# WORKING PAPERS

Karin Mayr
Steffen Minter
Tim Krieger

**Policies on illegal immigration in a federation**

May 2009

Working Paper No: 0909


# DEPARTMENT OF ECONOMICS

# UNIVERSITY OF VIENNA

All our working papers are available at: http://mailbox.univie.ac.at/papers.econ

# Policies on illegal immigration in a federation*

Karin Mayr† Steffen Minter‡ Tim Krieger§

May 2009

**Abstract**

Illegal immigration is a major policy challenge in Europe, in particular in countries on the external border of the EU such as Italy or Spain. However, there are likely to be important effects on the rest of the EU, too, depending on the policies against illegal immigration in border countries. This paper determines optimal enforcement and amnesty policies on illegal immigration in a federation with border and non-border countries. We show that in the Nash equilibrium with positive enforcement spending in both countries, total enforcement spending is too low to maximize joint welfare. We find that in this case a side payment can be necessary to achieve the cooperative optimum, depending on the relative size of populations in the two countries.

**Key Words**: illegal immigration, enforcement, amnesty, EU cooperation.

**JEL Codes**: F22, J61, J68.

*Acknowledgments: We thank Johannes Becker, Maarten Janssen and seminar participants at IAS in Vienna, the annual meeting of the IIPF in Maastricht and the Spring Meeting of Young Economists in Lille for helpful comments.

†Corresponding author. Department of Economics, University of Vienna, Austria. Email: karin.mayr@univie.ac.at. Phone: +43-1-4277-37426. Fax: +43-1-4277-9374.

‡Department of Economics, University of Paderborn, Germany. Email: sminter@notes.upb.de. Phone: +49-5251-60-2120. Fax: +49-5251-60-5005.

§Department of Economics, University of Paderborn, Germany. Email: tim.krieger@notes.upb.de. Phone: +49-5251-60-2117. Fax: +49-5251-60-5005.

# 1 Introduction

The fight against illegal immigration is on the forefront of the current political debate in the EU. While it is difficult to come up with reliable data about the scope of illegal immigration, the European Commission estimates that up to 6 million immigrants were residing illegally in the EU as of 2005.[1] The Mediterranean Sea is one of the main routes of illegal immigrants coming into the EU, accounting for 100.000–120.000 migrants that cross this maritime border to the EU every year (Baldwin-Edwards, 2005). This is not only seen as a concern for the southern EU member countries adjacent to the Mediterranean Sea but for the entire Union. A letter from eight leaders of southern EU member states to the EU presidency in 2006 calls illegal immigration 'a problem which concerns the entirety of the Union and not only the countries on its external borders' (Cuschieri, 2007). Their view was confirmed by the German minister of the interior in 2007 who stated that '(t)he citizens expect effective enforcement at the external border of the EU. And only collectively ... can we effectively fight illegal migration.'[2]

There are several policy tools for the host countries of illegal immigration to cope with this phenomenon. Among the most common ones are border controls and deportation, but also the granting of legal status to illegal aliens. The last option has gained particular importance over the last 20 years since countries like Spain and Italy have made repeated use of legalization or regularization programs since 1980.[3] Italy alone legalized around 1.5 million illegal aliens in the period from 1987–2002. The most recent amnesty program was implemented in 2005 by Spain, which granted legal status and work permits to around 700,000 migrants.[4]

The amnesty measures in southern Europe spurred protest among fellow EU member states. Germany and the Netherlands criticized Spain during a meeting of EU ministers of the interior for acting arbitrarily and in an uncoordinated way, and phrased their concern about legalized immigrants entering other member states. In a similar manner, Austria and Switzerland 'accused Italy of turning a blind eye to would-be refugees heading north.'[5] More recently, the then-EU presidency

[1] For detailed estimations see the database of the CLANDESTINO project funded by the European Commission at http://irregular-migration.hwwi.net/. Note that estimates of the number of illegal immigrants are necessarily imprecise. See Jandl (2004) for a critical assessment of different methods of estimation.

[2] Wolfgang Schäuble, German Minister of the Interior on 15 February 2007.

[3] The terms legalization and regularization are used interchangeably in the following, although there is a slight difference as pointed out by Papademetriou et al. (2004). While legalization comprises the granting of settlement rights, regularization refers to the granting of work permits. Both can be given on a permanent or temporary basis. Past amnesty programs in Europe encompassed legalization as well as regularization. For an overview see Krieger and Minter (2007) and the literature cited therein.

[4] For a detailed representation of amnesty programs in Europe, see Papademetriou et al. (2004), Levinson (2005) and ICMPD (2009).

[5] The Economist (September 6, 2001), cited in Facchini et al. (2006).

led by France pushed towards a Europe-wide ban on regularization and amnesty programs for illegal migrants. The proposal was rejected due to the intervention of Spain. These conflicts of interest are to be seen in the context of the broader EU policy of free movement of persons within the common market. According to Schengen law[6] (legalized) immigrants from third countries are allowed to move freely within the European territory after a waiting period of 5 years. Due to the option of migration within the EU, the legalizing country can expect at least some of its legalized immigrants to leave the country after a short time, while fellow member states can expect some immigration of migrants from the country of first entry. While empirical evidence on the issue is largely missing, at least according to Chiuri et al. (2007) the phenomenon of onward migration is real and significant: they show that among illegal immigrants in Italy around 23% expressed the intention to move on to another country in Europe.[7]

The existing literature on immigration policy has only recently turned to the analysis of immigration amnesties. The focus of the few existing contributions is on the causes for and the timing of amnesty decisions. Epstein and Weiss (2001), for example, analyze the optimal timing of an immigration amnesty in a dynamic setting given that the policymaker desires as little illegal immigrants as possible. Karlson and Katz (2003) assume that some illegal immigration is desirable and show how the government can select the high-skilled among potential illegal immigrants by setting up a mix of border control and amnesty provision. Chau (2001) considers the optimal policy mix of employer sanctions and amnesties, while Hillman and Weiss (1999) and Garcia (2009) use a political economy approach to explain amnesty policies.

All of these studies exclusively consider the policy perspective of a single host country that faces an influx and a presence of illegal immigrants. In contrast, our approach focuses on a situation where a host country of illegal immigrants is part of an economic union or a federation with free movement within.[8] In this situation, externalities arise between member states and generate a number of interesting questions such as: What is the optimal amnesty decision of a country that is part of a federation? What is the optimal policy response of other countries in the federation, given this amnesty decision? How large is the optimal amount of spending on enforcement of the external border in a federation, and how is the cost of this enforcement spending distributed? How do amnesty and enforcement policies differ depending on whether or not countries cooperate to maximize joint welfare? The last question is of particular importance for the EU at large as well as for existing common institutions such as the EU Frontex agency, which was introduced in 2005.

[6]EU Directive 2003/109/EG.

[7]Of the 920 illegal immigrants in Italy who were surveyed, 10% stated Germany and 5% stated France as their intended final destination.

[8]Fenge and Meier (2006) apply interregional transfers as a migration deterrent mechanism in a federal setting with a rich and a poor country but do not consider illegal migration or amnesty policy.

Frontex is financed by joint contributions of EU member states and supports the enforcement of the external EU border.[9] Our model goes, however, beyond a standard fiscal federalism analysis because of an asymmetry of policy instruments between the countries involved. Thus, besides the externalities between member states, the interaction between enforcement and amnesty policies is important in the model.

