Illegal Immigration and Fiscal Competition

Subhayu Bandyopadhyay
and
Santiago M. Pinto

Working Paper 2014-030A

October 2014

The views expressed are those of the individual authors and do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis, the Federal Reserve System, or the Board of Governors.

Federal Reserve Bank of St. Louis Working Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Federal Reserve Bank of St. Louis Working Papers (other than an acknowledgment that the writer has had access to unpublished material) should be cleared with the author or authors.
Illegal Immigration and Fiscal Competition

Subhayu Bandyopadhyay*

and

Santiago M. Pinto†

October 24, 2014

Abstract

This paper examines illegal immigration in a spatial context. Consider two countries: a source and a host of illegal immigration. Both countries produce the same good employing labor. There are legal restrictions to the movement of labor across countries. The host country consists of two regions (jurisdictions or states). These two regions share their borders with the source country. The host country controls illegal immigration using two alternative policy instruments: (i) it devotes resources to stop illegal immigrants at the border preventing them from entering the country; and (ii) it allocates resources to internal enforcement. Enforcement levels, both internal and border, may a priori differ by regions. The paper compares the provision of enforcement chosen by a federal government in the host country to the levels that would prevail under different allocation of responsibilities between the federal and regional governments in deciding border and internal enforcement levels.

JEL Classification: F21, F23, D72, D78

Keywords: illegal immigration, fiscal competition, border enforcement, internal enforcement

*Federal Reserve Bank of St. Louis, and IZA, Bonn; Subhayu.Bandyopadhyay@stls.frb.org.
†Federal Reserve Bank of Richmond; Santiago.Pinto@rich.frb.org.
1 Introduction

This paper examines illegal immigration in a spatial context where regions in a host country strategically determine the levels of illegal immigration enforcement. Recently, several states in the USA (Arizona, Alabama, South Carolina) have passed different types of legislation granting state governments additional discretion in controlling illegal immigration. The Federal Government has been challenging the implementation of such actions. But, regardless of the legality of the measures, all this has spurred the discussion on the role of different levels of governments in enforcing immigration laws.

This paper is built on the following assumptions. Illegal migration of workers can take place between a source and a host country. The host country consists of two regions (jurisdictions or states). These two regions share their borders with the source country.\(^1\) There are, however, legal restrictions to the movement of labor across countries. The host country controls illegal immigration using two alternative policy instruments. On one hand, the host country devotes resources to catch illegal immigrants at the border preventing them from entering the country. On the other hand, it chooses different levels of internal enforcement to determine whether firms employ illegal immigrant workers. If firms are caught employing illegal immigrants, they are subject to penalties and workers are deported. It is assumed that both internal and external enforcement may differ across regions. In other words, enforcement levels can be targeted to specific regions. Additionally, residents in each region have access to regionally provided goods. Illegal workers first decide whether to move to the host country, and next, they decide where (in which region of the host) to work. Firms operating in each region of the host decide, at the same time, the number of illegal workers to hire.

The paper compares the provision of enforcement, both at the border and internal, and the level of regional goods chosen by a federal government in the host country to the levels that would be observed when each region makes decisions in a decentralized way. The levels of enforcement and regional goods in the decentralized case depart from their efficient levels depending on the effect of several opposing externalities. To the extent that

\(^1\) An extension of the paper considers a different geographical configuration of the host country, where only one region shares the border with the source country and the other region is “internal”.

2
targeted regional border enforcement in the host country reduces the overall pool of illegal immigrants, it would generate a positive externality on the other region. Higher levels of targeted regional internal enforcement, on the other hand, would generate a negative externality by diverting illegal immigrants from one region to the other. Higher levels of the regional good would, however, generate the opposite effect.

Several papers have addressed the issue of illegal immigration. Ethier (1986) analyzes the problem of illegal immigration from the host nation perspective in a general equilibrium model of optimal enforcement. The paper assumes that there is a target level of illegal immigration which can be sustained with either border or internal enforcement. Bond and Chen (1987) also focus on the host country and examines the effect of allowing capital mobility. Djajic (1987) considers the problem from the source country perspective, and Djajic (1997) examines the resource allocation effects of illegal immigration on the host nation. Bandyopadhyay and Bandyopadhyay (2005) analyzes the effectiveness of enforcement, internal and border, in controlling illegal immigration under both capital mobility and capital immobility. They show that the net enforcement expenditure is higher (lower) in the presence of capital mobility if the host nation is an importer (exporter) of capital at the target immigration level.

Section 2 introduces the model. In section 3, we characterize the behavior of illegal immigrants conditional on the levels of enforcement and regional good. Section 4 studies the determination of the relevant policy variables under different institutional arrangements. For this purpose, we consider alternative settings. First, we assume that all policies are decided centrally by the federal government. Second, we assume that all decisions are completely decentralized. Third, we assume that regional governments choose the level of internal enforcement and the level of the regional good, while the federal government decides the level of border enforcement. And fourth, we assume that the federal government chooses both internal and border enforcement and the regional government only chooses the level of the regional good. We compare the results obtained in each case in section 5. Section 6 studies the implications of assuming an endogenous supply of illegal immigrants. Finally, section 7 concludes.
2 The Model

Consider two countries: a source and a host (or destination) of illegal immigration. Both countries employ labor and a fixed specific factor (land) to produce an homogeneous good. The host country consists of two regions (jurisdictions or states): A and B. The regions share their borders with the source country. Legal restrictions prevent a free movement of labor from the source to the host country. The host country controls illegal immigration using two policy instruments. On one hand, the host country can devote resources to prevent illegal immigrants from entering the country at the border (border enforcement). On the other hand, it can allocate resources to enforce illegal immigration laws internally (internal enforcement). The latter basically consists of inspecting domestic firms and determining whether they employ illegal workers. If firms are caught employing illegal immigrants, they are subject to penalties and workers are deported. Figures (1a) and (1b) in 1 help describe the model.

Internal and external enforcement may differ across regions. Specifically, the model assumes that the probability of detecting an illegal immigrant at the border is \( q_i(c_i) \), where \( c_i \) is expenditure on enforcement at the border between region \( i \) of the host country and the source country, where \( q(0) = 0, q'(c_i) > 0, q''(c_i) < 0, \) and \( 0 \leq q_i(c_i) \leq 1 \) for all \( c_i \geq 0 \). A firm operating in region \( i \) is detected hiring illegal workers with probability \( p_i(e_i) \), where \( p(0) = 0, p'(e_i) > 0, p''(e_i) < 0, \) and \( 0 \leq p_i(e_i) \leq 1 \) for all \( e_i \geq 0 \). If a firm is caught hiring illegal workers, it has to pay a penalty of \( z_i \) per illegal worker.\(^2\)

After observing the levels of border and internal enforcement, workers from the source country decide to enter the host as illegal immigrants through region \( A \), region \( B \), or stay in the source country; once they enter the host, they choose where (in which region of the host) to locate and work. Illegal immigrants face, however, a cost of moving across regions in the host country. Firms operating in each region of the host decide, at the same time, the number of illegal workers to hire.

The functions \( f^i(n^i), i = A, B, \) describe the production technology in the host

\(^2\)For simplicity, the probabilities \( q(\cdot) \) and \( p(\cdot) \) only depend on border and internal law enforcement expenditures. In a more general setting, \( q(\cdot) \) may also depend on the number of illegal migrants crossing the border, and \( p(\cdot) \) on the number of illegal workers employed by the firms.
country, where \( n^i \) the total number of workers, both legal and illegal, in region \( i \) of the host country, with \( f''^i(\cdot) > 0 \), and \( f'''^i(\cdot) < 0 \).

2.1 Legal residents/workers

There are \( \bar{n}^i \) immobile legal residents in region \( i \), who also own the fixed factor.\(^3\) Individuals derive utility from the consumption of private goods, and from a publicly provided regional good \( g^i.\)\(^4\) The consumption of private goods is equal to disposable income \( y^i_L \). Legal residents in \( i \) are paid a wage as legal workers \( w^i_L(n^i) = f''^i(n^i) \), receive rents from the ownership of the fixed factor, and pay taxes. Total rents, given by \( \pi^i \equiv f^i(n^i) - f''^i(n^i)n^i \), are equally divided among legal residents, so each legal resident receives \( \pi^i/\bar{n}^i \). Legal residents pay lump-sum taxes to finance expenditures in law enforcement and the cost of providing the regional public goods. Specifically, the utility of a legal resident of region \( i \) is \( u^i_L = y^i_L + \phi(g^i) \), with \( \phi' > 0, \phi'' < 0, \phi(0) = 0 \).

