Illegal immigration and multiple destinations*

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Abstract

This paper examines the efficacy of internal and external interception policy to combat immigration. The model features search-theoretic unemployment and policy interdependency among destination countries. With one destination country, internal and external interception policy have similar effects on the destination’s labor markets. With multiple destinations, external interception policy produces inefficient outcomes due to policy interdependency but internal interception policy remains undistorted. The source of policy inefficiency depends on the way the destination countries are arranged geographically vis-a-vis the source country.

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1 Introduction

Immigration of illegal workers into advanced economies such as the U.S., Australia, and Western Europe has surged in recent years, prompting those countries to reconsider their immigration policy to meet new challenges. Some decades ago Ethier (1986) had already analyzed immigration problems, emphasizing the importance of the then-novel idea to use employer sanction alongside border control to moderate immigration flows. In this paper we re-examine the efficacy of external interception (border control) and internal interception (employer sanction) policy in a model with two features that are relatively novel in the immigration literature. First, Ethier (1986) and subsequent work (e.g., Yoshida and Woodland, 2005) consider unemployment of a Harris-Todaro (1970) type caused by institutional wage rigidity (e.g., wages set by minimum wage legislation or labor unions). By contrast, here we highlight equilibrium unemployment; i.e., unemployment caused by random job separations and inducing job search (e.g., Pissarides, 2000, and a survey by Rogerson, Shimer and Wright 2005)).

Second, Ethier (1986) and subsequent analyze immigration problems in a setting that features one source country and one destination country. In contrast, our model highlights multiple destination countries. Our analysis distinguishes between two types of geographical configurations of destination countries. In one type, which we call the common-border case, all destination countries share the border with the source country. This may depict, for example, the states of California and Arizona, both of which are contiguous to Mexico. This type of model exhibits Hirshleifer’s weakest-link features (Hirshleifer 1983 and 1985); immigrants first enter the country that has the weakest border control policy and then spread to other destinations. In the other configuration, which we call the single-border case, only one destination country shares the border with the source country. In this case, only the bordering country can administer external interception policy whereas other destination countries have only internal interception policy at their disposal to fight illegal immigration. Such a setting is more fitting for understanding the relationship between Greece, which serves as the main port to Europe for many immigrants, and other European countries such as Germany, which are eventual targets of most immigrants.
In the next section, we begin with the baseline model with one destination country, which however, extends the Ethier (1986) model to the case of search-theoretic unemployment. In this model all firms are hit randomly by adversity that causes job separations. Firms employing illegal immigrants experience additional job separations under employer sanctions programs. In section 3 we do some policy experiments within the baseline model. Stronger border control reduces the number of immigrants in the destination country, raises native and immigrant wages, and lowers their unemployment rates. Employer sanctions have similar effects. In this sense, external and internal interception policy are close substitutes so that the destination country can use either policy or both to reduce the cost of immigration policy administration as shown in Ethier (1986).

In the next two sections we turn to the models with multiple (more exactly two) destination countries. Section 4 assumes symmetry across destination countries whereas section 5 relaxes the symmetry assumption as regards the labor force size. In both sections, we let two countries set their policy levels independently, and show that distinct differences arise in policy effectiveness between external and internal interception policy. In the common-border case, as demonstrated by Hirshleifer (1983), the weakest-link feature results in a continuum of equilibrium optimal border control policy outcomes, which are less than the joint optimum. In contrast, internal interception policy remains undistorted. In the single-border case, the equilibrium border control level is also less than the jointly optimal level. Although we observe inefficient outcome in both the unique and common border cases, the inefficiencies arise for different reasons: in the common-border case, border control enforcement is akin to provision of public goods, and the built-in weakest link leads to underprovision of the public good. By contrast, the inefficiency in the single border case is ascribed to the externalities; the unique bordering destination country fails to take into account other destinations’ welfare when implementing its external interception policy. In contrast, internal interception policy remains undistorted in both common- and single-border cases.

We now relate our paper to the relevant literature. Giordani and Ruta (2013) study coordination failures in external interception policy among multiple destination countries in what
we call the common-border case. The existence of continuous equilibria is due to the weakest link as demonstrated in Hirshleifer (1983, 1985). These authors do not model unemployment, nor do they analyze the single-border case like in this paper. Equilibrium unemployment is featured in the immigration model of Chassanboulli and Palivos (2014). These authors assume legal immigration and hence do not discuss external and internal interception policy. Neither do they examine the policy interdependency problem since immigration is legal and there is one destination country in their analysis.

Coordination failures are also a familiar phenomenon in the tax competition literature. For example, taxation of internationally mobile capital and firms result in too low tax rates as competing governments lose their ability to fully capture the rents from mobile factors (Zodrow and Mieszkowski, 1986; Wilson, 1986, 1999). Its source of externality is capital or firm flight caused by taxation, which increases tax base and public good provision in other countries. Hence, although our inefficiency result and those observed in tax competition models looks similar, their mechanisms are different.