In our model, we capture the stylized facts as described above in a model of a federation that consists of two countries, one located at the external border of the federation and one within the border. Illegal immigrants get into the 'port-of-entry' country on the external border, unless they are deterred by costly border enforcement. Alternatively, undesirable illegal immigration can be reduced by an amnesty, which affects both the costs of illegal immigration and the distribution of these costs between member states. Here, the rate of onward migration of legalized migrants due to free mobility between member states is important. With onward migration, the country of final destination is negatively affected by an amnesty in the port-of-entry country, but it can affect the amnesty and enforcement spending decisions through co-financing border enforcement. In our model, we first determine the policy outcome with strategic behavior of member states in a federation like the EU and then compare it to the optimal cooperative policy on illegal immigration.

As a result, we determine the Nash equilibria of the decisions on amnesty and enforcement spending in the two countries. We find that enforcement spending in the border country is always greater than or equal to enforcement spending within the border. A greater rate of onward migration within the federation makes an amnesty more likely; given that there is an amnesty, greater onward migration decreases enforcement spending in the border country (ceteris paribus) and increases it within the border. Further, we find that in a situation with positive enforcement spending in both countries, enforcement spending is too low to maximize joint welfare, and a side payment from one of the two countries to the other might be necessary to achieve the cooperative equilibrium. In an extension, we consider endogenous onward migration of legalized migrants within the federation and show that results from the basic model remain qualitatively unchanged. We also find that a Coasian bargaining solution exists for an efficient rule on onward migration of immigrants within the federation, which either restricts migration to zero or allows free migration.

Our paper is organized as follows. We first introduce the two-country framework and the timing of events in Section 2. In Section 3, we determine the optimal decisions on enforcement spending and the granting of an amnesty in non-cooperative (Nash) equilibrium. In Section 4, we show how the cooperative equilibrium compares to the non-cooperative equilibrium. In Section 5 we present the case where onward migration of legalized migrants is either endogenous or the outcome of Coasian bargaining between countries in the federation. Section 6 concludes.

[9] More details on the origin, tasks and activities of Frontex can be found in Jorry (2007) and Carrera (2007).

# 2 The Model

## 2.1 The Economic Environment

There are two countries in a federation: country A, which is situated at the external border of the federation and country B, which is not. There is illegal immigration from outside the federation and free migration within the federation for immigrants who have been legalized. Due to its geographic location, any illegal immigrants from outside the federation have to pass through country A in order to arrive at country B. A detailed discussion of the timing of events follows in the section below.

In each country, a single consumption good is produced only from labor input, which is homogeneous and supplied inelastically. Wages $w_A$ and $w_B$ in the two countries are determined by country-specific labor productivity $A_A$, $A_B$ and labor supply $L_A$, $L_B$. We consider an economy with perfect competition, wages are expressed in units of the consumption good and are equal to the marginal product of one unit of labor. Labor is provided by native workers and legal migrants only. Following the segmentation hypothesis, we assume – but do not explicitly model – that illegal immigrants work in a specific sector or part of the labor market (for example in particular jobs in the agricultural or services sectors).[10] As a consequence, illegal immigrants do not exert a negative wage effect on the native population in the regular labor market unless they are legalized (see Cohen-Goldner and Paserman, 2004, for a justification).[11] Neither natives nor legalized immigrants choose to work in the illegal sectors due to poor working conditions. Wages are sufficiently high in the illegal sector compared to wages outside the federation that there is a potentially unlimited supply of immigrants.

The governments in countries A and B redistribute income by levying a flat rate income tax $t_A$

[10] There is some academic debate about the question of whether immigrants and natives tend to be substitutes in the labor market or whether they work on different labor markets (see Martin, 1988; Greenwood and McDowell, 1986; and Winegarden and Khor, 1991, for discussions). Recent theoretical models on illegal immigration tend to take the latter view (see, e.g., Carter, 1999, 2005; Hillman and Weiss, 1999; or Djajič, 1997). There is some empirical evidence pointing in this direction as well (see, e.g., Greenwood and McDowell, 1986; Massey, 1987; Card, 1990; Winegarden and Khor, 1991; Friedberg and Hunt, 1995; Chiswick, 1988a,b).

[11] There is little empirical evidence for negative wage effects of illegal immigration on natives (see, e.g., Winegarden and Khor, 1991; Hanson et al., 2002). After legalization, illegal immigrants were found to move into urban jobs with more stability and higher wages in Taylor (1987). Carrasco et al. (2008) find 'weak' evidence for legalized immigrants to be better substitutes for native workers than illegal immigrants, thus exerting a relatively stronger negative wage effect on natives (even though a potentially biased estimator has to be taken into account). Fakiolas (1999) reports similar evidence from Greece, arguing that illegal immigrants have to acquire country-specific knowledge before they can compete with natives on the labor market, which may coincide with the time of legalization. Orrenius and Zavodny (2007) indicate that immigrants adjusting their immigration status within the U.S., but not newly arriving immigrants, have a significant negative impact on the wages of low-skilled natives.

and $t_B$ and spending the resulting tax revenue lump-sum via a benefit $b_A$ and $b_B$, respectively. We assume that the governments' budgets must be balanced. Natives and legal immigrants are treated alike fiscally: the tax revenue from the income tax $0 \leq t_i \leq 1$ levied on labor income of both natives and legal immigrants is redistributed evenly through the lump-sum benefit $b_i$, $i \in \{A, B\}$, which is granted to natives as well as legal immigrants. Illegal immigrants do not pay taxes but receive a benefit (see below).

## 2.2 Timing of Events

In the following, we determine optimal policies in the presence of illegal immigration that is costly because of the benefit that accrues to illegals. There are two potential policies: i) to reduce the number of illegals by spending part of the tax revenue on border enforcement or ii) to legalize illegal immigrants by granting an amnesty. In the latter case, the immigrants earn wages and contribute to the tax revenue.

Immigrants have a harder time getting into country B than into country A due to its geographic location, and we assume that only country A faces illegal immigration for simplicity. Enforcement, therefore, is only possible at the federation's external border in country A. Immigrants can move on to country B once they are legalized due to a right for free movement within the federation.[12] While country A determines both the optimal amount of its enforcement spending $e_A$ as well as the optimal amnesty $a$, country B can contribute to total enforcement spending in the form of a subsidy $e_B$ to country A.

Events are as follows:

1. There is illegal immigration M into country A, which can be reduced by enforcement spending in country A: $\frac{\partial M}{\partial e_A} < 0$.
2. Country A decides on the optimal amount that it spends on enforcement, $e_A$, and on whether to grant an amnesty or not, given illegal immigration, $a \in 0, 1$. The optimal amount of enforcement spending $e_A$ will depend on the amnesty and on the enforcement subsidy from country B: $e_A(a, e_B)$.
3. Once they are legalized, immigrants can move on to country B. They do so at a rate $\beta$, which we assume to be given for now.
4. Country B decides on the optimal amount of enforcement spending $e_B$ that it transfers to country A as a subsidy. This amount will depend on the amnesty and enforcement spending in country A: $e_B(e_A, a)$.

[12] We assume that illegal immigrants in country A do not move to country B as the wage gain relative to high migration costs in the form of fear of detection and deportation is negligible.

All of the decisions above are taken simultaneously. Every player in the game (country A, country B) has perfect and complete information. Country A takes into account the response of country B (4) in its decision on enforcement and amnesty (2), and vice versa. In the following analysis, we solve for the Nash equilibria of the amnesty, the enforcement subsidy in country B and enforcement spending in country A.

# 3 Optimal Amnesty and Enforcement Spending

In this section, we first solve for the optimal amnesty and enforcement in country A and then for the optimal enforcement subsidy of country B. After that, we determine the equilibrium when countries behave non-cooperatively. In the next section, we consider the cooperative equilibrium and show how it compares with the non-cooperative outcome.