2.2 Illegal residents/workers

\( M^i \) workers attempt to enter the host country illegally through region \( i \). Each worker faces a cost from such action that depends positively on the number of illegal immigrants attempting to cross through border \( i \). We denote this cost by \( \gamma^i(M^i) \), with \( \gamma'^i > 0, \gamma''^i < 0 \). A proportion \( q^i M^i \) are caught at the border, which means that only \( \hat{M}^i = (1 - q^i)M^i \) enter the host through region \( i \). The total number of illegal workers in the host country is

\[
\hat{M} = \hat{M}^A + \hat{M}^B,
\]

\[
= (1 - q^A)M^A + (1 - q^B)M^B. \tag{1}
\]

An illegal worker that succeeds in migrating into region \( i \) may stay in region \( i \) or move and work in region \( j \). The number of illegal workers in region \( i \) is \( m^i = m^{ii} + m^{ij} \), where \( m^{ii} \) is the number of illegal workers that enter the country through region \( i \) and stay there,

\(^3\)In an extension to this paper we consider the distributional impact of illegal immigration policies by distinguishing between their effects on domestic workers and owners of the fixed factor.

\(^4\)In this model, \( g^i \) is assumed to be a publicly provided private good, such as health services, or maybe education. We assume that the cost of providing the good rises with the number of users. Alternatively, we could have assumed that \( g^i \) is subject to congestion, so as the number of users increase, the quality and the utility derived from the consumption of this good declines.
and \( m_{ji} \) the number of those that enter through region \( j \) and decide to move and work in region \( i \).

The residential decision is formalized through a random utility model. Consider the decision of an illegal immigrant that enters the host through region \( i \). If he stays in \( i \), he obtains a utility \( \tilde{u}^{ii} = u^i + \varepsilon^i \). The first term is \( u^i = y^i + \phi(g^i) \). We assume illegal workers do not pay taxes and do not receive rents from the fixed factor, so disposable income is simply the wage received as an illegal worker, i.e., \( y^i = u^i \). Illegal immigrants also receive utility from the regionally provided public good \( g^i \), captured by \( \phi(g^i) \). The second term of \( \tilde{u}^i \) is a random component, where \( \varepsilon^i \) is an iid extreme-value distributed random variable. Note that \( \varepsilon^i \) varies by individual, but we suppress the subscripts to simplify notation.\(^5\)

Moving to the other region entails an explicit moving cost represented by \( \tau \). Thus, the utility of that same illegal worker when he moves from \( i \) to \( j \) is \( \tilde{u}^{ij} = u^j - \tau + \varepsilon^j \), where \( u^j = y^j + \phi(g^j) \), and \( \varepsilon^j \) is an iid random variable with the same probability distribution as before.

We consider two alternative scenarios concerning the number of potential illegal immigrants. In the first case, the pool of workers in the source country willing to migrate to the host country is assumed fixed in supply, which means that \( \bar{M} = M^A + M^B \). We assume that a worker that is caught at the border and sent back to the source country will earn an exogenously given wage \( w^* \). In the second case, the pool of migrants is endogenously determined. In particular, we assume the total number of workers in the source country is \( \bar{n}^* \). A worker that participates in the source country’s labor market (either because the worker never attempted to migrate or because the worker was stopped at the border and sent back to the source country) is paid the wage at the source country \( w^*(n^*) = f^{**}(n^*) \). The wage depends on the number of effective workers in the source country \( n^* = \bar{n}^* - \dot{M} \), with \( w^{**}(n^*) \leq 0 \).

In both cases, the level of the publicly provided good at the source country is fixed and normalized to 0, so the utility of a worker residing in the source country is simply \( u^* = w^* \) in the first case, and \( u^* = w^*(n^*) \), in the second case.

\(^5\)This variable may also be thought as capturing the individual perception of attitudes towards immigration and how these attitudes differ by region.
2.3 Firms

We assume that the firm operating in region $i$ can distinguish between legal and illegal workers (complete discernment case).\textsuperscript{6} A firm in region $i$ is detected hiring illegal workers with probability $p^i(e^i)$. If the firm is caught, it pays a penalty of $z^i$ per illegal worker.\textsuperscript{7} In equilibrium, since legal and illegal residents are perfect substitutes in production,

$$w^i_L = f'(\bar{n}^i + m^i), \quad w^i = w^i_L - p^i(e^i)z^i.$$  

2.4 Governments

Legal residents pay lump-sum taxes to governments (central or regional governments, depending on the specific allocation of responsibilities). These taxes are used to finance three types of expenses: the cost of internal enforcement $T^i_e$, the cost of border enforcement $T^i_g$, and the cost of providing the publicly provided local good $T^i_c$. Specifically,

$$T^i_e = \sigma^i e^i + (v^i - z^i)p^i m^i, \quad T^i_c = \theta^i c^i, \quad T^i_g = (\bar{n}^i + m^i)\delta^i g^i,$$

and $T^i = T^i_e + T^i_g + T^i_c$. The cost of internal enforcement $T^i_e$ is the sum of direct enforcement costs $\sigma^i e^i$, and the cost of deporting immigrants net of the penalties paid by firms that hire illegal immigrants $(v^i - z^i)p^i m^i$, where $v^i$ is the cost of deporting an illegal immigrant, and $z^i$ represents the penalty per worker. Throughout the analysis we assume that $v^i \geq z^i$.

The cost of border enforcement $T^i_c$ is assumed to increase linearly with $c^i$, where $\theta^i > 0$

\textsuperscript{6}An extension of the model will focus on the no discernment case, i.e., when domestic firms cannot differentiate between legal and illegal workers.

\textsuperscript{7}The firm’s profit maximization problem is

$$\max_{\{n^i, m^i\}} \pi = f^i(n^i + m^i) - w^i_L n^i - w^i m^i - p^i z^i m^i.$$  

FOC:

$$m^i : \quad f'(n^i + m^i) - w^i_L = 0,$$

$$n^i : \quad f'(n^i + m^i) - w^i - p^i z^i = 0.$$  

This means that:

$$w^i = w^i_L - p^i z^i,$$

$$= f'(n^i + m^i) - p^i z^i.$$
is the constant marginal cost. Finally, the marginal cost of \( g^i \) is given by \( \delta^i > 0 \). Note, additionally, that \( T^i_g \) increases with number of users of that good, which includes both local residents and illegal immigrants.

2.5 Timing of events

The timing of the model is as follows:

1. Host country government(s): determination of law enforcement expenditures

   The government(s) in the host country decides (decide) the level of border \( c^i \) and internal enforcement \( e^i \), and the level of the regional publicly provided good \( g^i \) for \( i = A, B \).

2. Illegal workers: entry and residential choice

   (a) Illegal immigrants decide to enter the county through region \( A \) or region \( B \). An illegal immigrant entering the country through region \( i \) is stopped at the border and returned to the source country with probability \( q^i \).

   (b) Illegal immigrants that successfully entered through region \( i \) decide to stay and work in \( i \) or move and work in region \( j \), with \( i \neq j = A, B \). A firm in region \( i \) is detected hiring illegal immigrants with probability \( p^i \). The firm is subject to a penalty of \( z^i \) per illegal worker employed by the firm.

   (c) Region labor markets clear. In (a) and (b), individuals assume their decisions do not affect the outcome of the regional labor markets nor the decisions of other potential illegal immigrants. At the end, however, labor markets should clear.

We find the Sub-game Perfect Nash equilibria of this game.

3 Illegal Workers: Entry and Residential Choice

In this section, we examine the choices made by prospective illegal workers: migrate to the host or stay in the source country; enter the host country through region \( A \) or \( B \); and,
finally, decide whether to stay in the region of entry to the host country or move to the other region.

