4 characterizes the optimal immigration policy in the baseline model. Section 5 extends the analysis to the American case of multiple destinations. Section 6 does the same to the European case. Section 6 concludes the paper.

2 The baseline model: a single destination country

2.1 Model structure

Consider the two-country set up as in Ethier (1986), where the destination country is small and suffers unemployment. Focus is on the destination country, where there are L_n native workers and L_m illegal immigrant workers. L_n is exogenous while L_m is to be determined endogenously. All immigrants are assumed illegal; if there are legal immigrants, they are treated as part of the native labor force.

The model features equilibrium unemployment. To keep focus on immigration issues, we adopt the simplest model structure. Unemployed workers and firms with unfilled positions search each other and are matched in a Poisson process through the matching function, which is homogeneous of degree one in the number of workers and firms in search. Let θ denote the ratio of vacant jobs over unemployed workers, and let q denote the rate at which a vacancy is filled per unit of time. Generally, the more vacancies there are, the more difficult it is for a firm to fill its vacancy. This implies that q is a decreasing function of θ. Thus, we write $q = q(\theta)$ and denote the first derivative by $q' < 0$.[1] On the other side of the job market, let s denote the rate at which an unemployed worker finds a job per unit of time. Assume this rate is common to both native and immigrants. As θ increases, it becomes easier for a worker to find a job, so s is an increasing function of θ. Thus, we write $s = s(\theta)$ and denote the first derivative by $s' > 0$. Further, the homogeneity of the matching function relates s and q by the equation $s(\theta) = \theta q(\theta)$.[2]

The unemployment pool contains both natives and immigrants. A firm looking for a worker does not know beforehand whether it is going to be matched with a native (n) or an immigrant (m). After a match, however, a firm learns whether the new employee is a native or not. If we let V denote the value of a firm in search of a worker and J_i the value of a firm employing a worker of type $i = n, m$, the two values are related by the following asset-value equation:

$$rV = -c + q\alpha(J_m - V) + q(1 - \alpha)(J_n - V). \tag{1}$$

In (1), r denotes the interest rate, c denotes a search cost the firm incurs per unit of time and α denotes the probability that a matched worker is an immigrant. Thus, a firm is matched with an immigrant at rate $q\alpha$, and with a native worker at rate $q(1 - \alpha)$. A match with an

[1] Primes denote differentiation.
[2] See Pissarides (2000).

immigrants increases a firm's value by $J_m - V$, whereas a match with a native increase it by $J_n - V$. Thus, the right-hand side measures the flow value of a firm in search of a worker. In equilibrium this is just rV. Further, if we assume free entry, $V = 0$ in equilibrium. Substituting $V = 0$ simplifies (1) to

$$\alpha J_m + (1-\alpha) J_n = \frac{c}{q}. \tag{2}$$

All workers are assumed equally productive.[3] Each active firm produces y units of the aggregate good, which serves as numéraire. Since it knows its worker type, each firm pays the wage w_i if it employs a worker of type i $(= n, m)$. Further, all active firms are hit by idiosyncratic adverse shocks, which results in job separations. Job separations follow a Poisson process with rate λ, which is exogenous and common to all firms. Separated firms and workers return to the unemployment pool and engage in search activities.

With $V = 0$, a firm currently employing a native worker faces the asset-value equation:

$$rJ_n = y - w_n - \lambda J_n,$$

where $y - w_n$ is the net profit per unit of time. Collecting terms yields the value of a firm employing a native:

$$J_n = \frac{y - w_n}{r + \lambda}. \tag{3}$$

A firm employing an immigrant also experiences a job separation at rate λ. With internal enforcement (employer sanction) policy in effect, it faces the additional risk of job separation; when caught by authorities, an illegal immigrant is returned home, resulting in a job separation. To keep the analysis simple, assume that a firm suffers no penalty other than the loss of its worker. Letting δ denote the rate at which firms are inspected by authorities per unit of time, we can write the value of a firm employing an immigrant in:

$$rJ_m = y - w_m - (\lambda + \delta) J_m,$$

[3]We could introduce asymmetric productivity between natives and immigrants, but such an extension offers no new insight.

where $y - w_m$ is the net profit per unit of time to a firm employing an immigrant. Collecting terms yields:

$$J_m = \frac{y - w_m}{r + \lambda + \delta}. \tag{4}$$

We can now substitute from (3) and (4) to rewrite (2) as

$$\frac{\alpha(y - w_m)}{r + \lambda + \delta} + \frac{(1-\alpha)(y - w_n)}{r + \lambda} = \frac{c}{q}. \tag{5}$$

This equation relates the wages to q, the rate at which a firm fills its vacancy.

Turning to wage determination, we assume that the wages are set through Nash bargaining between a worker and a firm after a match. Thus, the equilibrium wage w_i is chosen to maximize the Nash product $(W_i - U_i)^p (J_i)^{1-p}$, where W_i and U_i denote, respectively, the value of employment and of unemployment for worker type $i = n, m$. The parameter p measures the worker's relative bargaining power.

To keep things simple, assume that a firm and a worker have equal bargaining power and set $p = 1/2$.[4] Then, in equilibrium the firm and the native worker split the joint surplus, so

$$W_n - U_n = \frac{W_n - U_n + J_n}{2},$$

that is,

$$W_n - U_n = J_n. \tag{6}$$

We have already calculated J_n as a function of w_n. To evaluate $W_n - U_n$, recall that a native worker is matched with a firm at rate $s(\theta)$ and separated from the job at rate λ. Thus, an unemployed native worker finds a job at rate s, which improves his/her welfare by $W_n - U_n$. An employed native is paid the wage w_n and gets separated from the job at rate λ, suffering the change of fortune of the size $U_n - W_n$. Therefore, the following asset value equations hold

[4] It may be more realistic to assume that immigrant workers have weaker bargaining power than native workers. Such asymmetries however have no qualitative impact on our results.

for a native worker:

$$
\begin{aligned}
rU_n &= s(W_n - U_n), \\
rW_n &= w_n + \lambda(U_n - W_n).
\end{aligned}
$$