## 3.1 Migration

Illegal immigration into country A from outside the federation is given by $M$. Once illegal immigrants are in country A, they are either legalized ($a = 1$) or they stay illegal ($a = 0$). Further, if they are legalized, they can stay in country A or move on to country B at a rate $0 < \beta < 1$. The stock of migrants in the two countries is therefore given by the sum of illegal migrants and legal migrants who stay in country A:

$$M_A = (1 - a)M + (1 - \beta)aM \tag{1}$$

and legalized migrants who move on to country B:

$$M_B = \beta aM. \tag{2}$$

Legal and illegal immigrants differ in their effects on the wage, tax revenue and per capita benefit in each country, as will be seen below. While legal migrants do not only receive the benefit but also contribute to tax revenue and put pressure on the wage, illegal migrants also receive (at least part of) the benefit,[13] but have – according to the segmentation hypothesis – no effect on the tax revenue or wage.

We assume that illegal immigration can be reduced by enforcement spending. While it would also be plausible to assume that (future) illegal immigration increases with an amnesty,[14] this would

[13]This serves to make illegal immigration costly. It does not matter for the results qualitatively whether migrants receive the full benefit or only part of it. For simplicity, we assume illegal immigrants receive the full benefit in the following.

[14]See for example Chau (2001).

only make an amnesty less likely in our model but not affect results otherwise (see below). Therefore we assume for simplicity that illegal immigration is not affected by the amnesty decision in country A.

### 3.2 Production

In each country $i$, $i \in \{A, B\}$ firms produce a private good with labor $L_i$ as the only factor of production. Labor is supplied inelastically and is fully employed. The relevant total labor supply consists of natives and legal migrants, i.e., all workers in the legal sector:

$$L_A = N_A + (1 - \beta)aM, \tag{3}$$

$$L_B = N_B + \beta aM. \tag{4}$$

In country A there also exists an illegal sector where the $(1-a)M$ illegal migrants work. We assume that neither income nor rents generated in the illegal sector affect the regular labor force or total output.[15] Then, total output in each country is given by

$$Y_i = A_i L_i^{\gamma}, \quad i \in \{A, B\}, \quad 0 < \gamma < 1, \tag{5}$$

where $A_i$ is a measure of technology in country $i$. Due to perfect competition the wage in each country equals the marginal product of labor, which is decreasing in the supply of labor:

$$w_A = A_A \gamma \frac{1}{(N_A + (1 - \beta a)M)^{1-\gamma}} \tag{6}$$

$$w_B = A_B \gamma \frac{1}{(N_B + \beta aM)^{1-\gamma}} \tag{7}$$

### 3.3 Country A: Optimal Amnesty

To determine the optimal amount of enforcement spending $e_A$ in country A, we maximize individual utility, which we assume to be equal to net income plus the lump-sum benefit:

$$U_A = w_A(1 - t_A) + b_A. \tag{8}$$

[15]The first part of this assumption follows from the segmentation hypothesis, the second part relates to the specification of the production function. One can simply assume that rents from the illegal sector accrue to foreigners only.

The government budget constraint requires that total tax revenue plus the enforcement subsidy from country B equals total benefits plus enforcement spending:

$$t_A w_A(N_A + (1-\beta)aM) + e_B = e_A + b_A(N_A + (1-a)M + (1-\beta)aM). \tag{9}$$

Only legalized immigrants who stay in country A pay taxes, but both legal immigrants who stay and illegal immigrants receive the benefit $b_A$. In addition to tax revenue, country A receives the enforcement subsidy $e_B$ from country B.

In order to determine whether country A will grant an amnesty or not, we substitute for $b_A$ using (9) and compare utility (8) for the case of an amnesty $a = 1$ with the case of no amnesty $a = 0$.

**Lemma 1.** *Country A grants an amnesty, if utility is higher with than without an amnesty. It does not grant an amnesty otherwise:*

$$a = \begin{cases} 1 & \text{if} \quad U_A\mid_{a=1} - U_A\mid_{a=0} \geq 0 \\ 0 & \text{otherwise,} \end{cases} \tag{10}$$

*where*

$$\begin{aligned} &U_A\mid_{a=1} - U_A\mid_{a=0} = \\ &A_A\gamma(1-t_A)\left[\frac{1}{(N_A+(1-\beta)M)^{1-\gamma}} - \frac{1}{N_A^{1-\gamma}}\right] + A_A\gamma t_A\left[\frac{1}{(N_A+(1-\beta)M)^{1-\gamma}} - \frac{N_A^{\gamma}}{N_A+M}\right] \\ &- \left[(e_A-e_B)\mid_{a=1}\frac{1}{N_A+(1-\beta)M} - (e_A-e_B)\mid_{a=0}\frac{1}{N_A+M}\right]. \end{aligned} \tag{11}$$

We assume that country A will grant an amnesty, if utility stays the same. An amnesty has an effect on both the net wage as well as the per capita benefit. First, it reduces the net wage via an increase in labor supply (first term on the right-hand side of (11)). Second, it increases the benefit derived from tax revenue, as tax revenue increases and the number of recipients decreases, because some of the formerly illegal immigrants are now legalized and move on to country B (second term). Finally, an amnesty increases per capita enforcement spending net of the enforcement subsidy $e_A - e_B$, as the number of those who bear the cost via a reduction in their benefit decreases (third and forth terms).[16] However, enforcement spending in both countries in turn depends on the amnesty decision as follows.

## 3.4 Country A: Optimal Enforcement Spending

To determine optimal enforcement spending in country A, we substitute in utility (8) for the benefit $b_A$ using (9) and for the wage $w_A$ using (6) and derive the first-order condition for enforcement

[16]Note that an amnesty could also increase illegal immigration $M$. As illegal immigration is costly, this would shift the cost of an amnesty and make it less likely. Results would not change otherwise.

spending $e_A$:

$$\begin{aligned}\frac{\partial U_A}{\partial e_A} \equiv & \Big[-A_A\gamma(1-\gamma)(1-t_A)(1-\beta)a(N+(1-\beta)aM)^{-(2-\gamma)} \\ & +A_A\gamma^2 t_A(1-\beta)a(N+(1-\beta)aM)^{-(1-\gamma)}(N+(1-\beta a)M)^{-1} \\ & -\left(A_A t_A\gamma(N+(1-\beta)aM)^{\gamma}+e_B-e_A\right)(1-\beta a)(N+(1-\beta a)M)^{-2}\Big]\frac{\partial M}{\partial e_A} \\ & -(N+(1-\beta a)M)^{-1}=0. \end{aligned} \tag{12}$$

Just as the amnesty, enforcement spending has an effect on the wage and on tax revenue. The only difference is the sign: as enforcement decreases the number of immigrants, it decreases the negative wage effect (first term on the right-hand side of (12)) as well as the positive tax revenue effect (second term) of immigration. In addition, it also decreases the negative effect of immigration on the per capita benefit $b_A$ for given tax revenue (third term) and has a marginal cost (fourth term).

The optimal amount of enforcement spending depends on how effective it is in deterring illegal immigration. For simplicity, we will assume that enforcement spending decreases illegal immigration one-to-one: $\frac{\partial M}{\partial e_A}=-1$. We solve (12) for $e_A$ to get optimal enforcement spending as a function of the enforcement subsidy $e_B$ and the amnesty $a$.