The paper proceeds as follows. Section 2 provides the base-line model with a single destination country. Section 3 examines the properties of immigration policies in the base-line model. In Section 4, we extend the base-line model to include multiple destination countries and examine the interdependency of immigration policies. Section 5 considers the case of asymmetric countries. Section 6 concludes the paper.

2 The base-line model: a single destination country

2.1 Model structure

Begin with the basic two-country model. Labor migrates from the source (or sending) country to the destination (or receiving) country. Focus is on the designation country. Let $L_n$ and $L_m$ denote, respectively, the numbers of native workers and immigrant workers residing there. $L_n$ is exogenously given while $L_m$ is to be determined endogenously. All immigrants are assumed illegal; if there are legal immigrants, they are regarded as part of the native labor force, as in

The model features frictional unemployment in the destination country. Unemployed workers and firms with unfilled positions search each other and are matched in a Poisson process through the matching function, which is assumed to be homogeneous of degree one. Let $\theta$ 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, $q$ is a decreasing function of $\theta$ because when there are more vacant jobs it is generally more difficult for any firm to fill its vacancy. Thus, write $q = q(\theta)$, assume it differentiable and denote the first derivative by $q' < 0$. On the other side of the job market, let $s$ denote the rate at which unemployed workers find jobs per unit of time. As $\theta$ increases, it becomes easy to find jobs, so $s$ is an increasing function of $\theta$. Thus, write $s = s(\theta)$, with the first derivative denoted by $s' > 0$. Furthermore, the homogeneity of the underlying matching function relates $s$ and $q$ by the equation $s(\theta) = \theta q(\theta)$.

The unemployment pool in the destination country 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 or an immigrant. After the matching, however, a firm learns whether the matched worker is a native or not. To keep things simple, assume that every worker is equally productive, and when employed he produces $y$ units of the aggregate good, which serves as the numéraire. 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 $i = n, m$, then a firm in search of a worker faces the following asset value function:

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

In (1), $c$ denotes a search cost the firm incurs per unit of time and $\alpha$ denotes the probability of being matched with an immigrant. We assume free entry into industry and set $V = 0$ to rewrite (1) as

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

Firms also experience adverse conditions that results in job separations. Job separations are

\[1\] Primes denote differentiation.

\[2\] Introduction of productivity asymmetry has no qualitative impact on our results.
assumed to follow a Poisson process with rate \( \lambda \), which is exogenous and common to all firms, regardless of whether they employ natives or immigrants. When separated from jobs, workers return to the unemployment pool, and workers and firms once again engage in search activities. With \( V = 0 \), a firm currently employing a native worker faces the asset value function

\[
 rJ_n = y - w_n - \lambda J_n,
\]

where \( w_n \) is the wage paid to the native worker. Collecting terms yields

\[
 J_n = \frac{y - w_n}{r + \lambda}.
\]  

(3)

A firm employing an immigrant also experiences a job separation at rate \( \lambda \). With internal interception policy in effect, such a firm is subject to the additional risk of job separation. When caught working illegally, an immigrant is returned to the source country, resulting in a job separation. To keep the analysis simple, we assume no additional penalty against the firm other than the job separation it suffers. Letting \( \delta \) denote the rate at which an immigrant is intercepted per unit of time, we can write the value of a firm employing an immigrant as:

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

where \( w_m \) is the wage paid to an immigrant. Collecting terms yields:

\[
 J_m = \frac{y - w_m}{r + \lambda + \delta}.
\]  

(4)

Substituting from (3) and (4), we rewrite (2) as

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

(5)

We now describe how the equilibrium wages are determined. We assume that the wages are determined through Nash bargaining between a worker and a firm when there is a match. To
calculate the equilibrium wages, let $W_i$ and $U_i$ denote, respectively, the value of employment and unemployment for worker type $i = n, m$. That is, the equilibrium wage $w_i$ maximizes the Nash product $(W_i - U_i)^p(J_i)^{1-p}$, where $p$ measures the worker’s relative bargaining power.

Assume, to keep things simple, that a firm and a worker have equal bargaining power $(p = 1/2)$. Then Nash bargaining implies that the firm and the worker split the joint surplus so that:

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

This implies that the equilibrium $w_n$ satisfies

$$W_n - U_n = J_n. \quad (6)$$

Above, we have already calculated $J_n$ as a function of $w_n$. We only need to evaluate $W_n - U_n$ to calculate $w_n$. To do so, recall that a native worker is matched with a firm at rate $s(\theta)$ and separated from the job at rate $\lambda$. Therefore, the following asset value functions hold for a native worker:

$$rU_n = s(W_n - U_n),$$

$$rW_n = w_n + \lambda(U_n - W_n).$$

Combining, we obtain

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

Now, we can substituting (3) and (7) into (6) to obtain, after rearranging, the equilibrium wage:

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

An immigrant worker is similar to a native worker except that they face the additional risk