The two equations combine to yield

$$W_n - U_n = \frac{w_n}{r + \lambda + s}. \tag{7}$$

Substituting (3) and (7) into (6) yields, after rearranging, the equilibrium wage as a function of the job-finding rate s:

$$w_n = \frac{y(r + \lambda + s)}{2\,(r + \lambda) + s}. \tag{8}$$

An immigrant worker is similar to a native worker except the additional risk of separation he or she faces due to internal enforcement policy. Thus, the following asset-value equations apply to an immigrant:

$$
\begin{aligned}
rU_m &= s(W_m - U_m), \\
rW_m &= w_m + \lambda(U_m - W_m) + \delta(W_0 - W_m).
\end{aligned}
$$

Here, W_0 denotes the value an immigrant obtains when staying permanently in the source country. The right-hand side of the second equation says that an employed immigrant earns w_m per unit of time but becomes unemployed at rate λ or is deported at rate δ. The former event changes the immigrant's welfare by $(U_m - W_m)$ and the latter by $W_0 - W_m$.

Since the destination country is small relative to the source country, W_0 is independent of the destination country's policy. As explained in Ethier (1986), the small-country assumption prevents the destination country from using immigration policy to extract the monopsony rents from the source country, and allows us to focus on the domestic effects of immigration policy. To keep the analysis tractable, we choose the utility units so that $W_0 = 0$. With this normalization, the two equations above can be solved to yield

$$W_m = \frac{(r+s)w_m}{(r+\delta)(r+s)+r\lambda}, \qquad (9)$$
$$U_m = \frac{sW_m}{r+s}.$$

Taking the difference yields

$$W_m - U_m = \frac{rw_m}{(r+\delta)(r+s)+r\lambda}. \qquad (10)$$

Nash bargaining implies that the immigrant's wage w_m satisfies

$$W_m - U_m = \frac{W_m - U_m + J_m}{2}.$$

which can be written, upon substituting from (4) and (10), as

$$\frac{rw_m}{(r+\delta)(r+s)+r\lambda} = \frac{y-w_m}{r+\lambda+\delta}.$$

Collecting terms and rearranging yields the equilibrium wage as a function of s:

$$w_m = \frac{[r(r+\lambda+s)+\delta(r+s)]\,y}{r\,[2(r+\lambda)+s]+\delta(2r+s)}. \qquad (11)$$

We now discuss an immigrant's decision to migrate. Suppose that the destination country can intercept immigrants at the border with a probability ϕ. Intercepted immigrants are sent back home, whereas those who successfully cross the border first enter the unemployment pool in the destination country. If we let b denote the disutility of border crossing an immigrant suffers, the expected welfare to an immigrant who decides to cross the border is given by:

$$-b+(1-\phi)U_m+\phi W_0.$$

In equilibrium, this welfare must equal W_0 to make an immigrant indifferent between trying to cross the border and staying home. Equating the above expression to W_0, and using the normalization $W_0 = 0$, we can express U_m as

$$U_m = \frac{b}{1-\phi}. \tag{12}$$

We next describe the relationships that must hold in steady state. First, the total number of jobs destroyed must equal the total number of jobs created for natives and for immigrants. For natives, that means

$$\lambda(1-u_n)L_n = su_nL_n.$$

The left-hand side measures the number of native jobs destroyed per unit of time. The right-hand side measures the number of jobs unemployed natives find per unit of time. Solving this equation yields

$$u_n = \frac{\lambda}{\lambda+s}. \tag{13}$$

The corresponding steady state condition for immigrants is:

$$(\lambda+\delta)(1-u_m)L_m = su_mL_m, \tag{14}$$

where the risk of internal interception is taken into account. Solving for u_m, we obtain

$$u_m = \frac{\lambda+\delta}{\lambda+\delta+s}. \tag{15}$$

The number of immigrants deported is $\delta(1-u_m)L_m$. This must equal the number of immigrants who succeed in crossing the border, $(1-\phi)M$, where M denotes the number of immigrants who try to enter the target country. Thus, in steady state

$$\delta(1-u_m)L_m = (1-\phi)M$$

This equation determines M once other variables are computed. Also, new arrivals in the destination country plus immigrants newly separated from jobs add to the pool of unemployed immigrants. In steady state, that sum must equal the number of immigrants in the pool who find jobs: that is,

$$(1-\phi)M + \lambda(1-u_m)L_m = su_mL_m.$$

Note that the last two equations together imply (14). They are accounting identities and can be safely ignored in the rest of our analysis.

Finally, by the law of large numbers, the probability α that any firm being matched with an immigrant equals the proportion of immigrants in the unemployment pool:

$$\alpha = \frac{u_mL_m}{u_mL_m + u_nL_n}. \tag{16}$$

This completes the description of the baseline model.

2.2 Solving the model

We now solve the model. First, (9) and (12) combine to yield

$$U_m = \frac{sW_m}{r+s} = \frac{b}{1-\phi}.$$

Substitution for W_m from (9) turns this equation into

$$\frac{sw_m}{r(r+\lambda+s)+\delta(r+s)} = \frac{b}{1-\phi}. \tag{17}$$

Substituting for w_m from (11), we can write (17) as

$$\frac{sy}{r\left[2\left(r+\lambda\right)+s\right]+\delta(2r+s)} = \frac{b}{1-\phi},$$

which can be solved uniquely for the equilibrium s:

$$s = \frac{2br(r+\delta+\lambda)}{(1-\phi)y - b(r+\delta)}. \tag{18}$$

Since $s > 0$, the equilibrium exists if and only if $(1-\phi)y > b(r+\delta)$. To ensure its existence, we make the following technical assumptions. First, assume that ϕ has domain $[0, \overline{\phi}]$ and that δ has domain $[0, \bar{\delta}]$. These upper bounds exist if enforcing immigration policy beyond them becomes prohibitively expensive. These domains are depicted in Figure 1.

[Figure 1 around here]

Assume next that y is large enough to satisfy

Assumption 1: $(1-\overline{\phi})y > b(r+\bar{\delta})$.

Assumption 1 guarantees that $s > 0$ for all relevant values of ϕ and δ.