3.1 Residential choice

Consider the decision of an illegal immigrant that successfully entered the host country through region \(i\). A proportion of \(\hat{M}^i = M^i(1 - q^i)\) illegal immigrants stays in \(i\), and the rest moves to \(j\). The probability an illegal immigrant stays in \(i\) is \(\lambda^{ii} \equiv Pr(\tilde{u}^{ii} = \max \{\tilde{u}^{ii}, \tilde{u}^{ij}\})\), and the probability he moves to \(j\) is \(\lambda^{ij} \equiv Pr(\tilde{u}^{ij} = \max \{\tilde{u}^{ii}, \tilde{u}^{ij}\})\). Then, \(m^{ii} = \lambda^{ii}\hat{M}^i\), and \(m^{ij} = \lambda^{ij}\hat{M}^i\). As result, the total number of criminals in each region becomes

\[
m^A = m^{AA} + m^{BA} = \lambda^{AA}\hat{M}^A + \lambda^{BA}\hat{M}^B, \tag{3}
\]
\[
m^B = m^{BB} + m^{AB} = \lambda^{BB}\hat{M}^B + \lambda^{AB}\hat{M}^A. \tag{4}
\]

Given that the \(\varepsilon\)'s are iid and follow an extreme value distribution, then

\[
\lambda^{AA} \equiv \frac{\exp(u^A)}{\exp(u^A) + \exp(u^B - \tau)}, \quad \lambda^{AB} = 1 - \lambda^{AA}, \tag{5}
\]
\[
\lambda^{BB} \equiv \frac{\exp(u^B)}{\exp(u^A - \tau) + \exp(u^B)}, \quad \lambda^{BA} = 1 - \lambda^{BB}. \tag{6}
\]

3.2 Entry decision

Suppose initially the pool of illegal immigrants attempting to enter the host country is fixed and equal to \(\hat{M}\), such that \(\hat{M} = M^A + M^B\), where \(M^i\) is the number of illegal immigrants that attempt entry through region \(i\).\(^8\) Prior to the residential choice, an illegal immigrant decides whether to enter the host country through region \(A\) or region \(B\). This decision, as before, is made taking wages as given.\(^9\)

Let \(u^i_E\) denote the expected utility of an illegal immigrant that already entered the

\(^8\)We relax this assumption in Section 6.
\(^9\)It should be noted that this choice can also be formalized using a RUM.
host country through region \(i\), where

\[
\begin{align*}
  u^A_E & \equiv \mathbb{E} \left[ \max \{ \tilde{u}^{AA}, \tilde{u}^{AB} \} \right] = \log \left[ \exp(u^A) + \exp(u^B - \tau) \right], \\
  u^B_E & \equiv \mathbb{E} \left[ \max \{ \tilde{u}^{BA}, \tilde{u}^{BB} \} \right] = \log \left[ \exp(u^A - \tau) + \exp(u^B) \right].
\end{align*}
\]

(7) (8)

Using this notation, we define the (expected) utility of an illegal immigrant deciding to enter through \(i\)

\[
U^i \equiv q^i(w^* - k) + (1 - q^i)u^i_E - \gamma^i(M^i),
\]

(9)

where \(w^*\) is assumed constant. If \(U^A = \max\{U^A, U^B, w^*\}\), illegal immigrants will enter through region \(A\), and if \(U^B = \max\{U^A, U^B, w^*\}\), they will all enter through \(B\). Our focus is on equilibria in which illegal immigrants enter through both regions. In other words, in equilibrium we should observe \(U^A = U^B \geq w^*\), or

\[
q^A(w^* - k) + (1 - q^A)u^A_E - \gamma^A(M^A) = q^B(w^* - k) + (1 - q^B)u^B_E - \gamma^B(M^B) \geq w^*.
\]

(10)

3.3 Labor market equilibrium

The entry and residential decisions are made individually by potential illegal immigrants from the source country assuming they do not have an effect on other potential illegal immigrants’ choices and taking the outcome of the regional labor markets as given. At the end, however, labor markets should clear. The labor demand in region \(i\), \(w^i_L = f^{l^i}(\ell^i) \Rightarrow \ell^i = \ell^i(w^i_L)\). In equilibrium, \(\ell^i(w^i_L) = \bar{n}^i + m^i\). Illegal immigrants in region \(i\) are paid \(w^i = w^i_L - p^i(e^i)z^i\).

3.4 Equilibrium in the Second Stage

When the pool of migrants is fixed the equilibrium can be defined as follows.

**Equilibrium** When the number of migrants from the source country is fixed at \(\bar{M}\), the
equilibrium values \( \{w^A, w^B, M^A, M^B\} \) are implicitly determined by:

\[
\begin{align*}
    w^i_L &= f'\nu(n^i + m^i), \quad i = A, B, \\
    U^A &= U^B \geq w^*, \\
    \bar{M} &= M^A + M^B,
\end{align*}
\]

where \( m^A \) and \( m^B \) are defined in (3) and (4), respectively. The equations determine \( \{w^i(x), M^i(x)\}_{i=A,B} \), where \( x = (c^A, c^B, e^A, e^B, g^A, g^B, \bar{M}, \tau) \).

By substituting the solutions \( \{w^i, M^i\} \) into (3) and (4), we obtain \( m^i \). We characterize the previously defined equilibrium by performing a comparative static analysis with respect to \( \{c^i, e^i, g^i\} \). The results are shown in the Appendix. We construct a series of numerical examples to help understand these results, which are summarized in figures 2, 3, and 4. A few remarks are worth pointing out from this exercise.

First, at a symmetric equilibrium, the values of \( \{w^A_L, w^B_L, m^A, m^B, M^A, M^B\} \) are independent of \( \tau \). However, the effect of a change in \( \{c^i, e^i, g^i\} \) on the equilibrium values (evaluated at a symmetric equilibrium) does depend on \( \tau \).

Second, when the supply of potential illegal immigrants is exogenous, an increase in \( e^i \) simply diverts the entry of illegal immigrants from region \( i \) to region \( j \) (when \( \tau > 0 \)) and reduces the number of illegal immigrants working in \( i \). Similarly, a higher level of \( g^i \) only induces illegal immigrants to enter through \( i \) (if \( \tau > 0 \)) and increases the supply of illegal immigrants in \( i \). In each case, wages adjust accordingly in response to \( m^i \). Specifically, consider the effect of increasing \( e^A \) evaluated at a symmetric equilibrium. Suppose, initially, that \( \tau = 0 \). Then, a higher level of \( e^A \) does not affect the entry decisions. However, under perfect discernment, an increase in the (expected) cost of hiring an illegal immigrant translates into a lower wage for illegal immigrants. Thus, the immediate effect of a higher level \( e^A \) is to reduce \( w^A \).\(^{10}\) As illegal immigrants now find it less attractive to work in \( A \) and start moving to \( B \), \( w^A_L \) will tend to rise. Now suppose that \( \tau > 0 \). In this case, it is less desirable to enter through \( A \) than through \( B \) because illegal immigrants anticipate they will later move to \( B \). However, when moving across regions illegal immigrants now

\(^{10}\)Recall that \( w^A = w^A_L - p^A z^A \).
face a positive cost. Hence, $M^A$ declines when $e^A$ increases and $\tau > 0$. A smaller (relative) supply of illegal immigrants in $A$ makes $w^A_L$ higher. Note however, compared to the case $\tau = 0$, the change in $w^A_L$ and $m^A$ is smaller partly because there are already less illegal immigrants entering through $A$. The corresponding effects on region $B$ are exactly the opposite. Concerning the effect of $g^A$ on $\{w^A_L, w^B_L, m^A, m^B, M^A, M^B\}$, note that lowering $g^A$ has the same effect on these variables as increasing $e^A$.

Third, a change in $c^i$, in addition to diverting illegal immigrants from region $i$ to $j$, also reduces the overall pool of (effective) illegal immigrants. Only the latter effect is present at a symmetric equilibrium when $\tau = 0$, so wages in both regions unambiguously increase with higher levels of $c^i$. When $\tau > 0$, an increase in $c^i$ reduces the number of (effective) illegal immigrants and the supply of illegal immigrants in region $i$, rising wages in the region. The impact on region $j$ is, however, ambiguous. Even though the number of illegal immigrants is smaller, some of those previously entering through $i$ would now enter through $j$, so the supply would tend to rise in $j$ due to this effect. To the extent that the latter effect dominates the former, $w^j$ could even end up declining as $c^i$ rises. Figure (2a) shows that as $\tau$ increases, $\partial w^B / \partial e^A$ becomes smaller in absolute value, and it becomes positive for a sufficiently high value of $\tau$.

### 4 Choosing Internal and Border Enforcement

We now examine the problem faced by the host country governments, regional and federal, in choosing the level of border and internal enforcement levels under different institutional arrangements. We consider four alternative scenarios and compare the outcomes reached in each case. In the first scenario, the central government chooses all policy variables: internal enforcement, border enforcement, and the levels of local public goods (fully centralized case). In the second scenario, the regional governments choose all the policy variables in a decentralized way (fully decentralized case). The last two scenarios consider mixed cases. In the first mixed case, the central government chooses the level of border enforcement and regional governments choose internal enforcement and the level of local public goods (mixed case $X_1$). In the second case, the central government chooses border and internal
enforcement, and regional governments only choose the level of local public goods (mixed case $X_2$).