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3 This is to keep the exposition simple. In reality, immigrant workers may have weaker bargaining power than native workers. To represent it, we can assume that $p$ is smaller for immigrant workers than for native workers without qualitative changes in our results.
of job separation due to internal interception policy. Therefore, these asset value functions
must hold for an immigrant:

\[ rU_m = s(W_m - U_m), \]
\[ rW_m = w_m + \lambda(U_m - W_m) + \delta(W_0 - W_m). \]

where \( W_0 \) denotes the value an immigrant obtains when staying permanently back home in the
source country. The right-hand side of the second equation shows that an employed immigrant
earns \( w_m \) per unit of time and becomes unemployed at rate \( \lambda \) or deported at rate \( \delta \). In
each instance of job separation the parenthetical expression is the change in an immigrant’s
expected welfare. Assume that the destination country is too small to affect the wages in the
source country. This not only makes \( W_0 \) exogenous. As explained in Ethier (1986), it also
prevents immigration policy from extracting the monopsony rents from the source country and
allows us to focus purely on the effects of immigration policy. To keep the analysis tractable,
we further choose the utility units so that \( W_0 = 0 \). With this normalization, the two equations
above yield

\[
W_m = \frac{(r + s)w_m}{(r + \delta)(r + s) + r\lambda},
\]
\[
U_m = \frac{sW_m}{r + s}.
\]

Hence,

\[
W_m - U_m = \frac{rw_m}{(r + \delta)(r + s) + r\lambda}.
\]

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

Collecting terms and rearranging yields the equilibrium wage:
\[
w_m = \frac{[r(r + \lambda + s) + \delta(r + s)]y}{r [2(r + \lambda) + s] + \delta(2r + s)}.
\]

We now turn to an immigrant’s decision to migrate. Suppose that the destination country can intercept immigrants at the border with probability \( \phi \). Intercepted immigrants are returned to the source country, whereas immigrants who cross the border successfully first enter the unemployment pool in the destination country before going to find jobs. If we let \( b \) denote the utility cost of a border crossing attempt, the expected welfare to an immigrant bent on crossing the border is given by:
\[
-b + (1 - \phi) U_m + \phi W_0.
\]

In equilibrium, this expression must equal \( W_0 \), the welfare from not leaving the source country. With \( W_0 = 0 \) under our normalization, we can solve this equation for \( U_m \)
\[
U_m = \frac{b}{1 - \phi}.
\]

We now 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 both natives and immigrants. For natives, that means that
\[
\lambda(1 - u_n) L_n = su_n L_n.
\]

This can be solved for the unemployment rate:
\[
u_n = \frac{\lambda}{\lambda + s}.
\]
The corresponding steady state condition for immigrants is:

\[ (\lambda + \delta)(1 - u_m)L_m = su_m L_m, \]  

(14)

where the risk of deportation is taken into account. Solving the above for \( u_m \), we obtain

\[ u_m = \frac{\lambda + \delta}{\lambda + \delta + s}. \]  

(15)

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

\[ \delta(1 - u_m)L_m = (1 - \phi)M \]

Also, new arrivals in the destination country plus immigrants newly separated from jobs add to the pool of unemployed immigrants. In steady state, such additions must equal the number of immigrants in the pool who find jobs: that is,

\[ (1 - \phi)M + \lambda(1 - u_m)L_m = su_m L_m. \]

The last two equations are redundant, however, because together they imply (14). Finally, by the law of large numbers, the probability, \( \alpha \), that any firm being matched with an immigrant during search equals the proportion of immigrants in the unemployment pool; that is, in equilibrium:

\[ \alpha = \frac{u_m L_m}{u_m L_m + u_n L_n}. \]

This completes the description of the basic model.
2.2 Solving the model

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

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

On substitution for \( W_m \) from (9), this equation can be expressed as

\[ \frac{sw_m}{r(r+\lambda+s) + \delta(r+s)} = \frac{b}{1-\phi}, \]

which defines a negative relationship between \( s \) and \( w_m \) as represented by curve A in Figure 1.

[Figure 1 around here]

Second, the right-hand side of the wage equation (11) is increasing in \( s \) and hence (11) gives us a positive relationship between \( s \) and \( w_m \), as shown by curve B in Figure 1. These two equations together therefore yield the equilibrium \( s \) and \( w_m \) as shown in Figure 1. Algebraically, substituting for \( w_m \) from (11), we can write (16) as

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

This equation determines the unique equilibrium value of \( s \) in terms of policy variables, \( \phi \) and \( \delta \) as in:

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

Since \( s > 0 \), the unique equilibrium exists if and only if \( (1-\phi)y > b(r+\delta) \). Thus, we make the following technical assumptions to ensure the existence of the equilibrium. Assume that \( \phi \) has domain \([0,\overline{\phi}]\) and that \( \delta \) has domain \([0,\overline{\delta}]\). These domains are depicted in Figure 2.

[Figure 2 around here]
Then assume that $y$ is large enough to satisfy

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

Under Assumption 1, $s > 0$ for all relevant values of $\phi$ and $\delta$.