We can now substitute the equilibrium s into (8) and (11) to determine the equilibrium wages w_n and w_m, and into (13) and (15) to determine the equilibrium unemployment rates u_n and u_m. Furthermore, inverting the function $s(\theta)$ yields the equilibrium θ and hence the equilibrium $q = q(\theta)$. Then we can substitute the equilibrium q, u_n and u_m, into (5) to solve for α, the proportion of unemployed immigrants in the unemployment pool. Finally, we can use (16) to compute the number of illegal immigrants L_m residing in the destination country.

The next proposition is our first key result.

Proposition 1 *Under Assumption 1 the model has a unique equilibrium.*

We can substitute the equilibrium wages into (3) and (4) for the equilibrium firm values:

$$J_n = \frac{y}{2(r+\lambda)+s}, \tag{19}$$
$$J_m = \frac{ry}{r[2(r+\lambda)+s]+\delta(2r+s)}.$$

A comparison shows that $J_n - J_m > 0$ for all $\delta > 0$.[5] A firm hiring a native has a higher firm value than one hiring an immigrant although all workers are equally productive. A comparison between (13) and (15) shows that $u_m > u_n$ for all $\delta > 0$; the unemployment rate is higher for immigrants than natives. These results make up the next proposition.

Proposition 2 For all $\delta > 0$, (i) $J_n > J_m$; (ii) $u_m > u_n$.

3 Policy experiments

We now consider the effect of external and internal enforcement policy. Begin with external enforcement policy. Tighter border control increases ϕ, the probability of interception at the border. Differentiation of (18) yields

$$\frac{\partial s}{\partial \phi} = \frac{2ybr(r+\lambda+\delta)}{\left[(1-\phi)y - b(r+\delta)\right]^2} > 0.$$

Then (8) and (11) imply that tighter border control raises the wage w_n for natives and the wage w_m for immigrants. As a result, the firm values J_n and J_m decrease. By (13) and (15) the unemployment rates u_n and u_m both fall. However, a calculation shows that $\partial(u_n/u_m)/\partial s < 0$, meaning that the unemployment rate falls by a greater percentage for natives than for immigrants.

To find the effect on the number of immigrants residing in the destination country, differentiate (5) to obtain

$$\left(\frac{y-w_n}{r+\lambda} - \frac{y-w_m}{r+\lambda+\delta}\right)\frac{\partial \alpha}{\partial \phi} + \frac{\alpha}{r+\lambda+\delta}\frac{\partial w_m}{\partial \phi} + \frac{1-\alpha}{r+\lambda}\frac{\partial w_m}{\partial \phi} = \frac{c}{q^2}\frac{\partial q}{\partial \phi}. \tag{20}$$

Given $s'(\theta) > 0$, $\partial s/\partial \phi > 0$ implies $\partial \theta/\partial \phi > 0$, which in turn implies $\partial q/\partial \phi < 0$, given $q'(\theta) < 0$. That makes the right-hand side of (20) negative. On the left-hand side, $\partial w_i/\partial \phi > 0$ implies that the second and the third term are positive. Hence, the above equation holds only if the first term on the left must is negative. The first term is equivalent to $(J_n - J_m)(d\alpha/d\phi)$.

[5] $J_n = J_m$ only if $\delta = 0$.

Since $J_n > J_m$ by Proposition 2, $d\alpha/d\phi < 0$; i.e., tighter border control (an increase in ϕ) decreases the proportion of immigrants in the unemployment pool. Finally, we rearrange (16) to obtain

$$L_m = \frac{\alpha}{1-\alpha}\frac{u_n}{u_m}L_n.$$

Since tighter border control lowers the two ratios $\alpha/(1-\alpha)$ and (u_n/u_m), the total number of immigrants in the destination country must fall.

We summarize the effect of border control in

Proposition 3 *An increase in ϕ (tighter border control) has the following results.*

(A) *The wages increase for both natives and immigrants.*

(B) *The unemployment rate falls for both types of workers but relatively more for natives than for immigrants.*

(C) *The values of firms employing workers of either type fall.*

(D) *The number of immigrants residing in the destination country declines.*

In short, tighter border control benefits native workers as they find jobs in greater numbers at higher wages. Rising wages decrease firm values and distributes income from firm owners to workers, as expected. Interestingly, immigrants residing in the destination country also benefit from tighter border control as their wage and unemployment rate go down.

We next turn our attention to internal enforcement (employer sanction) policy. Differentiation of (18) yields

$$\frac{\partial s}{\partial \delta} = \frac{2br\left[(1-\phi)y + b\lambda\right]}{\left[(1-\phi)y - b(r+\delta)\right]^2} > 0,$$

which by (8) implies a higher wage w_n for natives. Similarly for an immigrant because differentiation of w_m (i.e., (11)) yields:

$$\frac{\partial w_m}{\partial \delta} = \frac{ry\left[s\lambda + (r+\delta)(r+\delta+\lambda)\partial s/\partial\delta\right]}{\left\{r\left[2\left(r+\lambda\right)+s\right]+\delta(2r+s)\right\}^2} > 0.$$

Higher wages mean that $\partial J_n/\partial\delta < 0$ and $\partial J_m/d\delta < 0$; the values of all firms fall, as can be verified by differentiating (19). The unemployment rates also fall: $\partial u_n/\partial\delta < 0$ and $\partial u_m/\partial\delta < 0$.

However, $\partial(u_n/u_m)/\partial\delta < 0$; thus, the unemployment falls more for natives than for immigrants. Further, since $\partial w_m/\partial\delta > 0$, a procedure analogous to the one used earlier shows that $\partial\alpha/\partial\delta < 0$ and $\partial L_m/\partial\delta < 0$.

Proposition 4 *An increase in δ (internal enforcement) has the same qualitative effects as an increase in ϕ (external enforcement) as summarized in (A) through (D) of Proposition 3.*

Thus we have shown that external and internal enforcement policy are substitutes, as shown by Ethier (1986).