**Lemma 2.** *Optimal enforcement spending in country A equals*

$$e_A=\begin{cases} e_B+A_A\gamma t_A N_A^{\gamma}-(N_A+M) & \text{if} \quad a=0 \\ e_B+A_A\gamma(1-\gamma)(N_A+(1-\beta)M)^{\gamma}-\left(\frac{N_A}{1-\beta}+M\right) & \text{if} \quad a=1, \end{cases} \tag{13}$$

*given* $e_A>0$. $e_A=0$ *otherwise.*

Enforcement spending in country A increases by the amount of enforcement subsidy from country B as long as $e_A>0$.

## 3.5 Country B: Optimal Enforcement Subsidy

As before, we determine the optimal amount of the enforcement subsidy $e_B$ in country B by maximizing individual utility

$$U_B=w_B(1-t_B)+b_B. \tag{14}$$

The government budget constraint requires that total tax revenue equals total benefits plus the enforcement subsidy:

$$t_B w_B(N_B+a\beta M)=b_B(N_B+a\beta M)+e_B. \tag{15}$$

Immigrants who were legalized in country A and moved on to country B contribute to the tax revenue and receive a per capita benefit in the same way as natives.

Substituting for the benefit $b_B$ in (14) using (15) and for the wage $w_B$ using (7), and differentiating with respect to $e_B$ gives the first-order condition for the enforcement subsidy $e_B$ in country B:

$$\begin{aligned}\frac{\partial U_B}{\partial e_B} \equiv & \Big[A_B\gamma a\beta(N_B+a\beta M)^{-(2-\gamma)}\left(t_B\gamma-(1-t_B)(1-\gamma)\right) \\ & -\left(A_B t_B\gamma(N_B+a\beta M)^{\gamma}-e_B\right)a\beta(N_B+a\beta M)^{-2}\Big]\frac{\partial M}{\partial e_A}\frac{\partial e_A}{\partial e_B}-(N_B+a\beta M)^{-1}=0.\end{aligned} \tag{16}$$

An enforcement subsidy $e_B$ has four different effects on individual utility in country B. First, it decreases the negative marginal wage effect of immigration and, second, it decreases the positive marginal effect of immigration on tax revenue via an increase in enforcement spending $e_A$ and the resulting decrease of illegal immigration $M$. The net effect on the wage and tax revenue is given by the first term on the right-hand side of (16). It is positive if $t_B\gamma > (1-t_B)(1-\gamma)$ and negative otherwise. Third, the subsidy decreases the negative marginal effect of immigration on the lump-sum benefit $b_B$, which is given by the second term in (16),[17] via the increase in enforcement spending $e_A$ and the decrease of illegal immigration $M$. Finally, the subsidy has a marginal cost given by the third term in (16). Solution of the first-order condition (16) leads to the following optimal enforcement subsidy of country B as a function of $e_A$ and $a$.

**Lemma 3.** *The optimal enforcement subsidy by country B to country A equals*

$$e_B=\begin{cases}0 & \text{if either } \frac{\partial e_A}{\partial e_B}=0 \text{ or } a=0\\ A_B\gamma(1-\gamma)(N_B+\beta M)^{\gamma}-\left(\frac{N_B}{\beta}+M\right) & \text{otherwise,}\end{cases} \tag{17}$$

*given* $e_B>0$. $e_B=0$ *otherwise.*

The marginal benefit of the subsidy as expressed in the square brackets in (16) depends on the extent to which the subsidy translates into higher actual enforcement spending in country A. For example, the benefit is negative if country A does not spend more on enforcement as a result of the subsidy: $\frac{\partial e_A}{\partial e_B}=0$. As a result, the optimal subsidy is equal to zero. We determine the optimal subsidy for the two cases of i) $\frac{\partial e_A}{\partial e_B}=0$ and ii) $\frac{\partial e_A}{\partial e_B}=1$, as these are the two relevant cases, according to (13). The marginal benefit of the subsidy is also negative, if there is no amnesty in country A: $a=0$. Then, the optimal subsidy is also equal to zero.

## 3.6 Non-Cooperative Equilibrium

**Definition 1.** An *equilibrium* is a vector $(a^*, e_A^*, e_B^*)$ such that i) $a^*$ is the choice of amnesty in country A, given $e_A^*$ and $e_B^*$, ii) $e_A^*$ is the choice of enforcement spending in country A, given $a^*$, $e_B^*$ and iii) $e_B^*$ is the choice of enforcement subsidy in country B, given $a^*$, $e_A^*$.

[17] Note that $b=\frac{A_B t_B\gamma(N_B+a\beta M)^{\gamma}-e_B}{N_B+a\beta M}$ according to (15).

The optimal amnesty depends on enforcement spending in country A and B according to (10). Both optimal enforcement spending in country A and the optimal enforcement subsidy in country B depend on the amnesty granted in A, according to (13) and (17). In addition, $e_A$ in turn depends on $e_B$ and vice versa, as can be seen in (13) and (17). For the solution ($a^*$,$e_A^*$,$e_B^*$) to be a Nash equilibrium, each variable has to be the best response to the other two.

**Proposition 1.** *In equilibrium, the optimal amnesty $a^*$ is equal to 0 or 1 according to the conditions stated in Appendix A. Depending on the amnesty decision, optimal enforcement spending $e_A^*$ and $e_B^*$ in countries A and B are equal to the following.*

*For $a^* = 0$,*

$$e_B^* = 0$$
$$e_A^* = A_A \gamma t_A N_A^\gamma - (N_A + M),$$

*if $e_A^* > 0$. $(a^*, e_B^*, e_A^*) = (0, 0, 0)$ otherwise.*

*For $a^* = 1$,*

$$e_B^* = A_B \gamma (1-\gamma)(N_B + \beta M)^\gamma - \tfrac{N_B + \beta M}{\beta}$$
$$e_A^* = e_B^* + A_A \gamma (1-\gamma)(N_A + (1-\beta)M)^\gamma - \tfrac{N_A + (1-\beta)M}{1-\beta},$$

*if $e_B^* > 0$ and $e_A^* > 0$ and*

$$e_B^* = 0$$
$$e_A^* = A_A \gamma (1-\gamma)(N_A + (1-\beta)M)^\gamma - \tfrac{N_A + (1-\beta)M}{1-\beta},$$

*if $e_B^*$ according to the paragraph above $\leq 0$ and $e_A^* > 0$. $(a^*, e_B^*, e_A^*) = (1, 0, 0)$ otherwise.*

**Proof.** If there is no amnesty, country B does not pay any subsidy because it is not affected by immigration. Then, country A pays for enforcement, if its marginal benefit in the form of an increase in the per capita benefit $\frac{A_A t_A \gamma N_A^\gamma}{(N_A+M)^2}$ is greater than the direct marginal cost of enforcement $\frac{1}{N_A+M}$.

If there is an amnesty, country B pays a subsidy, if the marginal benefits in the form of an increase in the per capita benefit and an increase in the wage are greater than the marginal costs in the form of the direct cost and a decrease in tax revenue, respectively. Likewise, country A pays for enforcement, if the subsidy from country B plus the aforementioned marginal benefits are greater than the aforementioned marginal costs. Enforcement spending in A increases in the subsidy from B because the subsidy adds to the public revenue in A that can be distributed in the form of the per capita benefit, which in turn increases the marginal benefit of enforcement for A.

**Corollary 1.** *An amnesty in country A becomes more likely with an increase in the rate of onward migration $\beta$.*

The utility gain from an amnesty increases in the migration rate $\beta$. This is because income in case of an amnesty increases with $\beta$ due to a positive effect on both the net wage and the per capita benefit, as the population (and, therefore, labor supply) decreases.[18]

**Corollary 2.** *Given that there is an amnesty, enforcement spending decreases in country A (for given enforcement subsidy from country B), and increases in country B with an increase in the rate of onward migration $\beta$.*

An increase in the share of migrants who move from country A to country B decreases the marginal benefit of enforcement relative to the marginal cost in country A, and it increases the marginal benefit of enforcement relative to the marginal cost in country B. Therefore, enforcement (net of the subsidy) decreases with $\beta$ in A and increases in B.