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 $\theta$ and hence the equilibrium $q = q(\theta)$. Then we can substitute the equilibrium $q$, $u_n$ and $u_m$, into (5) to solve for $\alpha$, the proportion of unemployed immigrants in the unemployment pool. Finally, we can substitute the equilibrium $\alpha$ to compute the number of immigrants in the destination country from the defining equation of $\alpha$:

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

(18)

The next proposition is our first key result.

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

We can also compute the equilibrium values of firms with filled positions from substituting the equilibrium wages into (3) and (4):

$$J_n = \frac{y}{2(r + \lambda) + s},$$

$$J_m = \frac{ry}{r[2(r + \lambda) + s] + \delta(2r + s)}.$$ 

(19)

A comparison shows that $J_n - J_m > 0$ for all $\delta > 0$. Similarly, 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 two results make up the next lemma.

**Lemma 1.** For all $\delta > 0$, (i) $J_n > J_m$; (ii) $u_m > u_n$.

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$^4$ $J_n = J_m$ only if $\delta = 0$.  

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3 Policy experiments

The destination country has, at its disposal, external and internal interception policy to affect flows of illegal immigration. This section examines the positive effects of immigration policy. Begin with external interception (border control) policy. Recall that $\phi$ is the measure of difficulty with which immigrants can cross the border. Thus, tighter border control increases $\phi$.

For a fixed $\delta$, differentiating the right-hand side of (16) with respect to $\phi$ yields $b/(1 - \phi)^2 > 0$, implying that tighter border control causes an upward shift of curve A in Figure 1. A change in $\phi$ has no effect on curve B. It follows that tighter border control (an increase in $\phi$) raises $w_m$ and $s$. More precisely, differentiation of (17) yields

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

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 Eqs. (13) and (15) the unemployment rates, $u_n$ and $u_m$, fall for natives and immigrants. But they do not fall at the same rate. A calculation shows that $\partial(u_n/u_m)/\partial s < 0$, meaning that tighter border control decreases the unemployment rate more for natives than for immigrants.

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

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

$(20)$

$\partial s/\partial \phi > 0$ implies $\partial \theta/\partial \phi > 0$, and hence the right-hand side of (20) is negative. On the left-hand side, $\partial w_i/\partial \phi > 0$ implies that the second and the third term are positive. Hence, the first term on the left must be negative for the equality to hold. Since the first term can be written $(J_n - J_m)(d\alpha/d\phi)$, Lemma 1 implies that $d\alpha/d\phi < 0$; i.e., tighter border control (an increase in $\phi$) decreases the proportion of immigrants in the unemployment pool. Eq. (18) can
be arranged to yield
\[ L_m = \frac{\alpha u_n}{1 - \alpha u_m} L_n. \]

As tighter border control lowers both the ratios \( \alpha/(1 - \alpha) \) and \((u_n/u_m)\), the total number of immigrants in the destination country must also fall. We summarize the effect of border control in

**Proposition 2** An increase in \( \phi \) (tighter border control) increases the wages and decreases unemployment rates for both natives and immigrants. The values of firms employing either type of workers fall. The number of immigrants residing in the destination country declines, and there are fewer immigrants unemployed relative to natives.

We next turn to internal interception (employer sanction) policy. Differentiation of (17) yields
\[ \frac{\partial s}{\partial \delta} = \frac{2br [(1 - \phi)y + b\lambda]}{[(1 - \phi)y - b(r + \delta)]^2} > 0, \]
which by (8) implies that stepping up the employer sanction program increases the wage \( w_n \) for natives. Similarly for the wage of an immigrant, as differentiation of \( w_m \) (i.e., (11)) gives us
\[ \frac{\partial w_m}{\partial \delta} = \frac{ry [s\lambda + (r + \delta)(r + \delta + \lambda)\partial s/\partial \delta]}{\{r [2(r + \lambda) + s] + \delta(2r + s)\}^2} > 0. \]

Higher wages mean that \( \partial J_n/\partial \delta < 0 \) and \( \partial J_m/\partial \delta < 0 \); tighter internal interception policy reduces the values of all firms, as can be verified by differentiating (19). The unemployment rates also fall: \( \partial u_n/\partial \delta < 0 \) and \( \partial u_m/\partial \delta < 0 \). Further, since \( \partial w_m/\partial \delta > 0 \), it can be shown by a procedure analogous to the one following the discussion of the effect of \( \phi \) that \( \partial \alpha /\partial \delta < 0 \) and \( \partial L_m/\partial \delta < 0 \). The next proposition gives a summary.

**Proposition 3** An increase in \( \delta \) (employer sanction) increases the wages and decreases unemployment rates for natives and immigrants. The value decreases for firms employing both natives and immigrants. The number of immigrants residing in the destination country declines.
4 The optimal immigration policy when there is one destination country

We now consider optimal immigration policy for the destination country in the setting presented in the preceding sections. Before we proceed, however, we should heed the remarks of Ethier (1986); that is, there is no consensus in the economic literature as to what a destination country government wants to achieve with immigration policy. Firstly, the standard welfare criterion, social welfare maximization, is not directly applicable, because we are unsure whether to include immigrants’ welfare in the destination country’s aggregate welfare calculus. The literature usually takes the exclusivist approach and maximizes natives’ welfare only. Secondly, the destination country government may use immigration policy to affect domestic income distributions; namely, it may want to protect native (unskilled) workers at the expenses of skilled workers and capital owners for political reasons. Thirdly, reducing the unemployment rate may be the government’s policy objective.