4 The optimal immigration policy with one destination country

In this section we examine the nature of optimal immigration policy for the destination country in the baseline model. Before we proceed, we point out that there is no consensus among economists as to what objective a destination country government wants to achieve with immigration policy (Ethier 1986). First of all, there is no agreement among researchers as to whether to include immigrants' welfare in the destination country's aggregate welfare calculus. However, most writers seem to prefer an exclusivist approach and consider policy that maximizes only natives' welfare. Secondly, as noted above, immigration policy affects domestic income distribution, typically transferring income from skilled workers and capital owners to unskilled workers. As Ethier (1986) notes, income distribution itself may be a policy target for political reasons. Thirdly, authorities may also aim to reduce the unemployment rate of native workers.

Given the lack of consensus, we are somewhat at liberty to define the policy objective of the destination country. We thus assume that the destination country government choose as its objective the total surplus created by legitimate firms, i.e., firms employing native workers. This is consonant with the spirit of internal enforcement (employer sanction) policy. Thus, assume that the destination country maximizes

$$SW = (1 - u_n)L_n(J_n + W_n - U_n) - g(\phi) - h(\delta) \tag{21}$$

The expression $(J_n + W_n - U_n)$ is the social surplus created by each match between a firm and a native worker. Since $(1 - u_n)L_n$ native workers are employed, the first term in (21) represent the total (gross) social surplus. We denote it by GW. The last two terms, $g(\phi)$ and $h(\delta)$, are the costs of external and internal enforcement policy, respectively. These functions are assumed to satisfy the following technical assumptions. Under Assumption 1 the cost of internal enforcement policy $h(\delta)$ is defined over the closed interval $[0, \bar{\delta}]$. We assume that $h(0) = 0$ and $h(\bar{\delta}) = \infty$ to rule out $\delta > \bar{\delta}$ from policy consideration. We also assume $h(\delta)$ to be twice-continuously differentiable with $h' > 0$ and $h'' > 0$ over $(0, \bar{\delta})$, and $\lim_{\delta \to 0} h' = 0$. Similarly, $g(\phi)$ is defined over $[0, \overline{\phi}]$. We assume that $g(0) = 0$ and $g(\overline{\phi}) = \infty$. Further, $g(\phi)$ is assumed twice continuously differentiable with $g' > 0$, $g'' > 0$ over $(0, \overline{\phi})$ and $\lim_{\phi \to 0} g' = 0$.

Since a firm and a native worker evenly split the surplus a matching creates in Nash bargaining, we have that $J_n + W_n - U_n = 2J_n$. Thus, (21) can be rewritten as

$$SW = 2J_n(1 - u_n)L_n - g(\phi) - h(\delta). \tag{22}$$

Substitution for J_n and u_n from (13) and (19) we obtain

$$SW = GW(s) - g(\phi) - h(\delta),$$

where the gross welfare function $GW(s)$ depends only on s;

$$GW(s) \equiv \frac{2syL_n}{(\lambda + s)[2\,(r + \lambda) + s]}$$

We suppose that the destination country can choose ϕ and δ without budgetary constraints.

We examine each policy instrument separately, beginning with external enforcement. Maximizing (22) with respect to ϕ, given δ, yields the first-order condition:

$$\frac{\partial SW}{\partial \phi} = \frac{\partial GW}{\partial s}\frac{\partial s}{\partial \phi} - g'(\phi) = 0,$$

where

$$\frac{\partial GW}{\partial s} = \frac{2[2\lambda(r+\lambda) - s^2]yL_n}{(\lambda+s)^2\,[2(r+\lambda)+s]^2}.$$

From the preceding section we have $\partial s/\partial\phi > 0$. Since $g' > 0$, an interior optimum requires that $\partial GW/\partial s > 0$, a higher job-finding rate improve gross welfare. This condition is satisfied if y, the output per worker, is sufficiently large. More specifically, the following assumption is sufficient for $\partial GW/\partial s > 0$.

Assumption 2: $2\lambda(r+\lambda) > \left\{2br(r+\bar{\delta}+\lambda)/[(1-\overline{\phi})y - (r+\bar{\delta})]\right\}^2$

Let ϕ^* satisfy the first-order condition above. The second-order condition requires that it also satisfy

$$\frac{\partial^2 SW}{\partial\phi^2} = \frac{\partial^2 GW}{\partial s^2}\left(\frac{\partial s}{\partial\phi}\right)^2 + \frac{\partial GW}{\partial s}\left(\frac{\partial^2 s}{\partial\phi^2}\right) - g''(\phi) < 0,$$

where $g'' > 0$. Differentiation shows that $\partial^2 GW/\partial s^2 < 0$ so the first term on the right is negative, However,

$$\frac{\partial^2 s}{\partial\phi^2} = \frac{4y^2br(r+\lambda+\delta)}{[(1-\phi)y-(r+\delta)]^3} > 0,$$

which makes the second term positive, given $\partial GW/\partial s > 0$. Hence, SW may not be globally concave in ϕ. However, since $\lim_{\phi\to 0} g' = 0$ and $g(\overline{\phi}) = \infty$, there is at least one ϕ^* that satisfies the optimality conditions for a given δ.

We next turn to the optimal internal enforcement, δ^*, which satisfies the first-order condition

$$\frac{\partial SW}{\partial\delta} = \frac{\partial GW}{\partial s}\frac{\partial s}{\partial\delta} - h'(\delta) = 0.$$

The second derivative is

$$\frac{\partial^2 SW}{\partial\delta^2} = \frac{\partial^2 GW}{\partial s^2}\left(\frac{\partial s}{\partial\delta}\right)^2 + \frac{\partial GW}{\partial s}\frac{\partial^2 s}{\partial\delta^2} - h''(\delta)$$

As with external enforcement policy, the first term on the right hand side is negative. However, the second term is positive at h^* because $\partial GW/\partial s > 0$ and

$$\frac{\partial^2 s}{\partial \delta^2} = \frac{4b^2 r\left[(1-\phi)y + b\lambda\right]}{\left[(1-\phi)y - b(r+\delta)\right]^3} > 0.$$

Thus, SW may not be globally concave in δ, either. However, since $\lim_{\delta\to 0} h' = 0$ and $h(\bar{\delta}) = \infty$, there is at least one $\delta^*(\phi)$ that is a (local) internal maximizer for a given ϕ. For the remainder of the analysis we assume that SW is globally and strictly concave in ϕ and δ so that a unique maximizer pair (ϕ^*, δ^*) exists.