**Corollary 3.** *An increase in the factors of technology $A_A$ and $A_B$ increases any positive enforcement spending in country A and country B, respectively, for any given amnesty regime.*

The negative effects of immigration on the wage and the per capita benefit as well as the positive effect on tax revenue all increase with labor productivity. As the negative effects increase more strongly than the positive effect, enforcement spending increases.

# 4 Cooperative Equilibrium

Next, we determine the efficiency of each country's decision on enforcement spending for the federation overall. To this end, we determine whether a policy change on enforcement spending by country A or country B could increase the joint welfare of both countries, which we assume to be given by the simple utilitarian welfare function

$$W = U_A N_A + U_B N_B. \tag{18}$$

We analyze the overall efficiency of enforcement spending for each of the two possible amnesty regimes in country A.[19]

[18] Income does not change with $\beta$ in the case of no amnesty.

[19] The overall efficiency of the amnesty policy in country A depends on parameter values. A given amnesty regime is inefficient for the federation, if a regime change would result in a welfare loss in country A, $U_A(a=1) - U_A(a=0)$ (given by (27)-(30)), that is smaller than any analogous welfare gain in country B, $U_B(a=1) - U_B(a=0)$, and it is efficient otherwise. The joint welfare effect depends on the values of tax rates and productivity and population levels in the two countries, as well as on the size of illegal immigration and the rate of onward migration from A to B.

The marginal effect of enforcement spending in country A, $e_A$, on joint welfare is given by

$$\frac{\partial W}{\partial e_A} = \frac{\partial U_A}{\partial e_A} N_A + \frac{\partial U_B}{\partial e_A} N_B. \tag{19}$$

From (14) together with (15), we get

$$\frac{\partial U_B}{\partial e_A} \equiv \frac{A_B \gamma a \beta}{(N_B + a\beta M)^{2-\gamma}} \left((1-t_B)(1-\gamma) - t_B \gamma\right) + \frac{\left(A_B t_B \gamma (N_B + a\beta M)^{\gamma} - e_B\right) a\beta}{(N_B + a\beta M)^2}. \tag{20}$$

As enforcement spending in A reduces illegal immigration $M$, it has the same effects on utility in country B as the enforcement subsidy $e_B$ (without the cost): a positive effect on the wage, a positive effect on the per capita benefit for given tax revenue (as the number of recipients decreases) and a negative effect on the benefit for a given number of recipients (as tax revenue decreases). If there is no amnesty ($a = 0$) or no onward migration ($\beta = 0$), there is no effect of immigration and, therefore, no effect of enforcement spending $e_A$ on country B. In this simple case, the individually efficient level of $e_A$ is just equal to the efficient level overall.

More interesting is the case where both countries are affected by immigration, and enforcement spending in country A has an external effect on country B, and vice versa. Therefore, we assume in the following that there is an amnesty in country A and strictly positive onward migration from country A to country B.

**Proposition 2.** *The cooperative level of enforcement spending in A is greater than any positive Nash spending $e_A^* > 0$. Likewise, the cooperative level of the enforcement subsidy from B is greater than any positive Nash subsidy $e_B^* > 0$.*

**Proof.** According to (20), $\frac{\partial U_B}{\partial e_A} > 0$ iff

$$e_B < A_B \gamma (1-\gamma)(N_B + \alpha\beta M)^{\gamma}.$$

Substituting for $e_B$ using the Nash equilibrium values of the enforcement subsidy according to Proposition 1, we find that the condition above is always fulfilled.[20] In other words, the cost of immigration for country B via a decrease in the wage and in the per capita benefit (for given tax revenue) always exceeds the benefit of immigration via an increase in tax revenue. Therefore, country B gains from increased enforcement in country A. As $\frac{\partial U_A}{\partial e_A} = 0$ at any strictly positive Nash equilibrium $e_A^* > 0$, the marginal welfare effect $\frac{\partial W}{\partial e_A}$ according to (19) is positive.[21] The maximum welfare $W$ is achieved at a level $e_A$ that is higher than the level chosen by country A.

[20] It is also easy to see that $\frac{\partial U_B}{\partial e_B} > 0$ is sufficient for $\frac{\partial U_B}{\partial e_A} > 0$ by comparing (20) with (16).

[21] Note that if the Nash equilibrium level of $e_A$ is zero, the marginal effect for country A $\frac{\partial U_A}{\partial e_A}$ is negative, and the total marginal effect depends on parameter values.

Analogously, we determine the marginal effect of enforcement spending in country B, $e_B$, on joint welfare as the sum of marginal effects:

$$\frac{\partial W}{\partial e_B} = \frac{\partial U_A}{\partial e_B} N_A + \frac{\partial U_B}{\partial e_B} N_B. \tag{21}$$

According to (8) together with (9),

$$\frac{\partial U_A}{\partial e_B} = \frac{1}{N_A + (1 - a\beta)M}, \tag{22}$$

which is strictly positive, while $\frac{\partial U_B}{\partial e_B} = 0$ at any strictly positive Nash equilibrium $e_B^* > 0$.

■

From the results derived above, we can conclude that an increase in any positive non-cooperative equilibrium levels of enforcement spending in A and enforcement spending in B can increase joint welfare in the federation. However, the maximization of joint welfare in cooperative equilibrium may not result in an increase in welfare for both countries. For example, the welfare loss in A from an increase in $e_A$ might exceed the welfare gain in A from an increase in $e_B$. As a consequence, a side payment would be necessary from country B to country A to induce an increase in enforcement spending in both countries to the cooperative level.

**Proposition 3.** *Assume there is an amnesty and a positive enforcement subsidy in country B. Then, a side payment from country B to country A is necessary to achieve the cooperative equilibrium, if* $\frac{N_A}{N_A + (1-\beta)M} < \frac{N_B}{2(N_B + \beta M)}$.

**Proof.** Take the Nash equilibrium with $a = 1$ and $e_B > 0$. According to (22), the total marginal welfare gain in A from an increase in the enforcement subsidy $e_B$ is

$$\frac{\partial U_A}{\partial e_B} N_A = \frac{N_A}{N_A + (1 - \beta)M},$$

which is constant in $e_B$. In contrast, the total marginal welfare loss in A from an increase in enforcement spending $e_A$ from the Nash level to the cooperative level increases linearly from zero to some value equal to $\frac{\partial U_B}{\partial e_A} N_B$ according to the first-order condition following from (19). As

$$\frac{\partial U_B}{\partial e_A} N_B = \frac{N_B}{N_B + \beta M}$$

at the Nash level, and increasing in $e_A$[22], the total marginal welfare loss in A from an increase in $e_A$ to the cooperative level will be greater than

$$\frac{N_B}{2(N_B + \beta M)}.$$

[22]Note that M is a decreasing function of $e_A$.