Throughout the rest of the analysis, we assume that governments only care about the well-being of legal residents with the following caveat: while the regional governments are only concerned about the well-being of legal residents in their respective regions, the central government takes into account the well-being of all legal residents, regardless of where they reside.

### 4.1 Fully Centralized Solution

In this case, the central government chooses the levels of $\{c^i, g^i, c^i : i = 1, 2\}$, that maximize $U_L = U^A_L + U^B_L = \bar{n}^A u^A_L + \bar{n}^B u^B_L$, where $u^i_L = w^i_L + \pi^i / \bar{n}^i - T^i / \bar{n}^i + \phi(g^i)$. As explained earlier, the income of a legal resident in region $i$ is given by the legal wage $w^i_L$, and by the share $1/\bar{n}^i$ of the returns to the fixed factor $\pi^i$. In this case, a legal resident pays (lump-sum) taxes only to the central government. Substituting into the objective function, the central government’s problem can be rewritten as

$$
\max_{\{c^A, c^B, g^A, c^B, g^B\}} U_L = \frac{f^A(\bar{n}^A + m^A) - f'^A(\bar{n}^A + m^A)m^A + \bar{n}^A\phi(g^A)}{13} + \frac{f^B(\bar{n}^B + m^B) - f'^B(\bar{n}^B + m^B)m^B + \bar{n}^B\phi(g^B)}{14}
-(T^A + T^B)
$$
The Kuhn-Tucker conditions are characterized by

\[
\frac{\partial U_i}{\partial e^i} \equiv \frac{\partial U_i}{\partial e^i} + \frac{\partial U_j}{\partial e^i} \leq 0
\]

\[
= - \left[ f''m^i + (v^i - z^i)p^i + \delta^i g^i \right] \frac{\partial m^i}{\partial e^i} - \left[ \sigma^i + (v^i - z^i)p^i m^i \right] \\
- \left[ f''j m^j + (v^j - z^j)p^j + \delta^j g^j \right] \frac{\partial m^j}{\partial e^i} \leq 0, \tag{15}
\]

\[
\frac{\partial U_i}{\partial e^i} \equiv \frac{\partial U_i}{\partial e^i} + \frac{\partial U_j}{\partial c^i} \leq 0
\]

\[
= - \left[ f''m^i + (v^i - z^i)p^i + \delta^i g^i \right] \frac{\partial m^i}{\partial c^i} \\
- \left[ f''j m^j + (v^j - z^j)p^j + \delta^j g^j \right] \frac{\partial m^j}{\partial c^i} \leq 0, \tag{16}
\]

\[
\frac{\partial U_i}{\partial g^i} \equiv \frac{\partial U_i}{\partial e^i} + \frac{\partial U_j}{\partial g^i} \leq 0,
\]

\[
= - \left[ f''m^i + (v^i - z^i)p^i + \delta^i g^i \right] \frac{\partial m^i}{\partial g^i} + \left[ \delta^i \phi'(g^i) - (\bar{n}^i + m^i) \delta^i \right] \\
- \left[ f''j m^j + (v^j - z^j)p^j + \delta^j g^j \right] \frac{\partial m^j}{\partial g^i} \leq 0, \tag{17}
\]

for \( i \neq j = 1, 2 \), and the corresponding non-negativity constraints \( e^i \geq 0, c^i \geq 0, g^i \geq 0 \). The solution is denoted \( \{e_C^i, c_C^i, g_C^i : i = A, B\} \).

### 4.2 Fully Decentralized Solution

We now assume that \( \{e^i, c^i, g^i\}, i = 1, 2 \), are determined in a decentralized way by each jurisdiction. In this case, each region maximizes the total utility of local legal residents \( U_i^i = \bar{n}^i u_i^i \) and faces the cost of providing interior and border enforcement at its own border, and the cost of publicly providing the regional good. The problem for the regional government in \( i \) is

\[
\max_{\{e^i, c^i, g^i\}} U_i^i = f^i(\bar{n}^i + m^i) - f''i(\bar{n}^i + m^i)m^i + \bar{n}^i \phi(g^i) - T^i, \tag{18}
\]
taking \(\{e^i, g^i, c^i\}\) as given. The Kuhn-Tucker conditions are given by

\[
\begin{align*}
\frac{\partial U^i}{\partial e^i} &\equiv - [f''(m^i) + (v^i - z^i)p^i + \delta^i g^i] \frac{\partial m^i}{\partial e^i} - [\sigma^i + (v^i - z^i)p^i m^i] \leq 0, \\
\frac{\partial U^i}{\partial c^i} &\equiv - [f''(m^i) + (v^i - z^i)p^i + \delta^i g^i] \frac{\partial m^i}{\partial c^i} - \theta^i \leq 0, \\
\frac{\partial U^i}{\partial g^i} &\equiv - [f''(m^i) + (v^i - z^i)p^i + \delta^i g^i] \frac{\partial m^i}{\partial g^i} + [n^i \phi' - (\bar{n}^i + m^i)\delta^i] \leq 0,
\end{align*}
\]

in addition to the non-negativity constraints \(e^i \geq 0, c^i \geq 0, g^i \geq 0, i = A, B\). The solution is denoted \(\{e^i_D, c^i_D, g^i_D : i = A, B\}\).

### 4.3 Mixed Case 1 \((X_1)\): Decentralized Provision of Local Public Goods and Internal Enforcement and Centralized Border Enforcement

Consider a mixed case in which \(\{e^i : i = 1, 2\}\) is determined by the central government authority, and \(\{e^i, g^i : i = 1, 2\}\) by the respective regional governments in a decentralized way. The policy variables are all chosen simultaneously. The utility of a legal resident of region \(i\) is

\[
u^i_L = w^i_L + \pi^i/n^i + \phi(g^i) - T^i_e/n^i - T^i_c/(\bar{n}^A + \bar{n}^B) - T^i_g/\bar{n}^i.
\]

In this case, the total cost of border enforcement, \(T_e = T^A_e + T^B_e = \theta^A c^A + \theta^B c^B\), is equally shared among the entire legal resident population \(\bar{n}^A + \bar{n}^B\). As a result, a legal resident of the host country pays \(T^i_e/(\bar{n}^A + \bar{n}^B)\) to the central government.

The government in region \(i\) maximizes \(U^i_L = \bar{n}^i u^i_L\) with respect to \(\{e^i, g^i\}\), or

\[
\max_{\{e^i, g^i\}} U^i_L = f^i(\bar{n}^i + m^i) - f^{i^i}(\bar{n}^i + m^i)m^i + \bar{n}^i \phi(g^i) - T^i_e - T^i_g/(\bar{n}^A + \bar{n}^B),
\]

(22)

taking \(\{e^i, g^i, c^A, c^B\}\) as given. The Kuhn-Tucker conditions are exactly the same as those described in (19) and (21). Now, consider the central government’s problem. As before, the central government’s objective function is \(U = U^A_L + U^B_L\). When choosing \(\{c^A, c^B\}\), the central government takes \(\{e^A, e^B, g^A, g^B\}\) as given. The expressions resulting from the central government’s first-order conditions are exactly the same as those described by (16). The Nash Equilibrium in this case, denoted \(\{e^i_{X_1}, c^i_{X_1}, g^i_{X_1} : i = A, B\}\), is the solution of
the system of equations (16) (19), and (21).