In this section, we define the destination country government’s objective as maximization of the total surplus created by legitimate firms, i.e., firms employing native workers. This objective function is consonant with internal interception policy aiming to penalize the firms hiring illegal immigrants. Thus, we define the host country government’s policy objective function as

\[ SW = (1 - u_n) L_n (J_n + W_n - U_n) - g(\phi) - h(\delta) \]  

(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. The last two terms, \(g(\phi)\) and \(h(\delta)\), are the administrative costs of external and internal interception policy, respectively. Under Assumption 1 the cost of internal interception policy \(h(\delta)\) is defined over the closed interval \([0, \bar{\delta}]\). When there is no internal interception, \(\delta\) takes the value 0 and \(h(0) = 0\). On the other hand we assume that \(h(\bar{\delta}) = \infty\) so that \(\delta > \bar{\delta}\) can be ruled out from policy considerations. Further, \(h(\delta)\) is twice-continuously
differentiable with $h' > 0$ and $h'' > 0$ over $(0, \bar{\delta})$, and $\lim_{\phi \to 0} h' = 0$. The cost of external interception $g(\phi)$ is defined over $[0, \bar{\phi}]$. $\phi$ takes on the value of 0 and $g(0) = 0$ when there is no border control, and increases as border control gets tightened.\textsuperscript{5} We assume there is $\bar{\phi}$ such that $g(\bar{\phi}) = \infty$, meaning that any $\phi > \bar{\phi}$ can be disregarded from welfare calculus. Further, $g(\phi)$ is assumed twice continuously differentiable with $g' > 0$, $g'' > 0$ over $(0, \bar{\phi})$ and $\lim_{\phi \to 0} h' = 0$.

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

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

(22)

Further substitution for $J_n$ and $u_n$ from (13) and (19) leads to

$$SW = \frac{2syL_n}{(\lambda + s)[2(r + \lambda) + s]} - g(\phi) - h(\delta).$$

We suppose that the government can choose $\phi$ and $\delta$ without budgetary constraints. We examine each policy instrument separately. Begin with external interception. Maximizing (22) with respect to $\phi$, given $\delta$, yields the first-order condition:

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

(23)

where

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

Hereafter, we make the following assumption to ensure that a higher job finding rate improve the welfare, that is, $\partial SW/\partial s > 0$:

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

\textsuperscript{5}To see this, note that the value of immigration without border control equals $-b + U_m$, which must equal $W_0 = 0$. Thus, $U_m = b$. A comparison with Eq. (1) shows that $\phi = 0$. 

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Let $\phi^*$ satisfy the first-order condition. The second-order condition requires

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

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

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

which makes the second term positive, given $\frac{\partial SW}{\partial s} > 0$. Hence, SW may fail to be globally concave in $\phi$. However, since $\lim_{\phi \to 0} g'(\phi) = 0$ and $g(\bar{\phi}) = \infty$, there is at least one $\phi^*(\delta)$ that satisfies the optimality conditions for a given $\delta$.

We next turn to the optimal internal interception, $\delta^*$, which satisfies the first-order condition

$$\frac{\partial SW}{\partial \delta} = \frac{\partial SW}{\partial s} \frac{\partial s}{\partial \delta} - h'(\delta) = 0. \quad (24)$$

The second derivative is

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

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

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

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

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

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

**Proposition 4** 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.

Propositions 3, 3 and 4 imply that as long as we consider a single destination country, external and internal interception policy have similar effects.

## 5 Multiple destination countries

In this section we extend the model to a multi-country setting, in which immigrants can choose a destination country to move to. In such extensions we examine the efficacy of external and internal interception policy to control immigration. In this section we consider the simplest extension: there are only two destination countries, and they are symmetric. Extensions to more than two destination countries are straightforward but offer no additional insights beyond what we discover here. The implications of asymmetric destination countries are studied in the next section.

With two destination countries, we distinguish between two types of geographical configurations. In one, both destination countries share the border with the source country so immigrants can enter either destination country directly from their home country. We call this setup the the common-border case. In the other configuration, only one destination country shares the border with the source country. In this case immigrants must first enter that bordering country even if they aim to settle in the non-bordering destination country. We call this second arrangement the single-border case. In all other respects, the model of this section is essentially the same as the one in the preceding sections.

To analyze the model with multiple destination countries, we need to make three additional assumptions. First, there are no barriers to mobility across destination countries, possibly because two destination countries form an economic union (e.g., the E.U.) or are two states of

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6To keep the analytical simple, we ignore the spatial structure within each country. For the spatial dimension of job search within a country/region/city, see Zenou (2009) among others.
the same country (e.g., California and Arizona). Second, job search is still localized; to find a job in a destination country, an immigrant has to be in that country’s unemployment pool. Third, natives do not migrate. The third assumption is a simple way to represent the stylized fact that in general immigrants have more freedom to choose their locations than natives and tend to cluster in major cities in comparison with natives.