■

The welfare gain in A from an increase in the subsidy $e_B$ is achieved via an increase in the per capita benefit in A for natives. Similarly, the welfare gain in B (and, therefore, the equivalent marginal loss in A) from an increase in $e_A$ is achieved via an increase in the native per capita benefit in B. As a result, the net gain in A is smaller, the smaller the native population in A relative to B and the smaller the rate of onward migration $\beta$.[23]

# 5 Extensions

## 5.1 Endogenous Onward Migration

So far, we have assumed that illegal immigration $M$ and the rate of onward migration $\beta$ are given. However, migration is likely to increase in the income differentials that are to be gained from moving. In turn, these differentials will decrease with migration. Arbitrage via migration will therefore reduce any given income differential,[24] if the cost of migration is not too large. While we can argue that the migration cost from outside the federation is large enough for the effect of marginal changes in income on illegal immigration $M$ to be negligible, the effect on onward migration $\beta$ might be more substantial. In the following, we therefore model the rate of migration $\beta$ from country A to country B as a function of the difference in income between the two countries.

We assume that with an amnesty, immigrants in country A gain the right to move freely within the federation immediately.[25] They can choose whether to stay in country A or migrate on to country B. Their incentive to do so is assumed to depend on the difference in net wages plus per capita benefits that is to be gained by moving from A to B as well as their individual cost of migration.[26]

[23]Of course, a scenario where A has to pay a side payment to B is also possible. However, as the marginal gain in B is increasing in $e_A$, we can only derive a lower limit for the total gain in B and derive a sufficient condition for the payment from A to B *not* to be necessary to achieve cooperative equilibrium.

[24]For simplicity, here – and elsewhere in the paper – we exclude the possibility that natives of the federation migrate as to take advantage of income differentials within the federation. Allowing for natives' arbitrage would weaken the effect on $\beta$, but not qualitatively change our results. Our simplifying assumption may be justified by very low migration rates within the European Union (only 4% of all EU citizens have ever settled – at least temporarily – in another EU member state; see Eurobarometer, 2006) despite persisting income differentials. This stylized fact is usually explained by a strong attachment-to-home (see, e.g., Mansoorian and Myers, 1993) which implies particularly high migration costs, especially in comparison to migrants coming from outside the EU for whom the main migration costs have already occured when – illegally – entering the Union.

[25]Within the EU, immigrants typically gain the right of free movement only with delay, i.e. after having resided in an EU member state for a minimum of 5 years.

[26]For example, immigrants who have been in country A longer than others might have a higher cost of onward migration.

### 5.1.1 The Migration Decision

Let $\upsilon_i \in (0, \bar{c})$ denote the individual migration cost that is required by legal immigrant $i$ to move to country B. We assume that legal immigrants in A are uniformly distributed with respect to their migration cost $\upsilon_i$. An immigrant chooses to move to country B, if the income differential is large enough to cover her migration cost ($U_B - U_A > \upsilon_i$) and stays in country A otherwise. Denote any given income differential by

$$\upsilon \equiv U_B - U_A. \tag{23}$$

Since all legal immigrants with migration cost $\upsilon_i < \upsilon$ choose to move to country $B$, $\upsilon$ gives the number of legal immigrants in country $A$ choosing to move. Setting $\bar{c} = 1$, we can express their number as a share. Then, the rate of onward migration equals[27]

$$\beta = \begin{cases} 0 & \text{if} \quad \upsilon < 0 \\ 1 & \text{if} \quad \upsilon > 1 \\ \upsilon & \text{otherwise,} \end{cases} \tag{24}$$

where

$$\upsilon = [w_B(1 - t_B) + b_B] - [w_A(1 - t_A) + b_A] \tag{25}$$

according to (23) together with (8) and (14).

If income is lower in country B than in country A, then migrants will incur an income loss in addition to the migration cost when moving. As a consequence, none of them will move. If income is higher in B than in A and the income gain is large enough to compensate migrants for their migration cost, they move to B. If the income gain is not large enough, they stay in A.

After substituting for wages and per capita benefits in (25) using (6), (7) and (9), (15) and rearranging, we get

$$\begin{aligned} \upsilon \quad = \quad & \frac{A_B\gamma}{(N_B + a\beta M)^{1-\gamma}} - A_A\gamma\left[\frac{1 - t_A}{(N_A + (1-\beta)aM)^{1-\gamma}} + \frac{t_A(N_A + (1-\beta)aM)^{\gamma}}{N_A + (1 - a\beta)M}\right] \\ & - \frac{e_B}{N_B + a\beta M} - \frac{e_B - e_A}{N_A + (1 - a\beta)M}. \end{aligned} \tag{26}$$

The income differential and, in consequence, the rate of onward migration $\beta$ depend on the amnesty and on enforcement spending in both countries according to (26). In particular, migration increases in enforcement spending $e_A$ and decreases in the enforcement subsidy $e_B$ as the former (latter) reduces the per capita benefit to be gained in country A (B).

[27] Note that we substitute for $\bar{c} = 1$ in $\frac{\upsilon}{\bar{c}}$.

### 5.1.2 Equilibrium

**Definition 2.** An *equilibrium with endogenous migration* $\beta$ is a vector $(a^*, e_A^*, e_B^*, \beta^*)$ such that i) $a^*$ is the choice of amnesty in country A, given $e_A^*$, $e_B^*$ and $\beta^*$, ii) $e_A^*$ is the choice of enforcement spending in country A, given $a^*$, $e_B^*$ and $\beta^*$, iii) $e_B^*$ is the choice of enforcement subsidy in country B, given $a^*$, $e_A^*$ and $\beta^*$ and iv) $\beta^*$ is the rate of migration, given $a^*$, $e_A^*$ and $e_B^*$.

The rate of migration $\beta$ depends on the amnesty and enforcement decisions according to (24) together with (26), while the optimal amnesty and enforcement spending in country A and B depend on each other and on the rate of migration according to (10), (13) and (17). For the solution ($a^*$, $e_A^*$, $e_B^*$, $\beta$) to be a Nash equilibrium, each variable has to be the best response to the other three.

**Proposition 4.** *With an endogenous rate of migration $\beta$, there can be multiple Nash equilibria ($a^*$, $e_A^*$, $e_B^*$, $\beta^*$), a unique Nash equilibrium or none at all.*

**Proof.** See Appendix B.

With endogenous onward migration $\beta$, there can now be more than one Nash equilibrium for a given set of parameter values, or none at all. While the solution thus gets more complicated, the essential findings from the case with given $\beta$ (compare Corollaries 1-3) do not change.

## 5.2 The Policy Choice on Onward Migration

Of course, the countries within the federation may choose to restrict any migration rate $\beta$ that arises endogenously as migrants move to maximize their income. In the following, we determine the optimal rate of migration for both countries A and B and derive the outcome of Coasian bargaining over the migration rate between the two countries.

We only consider the case where $\beta \geq \tilde{\beta}$ such that $a = 1$ according to the proof to Proposition 4. If $\beta < \tilde{\beta}$, then there is no amnesty and no legal migrants who could move.

**Lemma 4.** *Assume $\beta \geq \tilde{\beta}$ such that the optimal amnesty decision is $a = 1$ and migration from country A to country B is possible. Then, the optimal rate of migration for country A is $\beta = 1$. The optimal rate of migration for country B is $\beta = 0$.*

**Proof.**

According to the expression for utility in country A (8) together with wage (6), benefit (9) and amnesty and enforcement spending according to Proposition 4, marginal utility in A with respect to migration is positive: $\frac{\partial U_A}{\partial \beta} > 0$. Analogously, (14) together with (7), (15) and Proposition 2 shows that marginal utility in B with respect to migration is negative: $\frac{\partial U_B}{\partial \beta} < 0$. See Appendix C.

An increase in the share of legal migrants who move from country A to country B decreases the population in A and, therefore, increases the net wage and the per capita benefit in A. It increases the population in B, where it decreases the net wage and the per capita benefit. As a result, utility in A increases, whereas utility in B decreases, and the optimal rate of migration for country A (B) is equal to one (zero).