Assumption 3: SW is strictly concave in $\phi \in [0, \overline{\phi}]$ and $\delta \in [0, \bar{\delta}]$.

Under Assumptions 1 through 3 it is straightforward to show that $\partial\phi^*/\partial L_n > 0$ and $\partial\delta^*/\partial L_n > 0$; the larger the size of native labor force, the more stringent are the levels of internal and external enforcement policy.

Proposition 5 *Under Assumptions 1 to 3, the larger the native labor force, the greater is the destination country's efforts to intercept immigrants internally and externally.*

5 Multiple destination countries

In this section and the next we extend the baseline model to cases of multiple destination countries.[6] We will show that with multiple destinations the nature of optimal immigration policy changes dramatically, as each country's optimal policy depends on its geographical configuration vis-a-vis the other destination countries and the source country. Although diverse geographic patterns are conceivable, we focus on two prototypes. In one, all destination countries share the border with the source country; as a result, immigrants cross the most weakly controlled border and move to the destination of their preferences. This is the case we referred to as the American (or common-border) case in the introduction. The other case, which we called the European (or single-border) case, has only one destination country bordering the

[6]For the spatial dimension of job search within a country/region/city, see Zenou (2009) among others.

source country; as a consequence, immigrants must first enter that country even though they target other destination countries.

We begin with enumeration of additional assumptions that keep the analysis simple in those two prototypal cases we consider. First, we assume that there are only two destination countries, indexed by $i = 1, 2$. Having more destinations only makes the algebra messy without giving us additional insight. Second, immigrants face no mobility barriers across destination countries. Third, job search is still localized; thus, to find a job in any destination country, an immigrant has to be in that country's unemployment pool. Fourth, natives do not migrate. The last assumption is a simple way to capture the fact that immigrants have more freedom in choosing where to live and work than natives, and is consistent with observations that immigrants tend to cluster in major cities relative to natives.

5.1 The American (common-border) case

Begin with the American (common-border) case. Since immigrants cross the more loosely controlled border, the effective border enforcement is given by $\phi = \min(\phi_{1,}\phi_2)$, where ϕ_i denote the probability of entering country i $(= 1, 2)$. Further, free mobility between the two destination equalizes. Thus,

$$U_{m1} = U_{m2} = \frac{b}{1-\phi}, \tag{23}$$

where U_{mi} is the value to an immigrant of being unemployed in country i. (We add the country subscript i to distinguish the values between two destinations.) Next, J_{mi}, U_{mi} and W_{mi} are determined independently for each country i as in the baseline model. Thus, an immigrant's wage in country i is given by

$$w_{mi} = \frac{\left[r(r+\lambda+s_i)+\delta_i(r+s_i)\right]y}{r\left[2(r+\lambda)+s_i\right]+\delta_i(2r+s_i)},$$

as in (11). Note that the parameters y, r, and λ are assumed common in two destination countries, whereas policy variable δ_i is country-i specific. The equilibrium condition (23) yields

$$\frac{s_i y}{r\left[2\left(r+\lambda\right)+s_i\right]+\delta_i(2r+s_i)}=\frac{b}{1-\phi}.$$

which determines the job-finding rate s_i in each country i, given its internal enforcement policy δ_i and the border policy ϕ; i.e., $s_i = s_i(\phi, \delta_i)$

Suppose that two destination countries simultaneously pursue their own immigration policy. Then, country i chooses the policy vector (ϕ_i, δ_i), given country j's policy choice (ϕ_j, δ_j), to maximize its welfare

$$SW_i = GW_i - g(\phi_i) - h(\delta_i).$$

where

$$GW_i = 2J_{ni}(1-u_{ni})L_{ni}$$

Recall that the country's gross welfare (GW_i) depends only indirectly on the policy variables through $s_i(\phi, \delta_i)$. Therefore, given ϕ, each country's welfare depends on only its internal enforcement policy δ_i and not on that of the other destination country. This means that the first order condition

$$\frac{\partial GW_i}{\partial s_i}\frac{\partial s_i}{\partial \delta_i} - h'(\delta_i) = 0$$

determines the optimal δ_i independently of δ_j $(i \neq j)$. In other words, the choice of δ_i is efficient, given ϕ. This implies that the policy game can be solved in two stages; the destination countries first choose ϕ_i and then, given $\phi = \min(\phi_1, \phi_2)$, they choose δ_i efficiently. With this in mind, we turn to the first-stage game that determines the equilibrium external enforcement policy. Given ϕ_2, denote country 1's best response by $BR_1(\phi_2)$. Let ϕ_1^* be its optimal external enforcement policy level in the baseline model. If $\phi_2 \leq \phi_1^*$, then $BR_1(\phi_2) = \phi_2$. To see this, note that raising ϕ_1 above ϕ_2 has its cost but no effect on the flow of immigration into country 1 because all immigrants come through country 2 when $\phi_2 \leq \phi_1^*$. On the other hand, lowering ϕ_1 reduces country 1 welfare, and hence the claim. On the other hand, if $\phi_2 > \phi_1^*$, country 1 controls immigration flows at any $\phi_1 < \phi_2$. Hence, $BR_1(\phi_2) = \phi_1^*$. Country 2's best-response function can be derived similarly; namely, $BR_2(\phi_1) = \phi_1$ for $\phi_1 \leq \phi_2^*$ and $BR_2(\phi_1) = \phi_2^*$ for $\phi_1 > \phi_2^*$.

Suppose that two destination countries are symmetric. With $L_{n1} = L_{n2} = L_n$, their best response functions are also symmetric, as shown in Figure 2, where ϕ_1 is on the horizontal axis and ϕ_2 on the vertical axis.