4.4 Mixed Case 2 ($X_2$): Decentralized Provision of Local Public Goods and Centralized Internal and Border Enforcement

Finally, consider a different mixed case in which \{\(e^i, c^i : i = 1, 2\)\} are determined by the central government authority, and \{\(g^i : i = 1, 2\)\} by the regional governments. The utility of a legal resident of region \(i\) is the same as before except for the financing of the government expenditures. Specifically,

\[
u^i_L = w^i_L + \pi^i/\bar{n}^i + \phi(g^i) - (Te + Tc)/(\bar{n}^A + \bar{n}^B) - T^i_g/\bar{n}^i.
\]

In this case, total enforcement \(Te + Tc = (T^A_x + T^B_x) + (T^A_c + T^B_c)\) is equally shared among the entire legal resident population. The government in region \(i\) simply maximizes \(U^i_L = \bar{n}^i u^i_L\) with respect to \(g^i\), or

\[
\max_{\{g^i\}} U^i_L = f^i(\bar{n}^i + m^i) - f''^i(\bar{n}^i + m^i)m^i + \bar{n}^i\phi(g^i)
\]

\[
-\bar{n}^i/(\bar{n}^A + \bar{n}^B)(Te + Tc) - T^i_g,
\]

(23)

taking \{\(g^i, e^A, e^B, c^A, c^B\)\} as given. The Kuhn-Tucker conditions are

\[
\frac{\partial U^i_L}{\partial g^i} = -\left[ f''^i m^i + \frac{\bar{n}^i}{(\bar{n}^A + \bar{n}^B)(v^i - z^i)p^i + \delta^i g^i} \right] \frac{\partial m^i}{\partial g^i} - \frac{\bar{n}^i}{(\bar{n}^A + \bar{n}^B)(v^j - z^j)p^j} \frac{\partial m^j}{\partial g^i} + \left[ \bar{n}^i \phi'(g^i) - (\bar{n}^i + m^i)\delta^i \right] \leq 0,
\]

(24)

The central government’s problem consists of maximizing \(U = U^A_L + U^B_L\), by choosing \{\(e^A, e^B, c^A, c^B\)\}, taking \{\(g^A, g^B\)\} as given. The expressions resulting from the central government’s first-order conditions are exactly the same as those described by (15) and (16). The Nash Equilibrium in this case, denoted \{\(e^i_{X_2}, c^i_{X_2}, g^i_{X_2} : i = A, B\)\}, is the solution of the system of equations (15) (16), and (24).
5 Comparing the Solutions: Fixed Supply of Illegal Immigrants

In this section, we focus exclusively on the case where the supply of migrants from the source country is given in supply at \( \bar{M} \). Consider, in first place, the fully centralized and decentralized solutions. In general, evaluating the centralized FOCs at \( \{e^i_D, c^i_D, g^i_D : i = A, B\} \) gives

\[
\frac{\partial U_L}{\partial e^i} = -\left[ f'' m^j + (v^j - z^j)p^j + \delta^j g^j \right] \frac{\partial m^j}{\partial e^i}, \tag{25}
\]

\[
\frac{\partial U_L}{\partial c^i} = -\left[ f'' m^j + (v^j - z^j)p^j + \delta^j g^j \right] \frac{\partial m^j}{\partial c^i}, \tag{26}
\]

\[
\frac{\partial U_L}{\partial g^i} = -\left[ f'' m^j + (v^j - z^j)p^j + \delta^j g^j \right] \frac{\partial m^j}{\partial g^i}, \tag{27}
\]

since \( \partial U_L^i / \partial e^i = \partial U_L^i / \partial c^i = \partial U_L^i / \partial g^i = 0 \). These expressions describe the external effects imposed by region \( i \) on region \( j \), not internalized by the authorities in \( i \) when they decide the policy variables in a decentralized way. To derive further results, the rest of the analysis assumes that regions are completely identical.\(^{11}\) We therefore focus on symmetric equilibria at which \( e^i = e, c^i = c, g^i = g, i = A, B \). Under these conditions, the equilibrium in the second stage becomes \( \{M^i, w^i, m^i\} = \{M, w, m\} \), where \( M = \bar{M}/2, w = f'(n + m), \bar{M} = \bar{M}(1 - q) \), and \( m^i = m = [(1 - q(c)\bar{M}/2] \).

Consider the fully centralized case. At a symmetric solution, \( \partial m^i / \partial e^i = -\partial m^j / \partial e^j \). As a result, \( \partial U_L / \partial e^i = -[\sigma + (v - z)p'(e)m] < 0 \), which means that \( e^A_C = e^B_C = 0 \). In other words, the centralized solution entails no internal enforcement. Hence, the values of \( c_C \) and \( g_C \) are jointly determined by

\[
[ f'' m + \delta g]q'(c)\bar{M} - \theta = 0, \tag{28}
\]

\[
\phi'(g) - \frac{(n + m)}{n} \delta = 0 \tag{29}
\]

where \( m = [1 - q(c)](\bar{M}/2) \) and \( M = \bar{M}/2 \).

**Proposition 1.** At a symmetric equilibrium, the centralized solution entails no interior

\(^{11}\)To denote identical variables we suppress indexes identifying the regions.
enforcement of illegal immigration, i.e., $e_C = 0$.

However, the latter does not necessarily hold in the completely decentralized case nor in case $X_1$. The amount of interior enforcement is positive whenever

$$\frac{\partial U^i_L}{\partial e^i} = -[f''m + (v - z)p(e) + \delta g^i]\frac{\partial m^i}{\partial e^i} - [\sigma + (v - z)p'(e)m] = 0$$

(30)
at $e > 0$.\footnote{Recall that $v^i \ge z^i$. Since $p''(e^i) > 0$ for all $e^i \ge 0$, then $\partial m^i / \partial e^i < 0$ for all $e^i \ge 0$. As a result, if $\partial U^i_L / \partial e^i < 0$, then $\partial U^i_L / \partial e^i < 0$ for all $e^i \ge 0$, but the converse is not necessarily true. This means that if the solutions in the decentralized case and mixed case $X_1$ are such that $e^i_D = e^i_{X_1} = 0$, then the solution in the centralized case is $e^i_C = 0$ (in fact, this always holds). But the converse is not true.} For the purpose of our analysis, we assume that this last condition is satisfied. Since $\partial m^i / \partial e^i < 0$, the expression between squared brackets should be positive for (30) to hold. Similarly, from (20) and given that $\partial m^i / \partial c^i < 0$, it is clear that for $c$ to be strictly positive in equilibrium, the expression between squared brackets should be positive.

In comparing the solutions, it should also be noted that the solutions for $c$ and $g$ in the (symmetric) centralized case, determined by (28) and (29), do not depend on $\tau$. However, this does not hold in all cases that involve some kind of decentralized decision.

5.1 Perfect Mobility Across Regions: $\tau = 0$

Suppose, initially, that once illegal immigrants successfully enter the host country, they can freely move across regions, i.e., $\tau = 0$. Evaluating the centralized FOCs for $c^i$ and $g^i$ at the symmetric decentralized solution $\{e_D, c_D, g_D\}$ gives $\partial U^L / \partial c^i > 0$ and $\partial U^L / \partial g^i > 0$.\footnote{This result is shown in Appendix A.2.} This means that starting at this point, the central authority should increase both $c^i$ and $g^i$. Additionally, since in the symmetric case $(\partial^2 U^L / \partial c^i \partial g^i) > 0$,\footnote{From the comparative static analysis developed in the appendix, $\partial m^j / \partial c^i = \partial m^j / \partial c^i < 0$ at a symmetric equilibrium with $\tau = 0$.} then $c^i$ and $g^i$ are unambiguously higher in the centralized case.

Combining these results and due to the fact that at a symmetric equilibrium with with free mobility across regions $\partial \hat{M} / \partial e^i = 0, \partial \hat{M} / \partial c^i < 0, \partial \hat{M} / \partial g^i = 0$, it follows that the total number of illegal immigrants successfully entering the host country $\hat{M}$, and, consequently, the number of immigrants working in each region $m$, are unambiguously lower when $c^i$ and $g^i$ are chosen by the central government.
Proposition 2. When $\tau = 0$, both $c$ and $g$ are underprovided in the completely decentralized case relative to the completely centralized case, i.e., $c_D < c_C, g_D < g_C$. Hence, $\hat{M}_C < \hat{M}_D$ and $m_C < m_D$.

We now focus on case $X_1$ in which $e^i$ and $g^i$ are chosen by the regions and $c^i$ by the central government. Replacing the symmetric mixed case $X_1$ solution into the FOCs of the centralized case (assuming that $e > 0$ in the $X_1$ case) gives

$$\frac{\partial U_L}{\partial c^i} = -(v - z)p(e)q'(c)M,$$

$$\frac{\partial U_L}{\partial g^i} = [f''m + (v - z)p(e) + \delta g]\frac{(1 - q)M\phi'(g)}{2[1 - q(c)]Mf''} > 0,$$

where $m = [1 - q(c)](\bar{M}/2)$ and $M = \bar{M}/2$. Suppose that $(v - z) = 0.15$ This means that starting from the mixed $X_1$ case solution, the central authority should initially not change $c^i$ but increase $g^i$. However, as $g^i$ changes, the curve (28) also changes. Specifically, since $\left(\frac{\partial^2 U_L}{\partial c^i \partial g^i}\right) > 0$, as $g^i$ increases, the curve determining $c^i$ shifts to the right affecting the determining $g^i$ (given by (29)) as well. The SOC guarantees that this process stops at values of $c^i$ and $g^i$ that are higher in the centralized case relative to the mixed case. Again, given that $\partial \hat{M}/\partial c^i < 0$, $\hat{M}$, and, consequently $m$, are higher when $c^i$ and $g^i$ are chosen by the central government.