■

**Lemma 5.** *As an outcome of Coasian bargaining over the migration rate, countries A and B will either restrict migration to zero or allow free migration.*

**Proof.**

The marginal gain from migration $\beta$ in country A is increasing in $\beta$, while the marginal cost from $\beta$ in country B is decreasing (see Appendix C). Denote the equilibrium rate of free migration according to Proposition 4 as $\overline{\beta}$. Then, for any $0 < \beta < \overline{\beta}$, it is true that either i) country B can compensate country A for a reduction of $\beta$ to zero, or ii) country A can compensate country B for a rise of $\beta$ to $\overline{\beta}$. Whether the bargaining outcome will be zero or free migration depends on the size of the gain from free migration for country A relative to the size of the loss for country B.

■

**Corollary 5.** *Coasian bargaining over the migration regime between country A and B is more likely to result in free migration, i) the greater the factor of technology in country A, $A_A$ and ii) the smaller the factor of technology in country B, $A_B$.*

The gain from free migration in A is increasing in $A_A$, while the loss from free migration in B is increasing in $A_B$. This is because the negative effect of legalized migrants on the net wage and the per capita benefit increases in the factor of technology in both countries (compare Corollary 2).

# 6 Conclusion

Illegal immigration is a persistent and growing phenomenon despite enhanced efforts of destination countries to tighten their borders. As not all illegal immigrants can be deterred by enforcement policies, amnesties become a policy option with regard to illegals already in the country. Within the EU, the policy on illegal immigration has remained rather uncoordinated so far, even though it has been recognized that cooperation on the issue is highly needed. In a federation with free movement of persons such as the EU, the policies on illegal immigration in one country can cause important externalities in another country. This has become apparent in recent conflicts between

EU member countries concerning the distribution of the costs of enforcement of the EU border and the amnesty policies of countries on the border such as Italy and Spain.

In this paper, we consider the external effects of the policies on enforcement spending and amnesty in a federation where illegals can move freely once they are legalized. In a game-theoretic setting, we determine the optimal amnesty and enforcement spending in a border country as well as the optimal enforcement subsidy of a country within the border of the federation. We determine the Nash equilibria on amnesty and enforcement, and show that enforcement spending in the border country is always greater than or equal to enforcement within the border. The distribution of enforcement spending crucially depends on the rate of onward migration of legalized migrants within the federation.

Further, we find that in non-cooperative equilibrium with positive enforcement spending in both countries, total enforcement spending is too low to maximize joint welfare. In this case, a side payment can be necessary to achieve the cooperative optimum, depending on the relative size of populations in the two countries. Coasian bargaining between countries can also achieve an efficient policy on amnesties or on the movement of legalized migrants within the federation.

Our paper contributes to the current quest for suitable policies in Europe with respect to the growing number of illegal immigrants. We show that important externalities arise from single country policies on illegal immigration and that there is scope for cooperation that would improve the efficiency of such policies. Recent initiatives like the common European border agency Frontex are a first step in this direction.

# References


Baldwin-Edwards, M. (2005): "Migration in the Middle East and Mediterranean," *Study prepared for the Global Commission on International Migration*, available online: http://www.mmo.gr/pdf/news/Migration_in_the_Middle_East_and_Mediterranean.pdf.

Card D. (1990): "The Impact of the Mariel Boatlift on the Miami Labor Market," *Industrial Labor Relations Review* 43, 245–257.

Carrasco, R, J.F. Jimeno, A.C. Ortega (2008): "The Effect of Immigration on the Labor Market Performance of Native-Born Workers: Some Evidence for Spain," *Journal of Population Economics* 21, 627–648.

Carrera, S. (2007): "The EU Border Management Strategy: FRONTEX and the Challenges of Irregular Immigration in the Canary Islands," *CEPS Working Document No. 261.*

Carter, T.J. (1999): "Illegal Immigration in an Efficiency Wage Model," *Journal of International Economics* 49, 385–401.

Carter, T.J. (2005): "Undocumented Immigration and Host-Country Welfare: Competition Across Segmented Labor Markets," *Journal of Regional Science* 45, 777–795.

Chau, N. (2001): "Strategic Amnesty and Credible Immigration Reform," *Journal of Labor Economics* 19, 604–634.

Chiswick, B.R. (1988a): "Illegal Aliens: Their Employment and Employers," Kalamazoo, Michigan: W.E. Upjohn Institute for Employment Research.

Chiswick, B.R. (1988b): "Illegal Immigration and Immigration Control," *Journal of Economic Perspectives* 2, 101–115.

Chiuri, M.C., G. De Arcangelis, A.M. D'Uggento, G. Ferri (2007): "Features and Expectations of Illegal Immigrants: Result of a field survey in Italy," *ChilD Working Paper n. 01/2007.*

Cohen-Goldner, S., M.D. Paserman (2004): "The Dynamic Impact of Immigration on Nativest' Labor Market Outcomes: Evidence from Israel. IZA Discussion Paper No. 1315.

Cuschieri, M.A. (2007): "Europe's Migration Policy Towards the Mediterranean," *ZEI Discussion Paper C168.*

Djajič, S. (1997): "Illegal Immigration and Resource Allocation," *International Economic Review* 38, 97–117.

Epstein, G.S., A. Weiss (2001): "A Theory of Immigration Amnesties," *IZA Discussion Paper No. 302.*

Eurobarometer (2006): "Europeans and Mobility: First Results of an EU-Wide Survey", European Communities, Publications Office.

Facchini, G., Lorz, O., G. Willmann (2006): "Asylum Seekers in Europe: The Warm Glow of a Hot Potato," *Journal of Population Economics* 19, 411–430.

Fakiolas, R. (1999): "Socio-Economic Effects of Immigration in Greece," *Journal of European Social Policy* 9, 211–227.

Fenge, R., V. Meier (2006): "Subsidies for Wages and Infrastructure: How to restrain undesired Immigration," *CESifo Working Paper No. 1741.*

Friedberg R.M., J. Hunt (1995): "The Impact of Immigrants on Host Country Wages, Employment and Growth," *Journal of Economic Perspectives* 9, 23–44.

Garcia, A.S. (2009): "Legal or Illegal? Preferences on Immigration," *International Journal of Social Welfare*, forthcoming.

Greenwood, M.J., J.M. McDowell (1986): "The Factor Market Consequences of U.S. Immigration," *Journal of Economic Literature* 24, 1738–1772.

Hanson, G.H., R. Robertson, A. Spilimbergo (2002): "Does Border Enforcement Protect U.S. Workers From Illegal Immigration?," *The Review of Economics and Statistics* 84, 73–92.

Hillman, A.L., A. Weiss (1999): "A Theory of Permissible Illegal Immigration," *European Journal of Political Economy* 15, 585–604.

ICMPD (2009): "Regularisations in Europe," *Study on practices in the area of regularisation of illegally staying third-country nationals in the Member States of the EU*, Ref. JLS/B4/2007/05.

Jandl, M. (2004): "The Estimation of Illegal Migration in Europe," *Studi Emigrazione/Migration Studies*, No. 153, 141–155.

Jorry, H. (2007): "Construction of a European Institutional Model for Managing Operational Cooperation at the EU's External Borders: Is the FRONTEX Agency a decisive step forward?," *CEPS Research Paper No. 6.*

Karlson, S.H., E. Katz (2003): "A Positive Theory of Immigration Amnesties," *Economics Letters* 78, 231–239.

Krieger, T., S. Minter (2007): "Immigration Amnesties in the Southern EU Member States – a Challenge for the entire EU?," *Romanian Journal of European Studies* 5–6 (2007), 15–32.