[Figure 2 around here]

Country 1's best response function BR_1 comprises the segment 0A of the 45-degree line and the vertical line at point A. BR_2 comprises the segment 0A and the horizontal line at point A. Therefore, any point on the segment 0A is a Nash equilibrium. Although there is a continuum of equilibria, the game is supermodular so all the equilibria are uniquely welfare-ranked, with point A representing the Pareto-dominant one. Since each country can implement internal enforcement policy efficiently, given ϕ, it follows that, if two destination countries agree to choose the Pareto-dominant strategy ϕ_i^*, each country can attain its optimal policy vector (ϕ_i^*, δ_i^*), undistorted by presence of the other destination country. It is straightforward to verify that the Pareto-dominant strategies also maximizes the joint welfare $SW_1 + SW_2$.

Proposition 6 *In the American (or common-border) case with symmetric destination countries, the model has a continuum of equilibria in external enforcement policy, which includes the policy vector that maximizes the joint welfare of the two destination countries. In all other equilibria, each country's external enforcement policy is too lax relative to the jointly optimum policy. In contrast, the internal enforcement policy choice is undistorted by the presence of the other country (given ϕ).*

The above results change dramatically however when the destination countries are asymmetric. Since the equilibrium internal enforcement policy remains efficient, here we focus on external enforcement policy. Suppose, without a loss of generality, that country 1 is larger than country 2, i.e., $L_{n1} > L_{n2}$. Then Proposition 1 implies that $\phi_1^* > \phi_2^*$; a large country (country 1) prefers tighter border control. Then, the procedure analogous to the one used above yields the best response functions in Figure 3.

[Figure 3 around here]

In Figure 3, BR_1 comprises the segment 0B of the 45-degree line and the vertical line at point B. BR_2 comprises the segment 0A and the horizontal line at point A. Thus, as in the symmetry case, all the points on the segment 0A represent the Nash equilibrium, with point A still representing the Pareto-dominant one. Although point A represnts the most preferred external enforcement policy ϕ_2^* for country 2, but country 1 finds it too lax relative to its preferred level at ϕ_1^*. Clearly, there is no Nash equilibrium that maximizes the joint welfare.

To explore that issue further, we solve the joint welfare maximization problem:

$$\max_{\phi_1,\phi_2,\phi} SW_1 + SW_2$$
$$\text{s.t. } \phi_1 = \phi_2 = \phi$$

The objective function is concave under Assumption 3 and differentiable. The first-order condition is

$$\left\{\frac{\partial GW_1}{\partial s_1}\frac{\partial s_1}{\partial \phi} - g'(\phi)\right\} + \left\{\frac{\partial GW_2}{\partial s_2}\frac{\partial s_2}{\partial \phi} - g'(\phi)\right\} = 0.$$

Let $\hat{\phi}$ denote the joint optimum. Evaluated at $\phi = \phi_1^*$, the first expression on the left-hand side vanishes while the second is negative. Thus, $\hat{\phi} < \phi_1^*$. At $\phi = \phi_2^*$, the second expression vanishes while the first is positive. Thus, $\hat{\phi} > \phi_2^*$. Thus, $\hat{\phi} \in (\phi_2^*, \phi_1^*)$; the jointly optimal policy, $\hat{\phi}$, lies in the interior of line segment AB in Figure 3.

Proposition 7 *In the American case with asymmetric destination countries, there is a continuum of Nash equilibria, which excludes the joint optimum. Any equilibrium external enforcement policy level is too low compared with the jointly optimum level.*

In deriving the joint optimum we did not specify how the policymaker (federal or supra-national government) covers the cost of border enforcement. If it collects taxes to defray the cost $g(\phi*)$

from each country, it is clear that the above optimal policy is untenable, since the smaller country prefers a lower level of enforcement. Thus, the joint optimum requires the appropriate amount of side payments from the larger country to the smaller one.

We conclude this section by considering, in the absence of the supranational government, whether it is possible to delegate the external enforcement policy to one country without side payments. Then that country i chooses ϕ to maximize $GW_i - 2g(\phi)$. The first-order condition is

$$\partial GW_i/\partial\phi - 2g'(\phi) = 0.$$

Denote the optimal level by ϕ_i^D. It is clearly less than its individual country optimum ϕ_i^*, since now country i pays for border enforcement for two countries. It is also clear that ϕ_i^D is less than the joint optimum $\hat{\phi}$ because the effect on the other country's gross welfare is excluded in the first-order condition above in comparison with that for the joint optimum. Since the join welfare function $SW_1 + SW_2$ is strictly increasing between any Nash equilibrium level ϕ^N and $\hat{\phi}$, delegating border control to country i yields a greater welfare level to each country than at the Nash equilibrium if (and only if) $\phi_i^D > \phi^N$. This implies that, if the equilibrium policy is the Pareto-dominant one (ϕ_2^*), then since $\phi_2^D < \phi_2^*$ the joint welfare must be smaller than the equilibrium level. Thus, it is impossible for country 2 to take over the border enforcement policy. However, that is not a foregone conclusion for country 1 since it is possible that $\phi_1^D > \phi_2^*$. If this inequality holds, delegating border control to country 1 increases both countries' welfare relative to the level in the Pareto-dominant equilibrium (and hence in any Nash equilibrium).

Proposition 8 *Delegating external enforcement policy to country 1 (the larger country) yields a greater level of joint welfare. If the countries initially agree to choose the Pareto-dominant strategies, delegation to country 1 improves each country's welfare but delegation to country 2 decreases it.*

6 The European (single-border) case

We now turn to the European (or single-border) case, where, without a loss of generality, we let only country 1 be contiguous with the source country. Since only country 1 enforces border control, in equilibrium we have

$$U_{m1} = \frac{b}{1-\phi_1}.$$

Since immigrants can move freely between countries 1 and 2, $U_{m2} = U_{m1}$ in equilibrium. Therefore,

$$U_{m1} = U_{m2} = \frac{b}{1-\phi_1}.$$

Since only country 1 can implement border control policy, in the simultaneous-move policy game, country 1 chooses (ϕ_1, δ_1) to maximize SW_1 as in the baseline, while country 2 chooses δ_2 to maximize $SW_2^E = GW_2 - h(\delta_2)$, where the superscript E indicates the European case. The game is equivalent to a two-stage game, in which country 1 first chooses its external enforcement policy ϕ_1 and then two countries choose their internal enforcement policy δ_i. Given the structure of the model, each country's internal enforcement policy choice has no effect on the other destination's country's welfare, and hence it is undistorted by the presence of the other country (given ϕ_1). Furthermore, since country 1 enforces border control, it is clear that it can implement the first-best immigration policy, namely (ϕ_1^*, δ_1^*), as in the baseline model. Given concavity of the welfare functions, the game has a unique equilibrium.