5.1 The common-border case

Begin with the common-border case. Call two destination countries country 1 and country 2. In this case, immigrants enter the country whose border control is laxer and settle down in the country that gives them a higher level of welfare. As a result, the expected welfare for an unemployed immigrant in both countries are equalized in equilibrium. If we let $\phi_i$ denote a probability of successfully crossing the border into country $i$ ($i = 1, 2$), and write $\phi = \min(\phi_1, \phi_2)$, then the immigration decision equation is given by

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

(25)

where $U_{mi}$ is the value to an immigrant of being unemployed in country $i$. As before, $J_{mi}, U_{mi}$ and $W_{mi}$ are determined by solving the value functions similar to the ones developed in the previous sections. An immigrant’s wage in country $i$ is given by

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

as in (11). In this wage expressions it is assumed that the parameters $y, r, \lambda$ are common between two countries, whereas $\delta_i$ is country-$i$ specific. The equilibrium condition (25) yields (25):

$$\frac{s_iy}{r[2(r + \lambda) + s_i] + \delta_i(2r + s_i)} = \frac{b}{1 - \phi}.$$  (26)

Suppose first that each destination country pursues its own immigration policy. Thus, country $i$ chooses the policy vector $(\phi_i, \delta_i)$, given country $j$’s policy choice $(\phi_j, \delta_j)$, to maximize
its welfare

\[ SW_i = 2J_{ni}(1 - u_{ni})L_n - g(\phi_i) - h(\delta_i), \]

where by symmetry two destination countries have the same population \( L_n \). We now look for the Nash equilibrium of this game between two destination country governments.

Before we proceed, notice that country \( i \)'s internal interception policy has no effect on flows of immigrants into country \( j \). That is, once \( \phi \) is given, each country’s \( s_i \) is uniquely determined by that country’s internal interception policy \( \delta_i \) independently of the other country’s policy choice, as is clear from Eq. (26). This implies that once \( \phi \) is given, \( \delta_i \) is chosen optimally. As a result, internal interception policy is always chosen efficiently at \( \delta_i^*(\phi) \). Thus, the game we consider here can be regarded as a two-stage game, in which each destination country chooses its border control policy and then determine its internal interception policy.

Given that internal interception policy will be optimally chosen, our focus turns on external interception policy. Define by \( \phi_i^* \) country \( i \)'s optimal border control policy in the absence of country \( j \); that is, as in the preceding section. Denote country 1’s best response external interception policy choice by \( BR_1(\phi_2) \). If \( \phi_2 \leq \phi_1^* \), then \( BR_1(\phi_2) = \phi_2 \). To see this, note that increasing \( \phi_1 \) over \( \phi_2 \) has its cost but no effect on the flow of immigration into country 1 because all immigrants would first enter country 2 and then move to country 1. On the other hand, raising \( \phi_1 \) reduces country 1 welfare, and hence the claim. In contrast, if \( \phi_2 > \phi_1^* \), country 1 can affect the flow of immigration into its territory by setting \( \phi_1 < \phi_2 \). Hence, \( BR_1(\phi_2) = \phi_1^* \). Country 2’s best response function can be obtained similarly; namely, \( BR_2(\phi_1) = \phi_1 \) for \( \phi_1 \leq \phi_2^* \) and \( BR_2(\phi_1) = \phi_2^* \) for \( \phi_1 > \phi_2^* \).

The two countries’ best response functions are shown in Figure 3, where \( \phi_1 \) is on the horizontal axis and \( \phi_2 \) on the vertical axis.

[Figure 3 around here]

\( BR_1 \) is the segment 0A of the 45-degree line plus the vertical line at point A. \( BR_2 \) is the segment 0A plus the horizontal line at point A. Point A has the coordinates \((\phi_1^*, \phi_2^*)\), where \( \phi_1^* \) is
the optimal immigration policy described in the preceding section. In symmetry, $\phi_1^* = \phi_2^* = \phi^*$. Thus, the game has a continuum of Nash equilibria represented at any point on the segment $0A$ in Figure 3. It follows that in equilibrium each country chooses less tight borer control policy, except at point A. Although there is a continuum of Nash equilibria, the equilibria are welfare-ranked, with point A representing the Pareto-maximal outcome. Note also that the Nash equilibrium at point A maximizes the joint welfare, $SW_1 + SW_2$, and hence socially efficient when two destination countries are taken together.

**Proposition 5** In the common-border case there is a continuum of equilibrium in external interception policy, which includes the policy vector that maximizes the joint welfare of the two destination countries. However, in all other equilibria, border control policy in each country is inefficient. In contrast, the internal interception policy choice is efficient in each destination country (given $\phi$).