Proposition 3. Consider a symmetric equilibrium and $\tau = 0$. In case $X_1$, $c$ is overprovided and $g$ is underprovided relative to the completely centralized case, i.e., $c_{X_1} < c_C$ and $g_{X_1} < g_C$. As a result, $\hat{M}_{X_1} < \hat{M}_C$ and $m_{X_1} < m_C$.

Consider now case $X_2$ in which the values of $g^i$ are chosen by the regions and $e^i$ and $c^i$ by the central government. As explained earlier, the central government chooses $e_C = e_{X_2} = 0$. Evaluating the completely centralized FOCs at the mixed case $X_2$ solution

\[\text{This argument holds if the difference } v - z \text{ is very small.}\]

\[\text{In addition to } (\partial^2 U_L/\partial c^i \partial c^i) < 0 \text{ and } (\partial^2 U_L/\partial g^i \partial g^i) < 0, \text{ the SOC requires that the direct effects are stronger than the indirect effects, i.e., } (\partial^2 U_L/\partial c^i \partial c^i)(\partial^2 U_L/\partial g^i \partial g^i) - (\partial^2 U_L/\partial c^i \partial g^i)^2 > 0.\]
\{c_{X_2}, g_{X_2}\} \text{ gives }

\begin{align*}
\frac{\partial U^L_i}{\partial c^i} &= 0, \\
\frac{\partial U^L_i}{\partial g^i} &= (f''m + \delta g) \frac{(1 - q)M\phi'(g)}{2(1 - \{1 - q(c)\}Mf'')} > 0.
\end{align*}

Hence, a central authority in the fully centralized case should increase \( g \). However, as this happens, \( (\partial U^L_i/\partial c^i) \) increases. As a result, both values of \( c \) and \( g \) will end up being larger in the completely centralized case compared to the solutions of the symmetric mixed case \( X_2 \), i.e., \( c_{X_2} < c_C \) and \( g_{X_2} < g_C \). The latter result implies that \( \hat{M}_C < \hat{M}_{X_2} \) and \( m_C < m_{X_2} \).

**Proposition 4.** Consider a symmetric equilibrium and \( \tau = 0 \). In the mixed case \( X_2 \), both \( c \) and \( g \) are underprovided relative to the completely centralized case, i.e., \( c_{X_2} < c_C \) and \( g_{X_2} < g_C \). As a result, \( \hat{M}_C < \hat{M}_{X_2} \) and \( m_C < m_{X_2} \).

Finally, we compare the solutions from cases \( X_1 \) and \( X_2 \). First, note that \( \partial U^L_i/\partial c^i \) in cases \( X_1 \) and \( X_2 \) are the same and given by equation (28). Moreover, this condition depends on \( g \) but not on \( e \). Second, suppose that \( (v^i - z^i) = 0 \). Then, \( \partial U^L_i/\partial g^i \) is also the same in both cases. Third, note that the only difference between these two cases is that in case \( X_1 \) the \( \partial U^L_i/\partial e^i \) is given by (19), while in case \( X_2 \) internal enforcement \( e_{X_2} \) is zero. However, since in case \( X_1 \), the level of \( e \) does not affect the FOC with respect to \( c \), and since it can be shown that \( \partial m^i/\partial g^i \) does not depend on \( e \), then the fact that \( e_{X_1} > 0 \) does not have an impact on the other equilibrium variables \( c \) and \( g \). Consequently, \( c_{X_1} = c_{X_2} \) and \( g_{X_1} = g_{X_2} \).

**Proposition 5.** At a symmetric equilibrium, the values of \( c \) and \( g \) in cases \( X_1 \) and \( X_2 \) are identical, i.e., \( c_{X_1} = c_{X_2} \) and \( g_{X_1} = g_{X_2} \).

### 5.2 Imperfect Mobility Across Regions: \( \tau > 0 \)

Now suppose that \( \tau > 0 \). It was stated earlier that the solutions in the centralized case does not depend on \( \tau \). However, since the partial derivatives \( \partial m^i/\partial e^i \), \( \partial m^i/\partial c^i \), and \( \partial m^i/\partial g^i \)

\^[17]\text{As before, from (28), in order for } c > 0, \text{ we need } (f''m + \delta g) > 0.

\^[18]\text{In other words, (21) is the same as (24).}
depend on $\tau$, the decentralized solutions ultimately depend on moving costs.

Figures (5a), (5b), and (5c) in 5 compare the solutions $\{c^i, e^i, g^i\}$ as a function of $\tau$ for the four cases considered earlier: (i) completely centralized, $C$; (ii) completely decentralized, $D$; (iii) mixed case $X_1$; and (iv) mixed case $X_2$. The conclusions from this exercise can be summarized as follows.

First, note that $c_{X_1} = c_X$ and $g_{X_2} = g_X$ also hold for values of $\tau > 0$ (and not only for $\tau = 0$). Second, even though with perfect mobility $c_D < c_{X_1} < c_C$ and $g_D < g_{X_1} < g_C$, this ordering is not necessarily preserved when $\tau > 0$. In particular, figures (5a) and (5c) show that border enforcement and the level of the regional good increase in the decentralized case as $\tau$ increases, and when $\tau$ becomes sufficiently high, they become larger than the corresponding levels of $c$ and $g$ in the centralized and mixed cases.

Consider the symmetric fully decentralized solution given by the system of equations (19) - (21) evaluated at $\tau = 0$. Suppose that $\tau$ is marginally increased. The immediate effect of such increase in a symmetric equilibrium is to raise $\partial^2 U_i^L / \partial e^i / \partial \tau$ in both locations.\(^{19}\) If this was the only effect, then the new equilibrium would be characterized by higher levels of $c^A$ and $c^B$. However, as $c^i$ and $c^j$ increase, $e^i, e^j, g^i$, and $g^j$ would be affected as well. Ultimately, the higher level of $c$ ends up reducing $e$, and increasing $g$. Note that when $\tau \to \infty$ the values of $c$ and $g$ for the fully decentralized case and case $X_1$ become $\{c_D, g_D\}_{\tau \to \infty} = \{1.48, 3.92\}$ and $\{c_{X_1}, g_{X_1}\}_{\tau \to \infty} = \{1.21, 3.65\}$, respectively. The centralized solution does not depend on $\tau$ so that $\{c_C, g_C\} = \{1.24, 3.85\}$ for all $\tau \geq 0$, which means that when it is prohibitively costly to move across regions (so immigrants must remain in the region of entry), $c$ and $g$ end up being overprovided in the decentralized case relative to the centralized case.

Third, as $\tau$ increases $e_D$ and $e_{X_1}$ decline and become zero when $\tau > 1.83$ in the former case, and when $\tau > 2.63$ in the latter case. Recall that $e_C$ and $e_{X_2}$ are always zero. When $\tau \to \infty$, internal enforcement becomes completely useless in all cases, so $e = 0$.

Finally, figures (6a) and (6b) in 6 describe the effect of the policies on the level of illegal immigration and wages in the host country for different values of $\tau$. First, note that in the mixed cases $X_1$ and $X_2$ the equilibrium values of $m^i$ and $w^j$ are identical. Second, under perfect mobility ($\tau = 0$), the lowest level of illegal immigration is achieved when the

\(^{19}\)It can be shown that $\partial^2 U_i^L / \partial e^i / \partial \tau = \partial^2 U_i^L / \partial g^i / \partial \tau = 0$ and $\partial^2 U_i^L / \partial c^i / \partial \tau > 0$. 21
policies are centrally decided, and the highest level of $m_i$ in the completely decentralized case. Specifically, $m_C < m_X_1 = m_X_2 < m_D$. As a result $w_C > w_X_1 = w_X_2 > w_D$. Third, as $\tau$ rises, illegal immigration falls in the decentralized and mixed cases and it is constant in the centralized case. For high enough values of $\tau$, however, illegal immigration becomes lowest in the decentralized cases. The latter also implies that wages will be highest in the decentralized case when mobility costs are large enough.