We are now interested in how the equilibrium compares with the jointly optimal policy. The latter maximizes

$$SW_1 + SW_2^E = GW_1 + GW_2 - g(\phi_1) - h(\delta_1) - h(\delta_2).$$

Given concavity of the welfare functions, there is the unique optimum border enforcement policy, $\widetilde{\phi}$, implicitly defined by the first-order condition[7]

$$\frac{\partial GW}{\partial s_1}\frac{\partial s_1}{\partial \phi_1} - g'(\phi_1) + \left.\frac{\partial GW_2^E}{\partial s_2}\frac{\partial s_2}{\partial \phi_2}\right|_{\phi_2=\phi_1} = 0.$$

When we evaluate the left-hand side at the equilibrium ϕ_1^*, the first two terms vanish but the last term is positive. Hence, $\phi_1^* < \widetilde{\phi}$; country 1's border control policy is not tight enough for a joint optimum.

Proposition 9 *In the European case, the border country implements its first-best external and internal enforcement policy, while the non-border country implements its internal enforcement policy efficiently, given the former's border policy. The equilibrium external enforcement policy is too low relative to the joint optimum.*

We now consider the policy delegation problem. If country 1 outsources border control policy to country 2, the preceding logic indicates that country 2 would choose its optimal enforcement level ϕ_2^*. Evaluated at ϕ_2^*, the second and the third term vanish, leaving on the first term, which is positive. Thus, $\widetilde{\phi} > \phi_2^*$. Thus, the jointly optimal border control is tighter than the optimal level for either country; that is, $\tilde{\phi} > \max(\phi_1^*, \phi_2^*)$. Since the joint welfare function is strictly increasing at $\phi < \tilde{\phi}$, delegating border enforcement to country 2 improves joint welfare if and only if country 2 is the larger of the two. The delegation to country 2 improves country 1 welfare because country 1 does not have to pay for border enforcement and its gross welfare is increasing in ϕ. The fact that joint welfare is greater implies that country 2 enjoys a welfare surplus, as well. If country 2 is smaller than country 1, delegation reduces joint welfare and hence country 2 cannot afford to take over border control.

Proposition 10 *In European case, the jointly optimal external enforcement policy exceeds the level each destination country would choose if it can pursue its external enforcement policy. Delegation of border enforcement policy to the non-border country improves both countries' welfare if and only if the non-border country is the larger of the two.*

[7] In the single border case, country 2's welfare is given by $SW_2 = [2J_{n2}(1 - u_{n2})]L_n - h(\delta_2)$ because country 2 is not contiguous to the source country.

7 Conclusions

In this paper we examine the effect of two common policy instruments to combat illegal immigration: border control (external enforcement) and employer sanctions (internal enforcement) policy. Our analysis extends the literature on two separate fronts. First, we replace the Harris-Todaro (1970) type unemployment with search-theoretic unemployment in the standard model of illegal immigration. Second, we examine the policy implications of having multiple destination countries instead of one.

We first work with the baseline model with only one destination country, finding that external and internal enforcement policy have similar effects. More enforcement efforts increases wage for both natives and immigrants and decreases the values of firms employing them, implying that immigration has the income distributional effect from capital owners and skilled labor to unskilled labor. Unemployment rates fall for both natives and immigrants. Thus, the single destination country can use both instruments to maximize its policy objective(s) efficiently.

With multiple destination countries, by contrast, we find that external enforcement policy yields suboptimal outcomes, although internal enforcement policy is undistorted (given the equilibrium external enforcement policy level). In the American case, in which all the destination countries contiguous are contiguous with the source country, the policy inefficiency arises because immigration flows into each country are determined not by that country's effort but by that of the country that enforces border control more weakly. There are cases in which delegating border enforcement to the largest country increases every country's welfare. In the European case, where only single country is contiguous with the source country, that border country can implement its first best immigration policy as in the baseline model. However, the equilibrium border enforcement is less than the joint optimum due to the the failure of the border country to take into account the effect of its policy on the non-border countries. In contrast to the American case, delegation of border enforcement policy to the largest country always improve each country's welfare.

Several extensions manifest themselves. First, it is straightforward to introduce a number of asymmetries between natives and immigrants; for example, natives may be more productive than immigrants, and immigrants may be in a weaker position than natives when bargaining with firms. These asymmetries are likely to lower the immigrants' wage relative to those of native workers but otherwise unlikely to affect our results qualitatively. We can also introduce asymmetries between destination countries, say, in productivity, bargaining powers, migration costs and enforcement costs, and so on. More challenging an extension is the introduction of capital and capital mobility between two destination countries. As shown by Kessler et al (2002), the properties of policy competition may change if another mobile factor is introduced.

Second, the prototype models can be extended to more complicated geographical arrangements. For example, consider the simple extension with two border countries and one non-border country. As in our model, the border country with the lower level of external enforcement determines the flows of immigrants to each country so external enforcement policy clearly suffers the inefficiency of the American type. Our analysis also implies that delegating external enforcement to the non-border country improves each country's welfare if it is the largest country. Thus, if Germany and the non-border country while Greece and Italy are two border countries, then delegating the policy to Germany is in the interest of every country, in case the European Commission cannot implement the optimal policy.

Third, it is found that internal enforcement policy does not cause any externalities and hence is efficient in both configurations. However, this result is due to the small country assumption that fixes an immigrant's welfare W_0 from staying in the source country. This assumption is reasonable when the source country has a substantially pool of potential immigrants. If destination countries are large enough to effect immigrants' welfare back home, then W_0 depends on immigration outflows, and gives rise to another source of externalities that distort internal enforcement policy. In equilibrium, each country is likely to compete in raising the level of internal enforcement effort to drive out immigrants into each other's territory. We leave these extensions for the future.