### 5.2 The single border case:

Turn next to the single-border case. Suppose that the source country shares the border with country 1 but not with country 2. In such a setting, only country 1 can implement border control. Thus, consider the simultaneous-move game, in which country 1 chooses $(\phi_1, \delta_1)$ to maximize $SW_1$ as defined in the preceding subsection, while country 2 chooses $\delta_2$ to maximize

$$SW_2 = 2J_{n2}(1 - u_{n2})L_n - h(\delta_2),$$

Before we proceed, three remarks are worth mentioning. First, since only country 1 can implement border control, in equilibrium we have

$$U_{m1} = \frac{b}{1 - \phi_1}.$$
However, having entered country 1, immigrants can move freely to country 2 so $U_{m2} = U_{m1}$ in equilibrium. That is, in equilibrium we again have

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

Second, as in the common-border case, each country’s internal interception policy choice has no effect on the other destination’s country’s welfare. Thus, country $i$ can choose $\delta_i$ optimally, given $\phi_1$. That is, internal interception policy again is efficiently implementable (given $\phi_1$).

Third, therefore, the game is equivalent to a two-stage game in which country 1 chooses its external interception policy and then two countries choose their internal interception policy independently.

The above remarks imply that in equilibrium country 1 implements the first-best policy in the single-country case, namely $(\phi^*_1, \delta^*_1)$ while country 2 implements its internal interception policy efficiently at $\delta^*_2(\phi^*_1)$.

Although each country’s immigration policy is efficient in the viewpoint of individual countries, they are inefficient when two countries are considered as an economic union. This can be demonstrated by solving the global optimization problem:

$$\max SW_1 + SW_2,$$

where

$$SW_1 + SW_2 = 2L_n[J(1 - u_{n1}) + J_{n2}(1 - u_{n2})] - g(\phi_1) - h(\delta_1) - h(\delta_2).$$

$SW_1 + SW_2$ is concave, given concavity of each constituent function. Hence, there is the unique optimum $\tilde{\phi}$, which satisfies this first-order condition\footnote{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.}

$$\frac{\partial SW_1}{\partial s_1} \frac{\partial s_1}{\partial \phi_1} - g'(\phi_1) + \frac{\partial SW_2}{\partial s_2} \frac{\partial s_2}{\partial \phi_2} \bigg|_{\phi_2 = \phi_1} = 0. \quad (27)$$

When evaluated at $\phi^*_1$, the first two terms on the left vanish but the last term is positive.
Hence, $\phi_1^* < \tilde{\phi}$; country 1’s external interception policy is not tight enough for joint welfare maximization. We summarize the above results in the following proposition:

**Proposition 6** With multiple destination countries, external interception policy is inefficiently low in equilibrium. In contrast, the equilibrium level of internal interception policy is efficient.

Two comments are in order. First, in both the common-border and the single-border border case, external interception policy are found to be inefficient. However, the inefficiency manifests itself for slightly different kinds of externalities. In the common-border case, two destination countries can get stuck in an inefficient equilibrium because one country’s border policy limits the effectiveness of the other’s border policy as immigrants seek out the easier border to cross, whereas in the single-border case, the inefficiency is caused by country 1’s failure to take into account country 2’s welfare when choosing its own policy level.

Second, in contrast to border control, internal interception policy does not cause any externalities and hence is efficient in both configurations. That is, there are no externalities because one country’s policy choice has no impact on the other country’s effective policy range in both cases. Note however that this result comes from the assumption that an immigrant’s welfare $W_0$ from staying in the source country is exogenous. This assumption is reasonable when the source country has a substantially larger labor force than either destination country. If this condition is not maintained, $W_0$ depends on the size of immigration, and hence there can arise two types of externalities. One arises from the extraction of the oligopsony rents from the source country. The other stems from each country’s effort to drive out immigrants from its territory by enforcing internal interception policy more than the other.

### 6 Asymmetric destination countries

In this section we relax the symmetry assumption between destination countries and suppose that two destination countries differ in population (labor force) size. Given the efficiency of
internal interception policy, we focus on the implications of asymmetry for external interception policy.

Begin with the common border case. Suppose without a loss of generality that country 1 is larger than country 2, i.e., \( L_{n1} > L_{n2} \). Then, Proposition 4 says that \( \phi^*_1 > \phi^*_2 \); country 1 prefers tighter border control than country 2. When two countries choose their border control independently, we can use an argument similar to the one given in the previous section to derive the best response functions are depicted in Figure 4.

[Figure 4 around here]

In Figure 4, \( BR_1 \) is the segment 0B of the 45-degree line plus the vertical line at point B. \( BR_2 \) is the segment 0A plus the horizontal line at point A. Thus, all the points on the segment 0A represent Nash equilibriums, which are welfare-ranked. At point A, country 2’s equilibrium external interception policy coincides with its preferred level \( \phi^*_2 \). However, the equilibrium policy level is too lax for country 1 relative to its preferred level \( \phi^*_1 \). Clearly, with an asymmetric country size there is no equilibrium that maximizes the joint welfare as in the case of symmetric country size.