6 Endogenous Number of Illegal Immigrants

We now assume that the number of migrants is endogenous. In this way, the illegal immigration process does not only involve deciding the region of entry, but it also determines the total number of illegal immigrants entering the host country. Specifically, we allow for the wage in the source country to adjust depending on the number of workers in the source country (which includes those workers that attempted to move but were caught at the border).

6.1 Equilibrium

In equilibrium we should observe

$$U^i \equiv q^i [w^* (\tilde{n}^* - \hat{M}) - k] + (1 - q^i) u^i_E - \gamma^i (M^i) = w^* (\bar{n}^* - \hat{M}), \quad i = A, B. \quad (33)$$

where $\hat{M} = (1 - q^A) M^A + (1 - q^B) M^B$. If, for instance, $U^i > w^*$, then workers will illegally enter the host country through $i$ until $U^i = w^*$. A solution with workers entering through both $i$ and $j$ necessarily entails $U^A = U^B = w^*$. Thus, the equilibrium when the pool of migrants is endogenously determined can be defined as follows.

**Endogenous supply of immigrants.** The equilibrium values $\{w^A, w^B, m^A, m^B, M^A,$

\footnote{The number of workers in the source country does not include, however, those workers that are caught as a result of internal enforcement efforts.}
\[ M^B, \hat{M} \} \text{ are implicitly determined by} \]
\[
f^{\prime i}(\bar{n}^i + m^i) = w^i, \quad i = A, B, \quad (34)
\]
\[
U^i = w^\ast(\bar{n}^\ast - \hat{M}), \quad i = A, B, \quad (35)
\]
\[
\hat{M} = (1 - q^A)M^A + (1 - q^B)M^B, \quad (36)
\]
\[
\hat{M} = m^A + m^B. \quad (37)
\]

The equilibrium determines \( \{w^A(x), w^B(x), m^A(x), m^B(x), M^A(x), M^B(x), \hat{M}(x)\} \), where \( x = (c^A, c^B, e^A, e^B, g^A, g^B) \).

### 6.2 Determination of Policy Variables

When the supply of illegal immigrants is endogenous, the policy variables will not only affect relative attractiveness of region (and, consequently, the localization of illegal immigrants across regions in the host country), but also affect the total pool of potential illegal immigrants. Figures 7 through 12 show how the variables change with \( \tau \) under different institutional arrangements.

The numerical examples show the following. First, as in the case with a fixed supply of illegal immigrants, internal enforcement is always zero (i.e., for all values of \( \tau \)) in the completely centralized and mixed \( X_2 \) cases. It decreases as \( \tau \) rises in the completely decentralized and mixed \( X_1 \) cases. The main difference is that now \( e_{X_1} \) reaches zero sooner than \( e_D \) (\( e_{X_1} = 0 \) for \( \tau > 1.7 \) and \( e_D = 0 \) for \( \tau > 2.4 \)). The reason is that when the supply of illegal immigrants is endogenous, raising \( e \) generates a positive externality on both jurisdictions. This externality is partially internalized in mixed case \( X_1 \), but completely neglected in case \( D \).

Second, the fact that \( e_{X_1} = e_{X_2} \) for all \( \tau > 1.7 \) has implications for the determination of the other policy variables. Specifically, the values of \( c \) and \( g \) are identical in these two cases when \( \tau > 1.7 \).

Third, consider the equilibrium values of \( c \). In all cases where border enforcement is decided centrally, \( c \) falls as mobility costs rise. Essentially this is because tighter border enforcement benefits both regions (higher values of \( c \) reduce the overall pool of illegal
immigrants entering the host). The externality is internalized when \( c \) is decided centrally. However, when mobility costs are higher, the marginal benefit of \( c \) becomes lower, so a central government does not need not maintain a high level of \( c \) since it is definitely costly to do so. In the decentralized case, \( c \) increases as \( \tau \) rises, but \( c_D \) is always below the corresponding values of \( c_{X_1}, c_{X_2} \) and \( c_C \).

Fourth, a similar effect takes place when considering the choice of \( g \) in the completely centralized case: the value of the positive externality generated by \( g \) declines as \( \tau \) rises, so \( g_C \) tends to become smaller. The opposite effect is present in the completely decentralized case, which means that \( g_D \) increases as \( \tau \) gets larger. It should be emphasized that in the decentralized case \( g \) ends up being underprovided relative to the centralized case. In both mixed cases \( X_1 \) and \( X_2 \), \( g \) increases as \( \tau \) rises, with the caveat that \( g_{X_2} > g_{X_1} \) for \( \tau < 1.7 \) and \( g_{X_1} = g_{X_2} \) when \( \tau > 1.7 \).

Finally, we examine the impact of the policy choices on \( \{m^i, M^i, w^i\} \). First, the amount of illegal immigrants attempting entry through region \( i \), \( M^i \), declines as mobility costs increase. Moreover, \( M^i \) is always lower in the completely centralized case. Second, \( m^i \) tends to decline in all cases, with \( m^i \) being lowest in the centralized case. Third, wages tend to increase as \( \tau \) rises in all cases, with \( w^i \) being highest in the completely centralized case.

## 7 Conclusions and Extensions

### 7.1 Conclusions

Many states in the USA have recently passed laws granting state governments the authority to enforce illegal immigration policies. This paper investigates the economic impact of such initiatives using a theoretical model of border and internal enforcement of illegal immigration. Specifically, we examine the determination of these two types of enforcement and the levels of regionally provided goods under four institutional arrangements: (i) completely centralized case; (ii) completely decentralized case; (iii) regional governments choose internal enforcement and the level of regional goods and the federal government chooses the level of border enforcement; and (ii) the federal government chooses both border and
internal enforcement and the regional government the level of the regional good.

The model shows that the outcome of implementing illegal immigration policies varies significantly depending on which level of government is involved in the decision process. Some of the most relevant insights emerging from the analysis are the following. First, the level of internal enforcement (in a symmetric equilibrium) is always zero in the completely centralized case. In other words, a central government would only rely on border enforcement to control illegal immigration. Second, in the decentralized cases the solutions depend on the cost for illegal immigrants of moving across regions once they have successfully entered the host country. If illegal immigrants are perfectly mobile across regions, then internal enforcement tends to be overprovided and border enforcement and the regional good underprovided in the decentralized cases. As a result, the level of illegal immigration is higher and domestic wages end up being lower in these cases. Third, as mobility costs rise, internal enforcement efforts tend to decline while border enforcement tends to increase in the decentralized cases. Under complete immobility, internal enforcement becomes completely irrelevant. Moreover, the levels of both border enforcement and regional good could even be higher when decisions are completely decentralized compared to the fully centralized outcome. Finally, when the supply of (potential) illegal immigrants is endogenous, then all then policy variables generate a positive externality on the other region, in addition to the diversionary effect present examined in the case of fixed supply.

7.2 Extensions

The paper can be extended in different directions:

1. Consider a different spatial configuration

   (a) Bordering and non-bordering (interior) state.

   (b) Two bordering states and one interior state.

2. Factors of production:

   (a) Skilled/unskilled labor. Host country: unskilled immobile, skilled mobile.

   (b) Capital: perfect capital mobility across regions of host, and/or across countries.

(a) Incorporate distributive considerations.
References


A Fixed number of illegal immigrants

A.1 Comparative static results

We define

\[ u^i \equiv w^i - p^i z^i + \phi^i, \quad i = A, B, \]
\[ u^i_E \equiv \mathbb{E} \left[ \max \{ \tilde{u}^i, \bar{u}^i - \tau \} \right] = \log \left[ \exp(u^i) + \exp(u^i - \tau) \right], \quad i = A, B, \]
\[ U^i \equiv q^i (w^* - k) + (1 - q^i) u^i_E - \gamma^i, \quad i = A, B, \]
\[ \bar{M} \equiv (1 - q^A) M^A + (1 - q^B) M^B. \]

In equilibrium,

\[ D^i \equiv w^i - f^{i,i}(n^i + m^i) = 0, \quad i = A, B, \]
\[ S^i \equiv m^i - (m^{ii} + m^{ji}) = 0, \quad i \neq j = A, B, \]
\[ F \equiv U^A - U^B = 0, \]
\[ G \equiv \bar{M} - M^A - M^B = 0. \]

(38)

A.1.1 Symmetric equilibrium

When the regions are identical and \( \{ c^i, e^i, g^i \} = \{ c, e, g \} \), \( i = A, B, \) a symmetric solution \( \{ M^i, m^i, w^i \} = \{ M, m, w \} \) exists and is equal to \( M = \bar{M}/2, m = \bar{M}[1 - q(c)]/2, \) and \( w = f'[n + \bar{M}[1 - q(c)]]/2 \).