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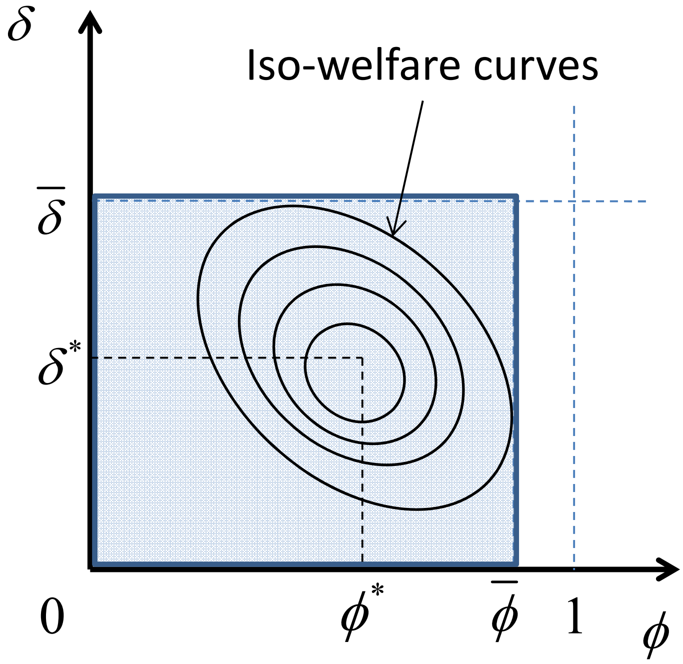

Figure 1. Range of ϕ and δ

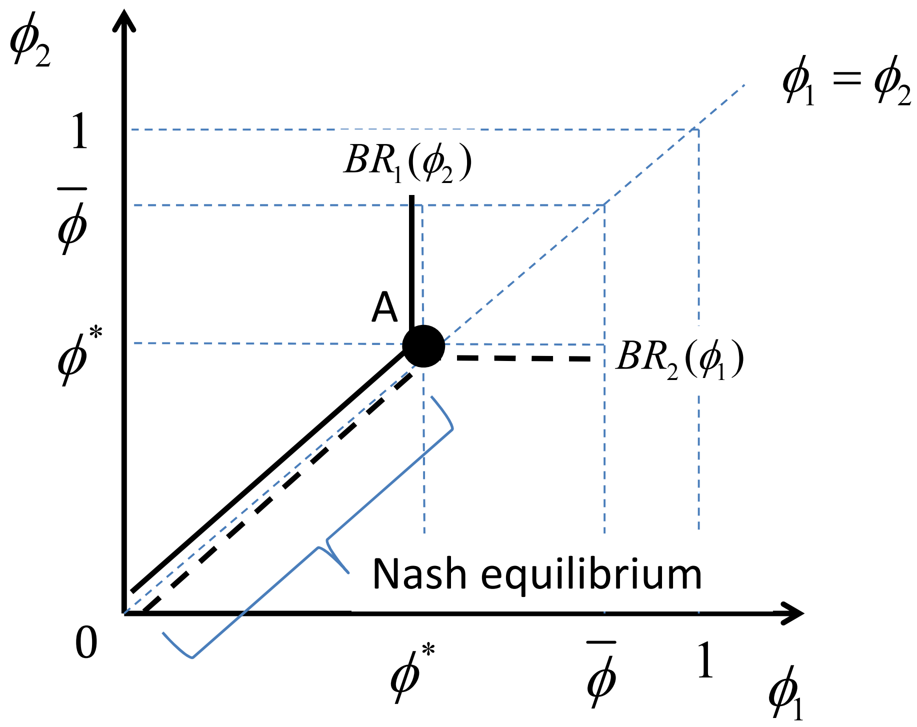

Figure 2. Symmetric two host countries with common border

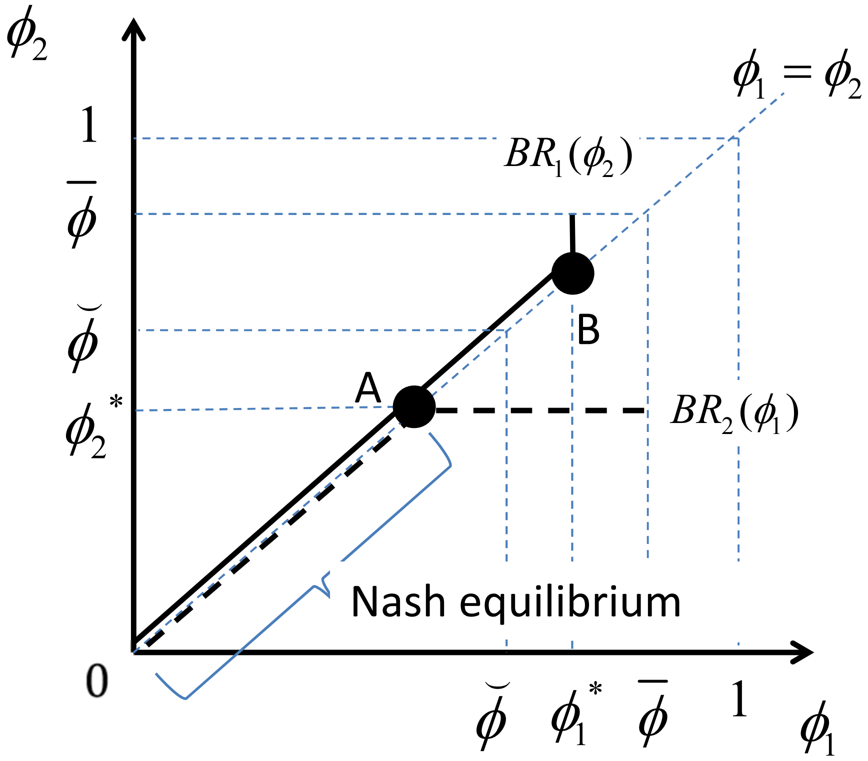

Figure 3. Asymmetric host countries with common border