To explore the implications of asymmetry further, consider the problem of joint welfare maximization:

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

The first-order condition is

\[
\left\{ \frac{\partial SW_1}{\partial s_1} \frac{\partial s_1}{\partial \phi} - g'(\phi) \right\} + \left\{ \frac{\partial SW_2}{\partial s_2} \frac{\partial s_2}{\partial \phi} - g'(\phi) \right\} = 0.
\]

Let \( \tilde{\phi} \) denote the joint optimum. Evaluated at \( \phi = \phi^*_1 \), the first expression in braces on the left-hand side of (28) vanish while the second is negative. Thus, \( \tilde{\phi} < \phi^*_1 \). Evaluated at \( \phi = \phi^*_2 \),
the second expression vanishes while the first expression is positive. Thus, $\tilde{\phi} > \phi_2^*$. Thus, $\tilde{\phi} \in (\phi_2^*, \phi_1^*)$. In other words, $\tilde{\phi}$ lies in the interior of line segment 0A in Figure 4.

**Proposition 7** If two destination countries have unequal population sizes, the Nash equilibrium external interception is too lax relative to the joint optimum.

Turn next the single-border case. Recall that country 1 borders the source country but country 2 does not. Suppose that $L_{n1} > L_{n2}$. This case may, for example, describe the relationship between California and Washington State of the United States. In such cases, since $\phi_1^* > \phi_2^*$ by Proposition 4. In country 2’s perspective, country 1’s border control is too stringent. Country 2 thus prefers that country 1 relax its external interception policy. Consider next the contrary case: $L_{n1} < L_{n2}$. This case may describe, e.g., the relationship between Germany and Greece, as many many immigrants enter Greece but eventually move to richer countries in the E.U. such as Germany. Since $\phi_1^* < \phi_2^*$, country 2 prefers that country 1 tighten its border control.

Now, we check the efficiency of the equilibrium outcomes. To that end, suppose that country 1 (or rather, the federal government) chooses external interception policy to maximize the joint welfare of the two destination countries. Then the joint optimum, which we denote by $\tilde{\phi}$, satisfies the first-order condition given by (27). Denote the left-hand side of (27) by $\Omega(\phi_1)$. Suppose that country 1 is larger than country 2. Then we have that $\phi_1^* > \phi_2^*$. $\Omega(\phi_1^*)$ equals $(\partial SW_2/\partial s_2)(\partial s_2/\partial \phi)$, which is positive. Hence, we have that $\tilde{\phi} > \phi_1^*$. Thus, the jointly optimal border control can be potentially tighter than the level each destination country would choose if it can pursue its external interception policy independently. The case in which country 2 is larger than country 1 yields similar results, namely, $\tilde{\phi} > \phi_2^* > \phi_1^*$.

**Proposition 8** Suppose that only country 1 shares the border with the source country. Then, the jointly optimal external enforcement policy exceeds the level each destination country would choose if it can pursue its external interception policy independently.
7 Conclusions

In this paper we examine the effect of two common policy instruments to combat illegal immigration: border control (external interception) and employer sanctions (internal interception). Our analysis extends the literature on two separate fronts. On one, many industrial countries confronting inflow of immigrants are concerned with the effect of immigration on native labor unemployment; to address this issue, our model features search-theoretic unemployment. On another, destination countries have different attitudes towards immigrants. In order to capture some aspects of immigration policy interdependency, our analysis include multiple destination countries. In this extension we examine two country configuration types. One is what we call the common-border case. In this case all destination countries share the border with the source countries. In the other, which we call the single-border case, only one destination country is contiguous to the source country.

We first work with the baseline model that has only one destination country. In that model we find that external and internal interception policy have similar effects; more interception efforts results in wage increases for both natives and immigrants, 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 interception policy yields suboptimal outcome, while countries can still set internal interception policy efficiently (given the inefficiency of external interception policy). In the common-border case, the policy inefficiency arises because immigration flows into each country are limited not by each country’s immigration policy but by the least stringent immigration policy among all destination countries. In the single-border case, by contrast, the inefficiency stems from the failure of the border country to take into account the effect of its border policy on the non-bordering destination countries’ welfare. Thus, even if destination countries want to coordinate their border policy, their preferred policy levels diverge, and hence they may not be able to agree on how to coordinate their border policy.

Finally, we mention two possible extensions. First, as shown by Bucovetsky (1991)
and subsequent works, the policy interdependency affects welfare of asymmetric countries in a different way. After introducing various types of asymmetry such as population, migration costs, and productivity, it would be worth uncovering welfare impacts of policy interdependency on each country’s welfare. Second, as shown by Kessler et al (2002), properties of policy competition may change if one introduces another mobile factors. Hence, if we consider, for instance, mobile capital that is complementary to labor in production, our results may change. These are significant topics for future research.@@
References


Figure 1. Existence of equilibrium with one host country
Figure 2. Range of $\phi$ and $\delta$.
Figure 3. Symmetric two host countries with common border
Figure 4. Asymmetric host countries with common border