At a symmetric equilibrium, the Jacobian determinant of (38) is

\[ |J| = \text{sech}(t/2)^2 \gamma' [1 + \cosh(t) - 2M(1 - q)f''] - 2 \tanh(t/2)^2 (1 - q)^2 f'' > 0. \]

(39)

where \( \cosh(\tau) = [\exp(\tau) + \exp(-\tau)]/2, \) \( \sinh(\tau) = [\exp(\tau) - \exp(-\tau)]/2, \) \( \text{sech}(\tau) = 1/\cosh(\tau), \) and \( \tanh(\tau) = \sinh(\tau)/\cosh(\tau). \)

Evaluated at the symmetric equilibrium, the comparative static results are as follows.

With respect to \( e^i: \)

\[ \frac{\partial w^i}{\partial e^i} = - \frac{\partial w^i}{\partial e^i} = \frac{(-1)}{|J|} z p' f'' (1 - q) \left[ \tanh(\tau/2)^2 (1 - q) + \frac{2M \gamma'}{1 + \cosh(\tau)} \right] > 0, \]
\[ \frac{\partial M^i}{\partial e^i} = - \frac{\partial M^i}{\partial e^i} = \frac{(-1)}{|J|} z p' (1 - q) \tanh(\tau/2) \leq 0, \]
\[ \frac{\partial m^i}{\partial e^i} = - \frac{\partial m^i}{\partial e^i} = \frac{1}{f''} \frac{\partial w^i}{\partial e^i} < 0. \]

(40)

(41)
Note that as a result, $\partial \hat{M} / \partial e^i = 0$.

With respect to $e^i$:

\[
\frac{\partial w^i}{\partial e^i} = -q' f'' \left\{ \frac{M}{2} + \frac{\tanh(\tau/2)}{|J|} [M\gamma' + (1 - q)\tilde{u}] \right\} > 0, \tag{42}
\]
\[
\frac{\partial w^j}{\partial e^i} = -q' f'' \left\{ \frac{M}{2} - \frac{\tanh(\tau/2)}{|J|} [M\gamma' + (1 - q)\tilde{u}] \right\}, \tag{43}
\]
\[
= -\frac{\partial w^i}{\partial e^i} - q' M f'', \tag{44}
\]
\[
\frac{\partial M^i}{\partial e^i} = \frac{q'}{|J|} \left\{ -\tanh(\tau/2)^2 M(1 - q) f'' + \left[ \text{sech}(\tau/2)^2 M(1 - q) f'' - 1 \right] \tilde{u} \right\}, \tag{45}
\]
\[
\frac{\partial M^j}{\partial e^i} = -\frac{\partial M^i}{\partial e^i}, \tag{46}
\]
\[
\frac{\partial m^i}{\partial e^i} = \frac{1}{f''} \frac{\partial w^i}{\partial e^i} < 0, \tag{47}
\]
\[
\frac{\partial m^j}{\partial e^i} = \frac{1}{f''} \frac{\partial w^i}{\partial e^i}, \tag{48}
\]
\[
= -\frac{\partial m^i}{\partial e^i} - q' M. \tag{49}
\]

where $\tilde{u} = u - \tau + k - w^* + \log[1 + \exp(\tau)]$ and $u = w - pz + \phi$. Except for $\partial w^i / \partial e^i$ and $\partial m^i / \partial e^i$, the signs of the comparative static results are ambiguous. Note that $\partial \hat{M} / \partial e^i = -q' M < 0$.

With respect to $g^i$:

\[
\frac{\partial w^i}{\partial g^i} = -\frac{\partial w^j}{\partial g^i} = \frac{1}{|J|} (1 - q) \phi' f'' \left[ \tanh(\tau/2)^2 (1 - q) + \frac{2M\gamma'}{1 + \cosh(\tau)} \right] < 0, \tag{50}
\]
\[
\frac{\partial M^i}{\partial g^i} = -\frac{\partial M^j}{\partial g^i} = \frac{1}{|J|} (1 - q) \tanh(\tau/2) \phi' > 0, \tag{51}
\]
\[
\frac{\partial m^i}{\partial g^i} = -\frac{\partial m^j}{\partial g^i} = \frac{1}{f''} \frac{\partial w^i}{\partial g^i} > 0.
\]

As a result, $\partial \hat{M} / \partial g^i = 0$.

### A.1.2 Perfect mobility across regions: $\tau = 0$

When illegal immigrants can freely move across regions after successfully entering the host country, i.e., $\tau = 0$, then$^{21}$

\[
\frac{\partial M^i}{\partial e^i} = \frac{\partial M^i}{\partial g^i} = 0, \quad \frac{\partial M^i}{\partial e^i} < 0, \quad \frac{\partial w^i}{\partial e^i} = \frac{\partial w^j}{\partial e^i} > 0,
\]

$^{21}$Note that $\sinh(0) = 0$ and $\cosh(0) = 1.$
which means that

$$\frac{\partial m^i}{\partial c^i} = \frac{\partial m^j}{\partial c^i} = -\frac{q'M}{2} < 0.$$  

(52)

**A.2 Cross partial derivatives in centralized case**

In general, the change in $\partial U_L/\partial g^i$ due to a change in $c^i$ for the central authority can be written as

$$\partial^2 U_L \frac{\partial}{\partial g^i \partial c^i} = -\left[ f''m_i \frac{\partial m_i}{\partial c^i} + f''c^i \frac{\partial m_i}{\partial c^i} \right] \frac{\partial m_i}{\partial g^i} - \left[ f''c^i \frac{\partial m_i}{\partial c^i} + (v^i - z^i)p^i + \delta^i g^i \right] \frac{\partial^2 m_i}{\partial g^i \partial c^i}$$

$$- \frac{\partial m_i}{\partial g^i} \delta^i.$$  

(53)

Evaluated at a symmetric solution

$$\frac{\partial^2 U_L}{\partial g^i \partial c^i} = (f'''m + f'') \left( \frac{\partial m^i}{\partial c^i} - \frac{\partial m^j}{\partial c^j} \right) \frac{\partial m^i}{\partial g^i} - \left[ f''m + (v - z)p + \delta g \right] \left( \frac{\partial^2 m^i}{\partial g^i \partial c^i} + \frac{\partial^2 m^j}{\partial g^j \partial c^j} \right)$$

$$- \frac{\partial m^i}{\partial c^i} \delta.$$  

(54)

since $\partial m^i/\partial g^i = -\partial m^j/\partial g^j > 0$. Moreover, at a symmetric equilibrium,

$$\frac{\partial m^j}{\partial c^i} - \frac{\partial m^i}{\partial c^i} = -\frac{q'\sinh(\tau)\ell'[M\gamma' + (1-q)\hat{u}]}{2H} \geq 0,$$

(55)

and

$$\frac{\partial^2 m^i}{\partial g^i \partial c^i} + \frac{\partial^2 m^j}{\partial g^j \partial c^j} = \frac{\sinh(\tau)(1-q)\ell'\phi'q'}{H} \leq 0.$$  

Consider the case $\tau = 0$. Then, $\partial m^i/\partial c^i = \partial m^j/\partial c^i < 0$, which means that $\partial^2 U_L/\partial g^i \partial c^i = -(\partial m^i/\partial c^i)\delta > 0$. 

30
Figure 1: Model description
Figure 2: Comparative statics with respect to $c^A$
Figure 3: Comparative statics with respect to $e^A$
Figure 4: Comparative statics with respect to $g_A$
Figure 5: Solutions values \{c^i, e^i, g^i\} as a function of \(\tau\): Fixed supply of illegal immigrants
Figure 6: Solutions values \( \{m^i, w^i\} \) as a function of \( \tau \): Fixed supply of illegal immigrants
Figure 7: Solutions values of $c^j$ as a function of $\tau$: Endogenous supply of illegal immigrants
Figure 8: Solutions values of $e^i$ as a function of $\tau$: Endogenous supply of illegal immigrants
Figure 9: Solutions values of $g^i$ as a function of $\tau$: Endogenous supply of illegal immigrants
Figure 10: Solutions values of $m^i$ as a function of $\tau$: Endogenous supply of illegal immigrants
Figure 11: Solutions values of $M^i$ as a function of $\tau$: Endogenous supply of illegal immigrants
Figure 12: Solutions values of $w^i$ as a function of $\tau$: Endogenous supply of illegal immigrants