Levinson, A. (2005): "The Regularisation of Unauthorized Migrants: Literature Survey and Country Case Studies," *COMPAS*, available online: http://www.compas.ox.ac.uk/publications/papers/Regularisation%20Report.pdf.

Mansoorian, A., G.M. Myers (1993): "Attachment to home and efficient purchases of population in a fiscal externality economy," *Journal of Public Economics* 52, 117–132.

Martin, P.L. (1988): "Network Recruitment and Labor Displacement," in David E. Simcox (ed.), U.S. Immigration in the 1980s. London: Westview Press, 67–91.

Massey, D.S. (1987): "Do Undocumented Migrants Earn Lower Wages than Legal Immigrants? New Evidence from Mexico," *International Migration Review* 21, 236–274.

Orrenius, P.M., M. Zavodny (2007): "Does Immigration Affect Wages? A Look at Occupation-Level Evidence," *Labour Economics* 14, 757–773.

Papademetriou, D.G., K. O'Neil, M. Jachimowicz (2004): "Observations on Regularization and the Labor Market Performance of Unauthorized and Regularized Immigrants," *Paper for the European Commission, DG Employment and Social Affairs.*

Taylor, J.E. (1987): "Undocumented Mexico–U.S. Migration and the Returns to Households in Rural Mexico," *American Journal of Agricultural Economics* 69, 626–638.

Winegarden, C.R., L.B. Khor (1991): "Undocumented Immigration and Unemployment of U.S. Youth and Minority Workers: Econometric Evidence." *The Review of Economics and Statistics* 73, 105–112.

# 7 Appendix

## A. The amnesty decision in Proposition 1

The amnesty decision of country A depends on whether utility is greater with or without an amnesty according to (11). Substituting for $e_A$ and $e_B$ using (13) and (17), we can distinguish four different conditions for the optimal amnesty to be equal to zero or one according to whether enforcement spending in country A is positive or zero in each amnesty regime.

Then, for $e_A \mid_{a=0} > 0$ and $e_A \mid_{a=1} > 0$,

$$a^* = \begin{cases} 1 & \text{if} \quad \frac{A_A\gamma^2}{(N_A+(1-\beta)M)^{1-\gamma}} - \frac{A_A\gamma(1-t_A)}{N_A^{1-\gamma}} + \frac{\beta}{1-\beta} \geq 0 \\ 0 & \text{otherwise,} \end{cases} \tag{27}$$

for $e_A \mid_{a=0} = 0$ and $e_A \mid_{a=1} = 0$,

$$a^* = \begin{cases} 1 & \text{if} \quad \frac{1}{(N_A+(1-\beta)M)^{1-\gamma}} - \frac{1-t_A}{N_A^{1-\gamma}} - \frac{t_A N_A^\gamma}{N_A+M} \geq 0 \\ 0 & \text{otherwise,} \end{cases} \tag{28}$$

for $e_A \mid_{a=0} > 0$ and $e_A \mid_{a=1} = 0$,

$$a^* = \begin{cases} 1 & \text{if} \quad \frac{A_A\gamma}{(N_A+(1-\beta)M)^{1-\gamma}} - \frac{A_A\gamma(1-t_A)}{N_A^{1-\gamma}} - 1 \geq 0 \\ 0 & \text{otherwise,} \end{cases} \tag{29}$$

and for $e_A \mid_{a=0} = 0$ and $e_A \mid_{a=1} > 0$,

$$a^* = \begin{cases} 1 & \text{if} \quad \frac{A_A\gamma^2}{(N_A+(1-\beta)M)^{1-\gamma}} - \frac{A_A\gamma N_A^\gamma}{N_A+M} - \frac{A_A\gamma(1-t_A)M}{N_A^{1-\gamma}(N_A+M)} + \frac{1}{1-\beta} \geq 0 \\ 0 & \text{otherwise.} \end{cases} \tag{30}$$

## B. Equilibria with endogenous migration in Proposition 4

In the case of endogenous migration, there are the following Nash equilibria ($a^*$, $e_A^*$, $e_B^*$, $\beta^*$):

$$a^* = 0$$

$$e_B^* = 0$$

$$e_A^* = A_A\gamma t_A N_A^\gamma - (N_A + M)$$

$$\beta = \beta_1,$$

if $\beta_1 < \tilde{\beta}$ and $e_A^* > 0$,

$$a^* = 0$$

$$e_B^* = 0$$

$$e_A^* = 0$$

$$\beta = \beta_2,$$

if $\beta_2 < \tilde{\beta}$,

$$a^* = 1$$
$$e_B^* = A_B\gamma(1-\gamma)(N_B+\beta_3 M)^\gamma - \tfrac{N_B+\beta_3 M}{\beta_3}$$
$$e_A^* = e_B^* + A_A\gamma(1-\gamma)(N_A+(1-\beta_3)M)^\gamma - \tfrac{N_A+(1-\beta_3)M}{1-\beta_3}$$
$$\beta = \beta_3,$$

if $\beta_3 \geq \tilde{\beta}$, $e_B^* > 0$ and $e_A^* > 0$,

$$a^* = 1$$
$$e_B^* = 0$$
$$e_A^* = A_A\gamma(1-\gamma)(N_A+(1-\beta_4)M)^\gamma - \tfrac{N_A+(1-\beta_4)M}{1-\beta_4}$$
$$\beta = \beta_4,$$

if $\beta_4 \geq \tilde{\beta}$ and $e_A^* > 0$ and

$$a^* = 1$$
$$e_B^* = 0$$
$$e_A^* = 0$$
$$\beta = \beta_5,$$

if $\beta_5 \geq \tilde{\beta}$,

where $\tilde{\beta}$ is the solution to $U_A\mid_{a=1} = U_A\mid_{a=0}$ according to (27)-(30), and

$\beta_1$ is equal to

$$\frac{A_B\gamma}{N_B^{1-\gamma}} - \frac{A_A\gamma(1-t_A)}{N_A^{1-\gamma}} - 1,$$

$\beta_2$ is equal to

$$\frac{A_B\gamma}{N_B^{1-\gamma}} - \frac{A_A\gamma(1-t_A)}{N_A^{1-\gamma}} - \frac{A_A\gamma t_A N_A^\gamma}{N_A+M},$$

$\beta_3$ is the solution to

$$\beta_3 = \frac{A_B\gamma^2}{(N_B+\beta_3 M)^{1-\gamma}} - \frac{A_A\gamma^2}{(N_A+(1-\beta_3)M)^{1-\gamma}} + \frac{1-2\beta_3}{\beta_3(1-\beta_3)},$$

$\beta_4$ is the solution to

$$\beta_4 = \frac{A_B\gamma}{(N_B+\beta_4 M)^{1-\gamma}} - \frac{A_A\gamma^2}{(N_A+(1-\beta_4)M)^{1-\gamma}} - \frac{1}{1-\beta_4},$$

and $\beta_5$ is the solution to

$$\beta_5 = \frac{A_B\gamma}{(N_B+\beta_5 M)^{1-\gamma}} - \frac{A_A\gamma(1-2t_A)}{(N_A+(1-\beta_5)M)^{1-\gamma}},$$

if $\beta_3 \in [0,1]$, $\beta_4 \in [0,1]$ and $\beta_5 \in [0,1]$. $\beta_3 = 0$, $\beta_4 = 0$, $\beta_5 = 0$, if the solution is smaller than zero, and $\beta_3 = 1$, $\beta_4 = 1$ , $\beta_5 = 1$, if the solution is greater than 1, respectively.

There is no Nash equilibrium otherwise.

**Proof.**

The endogenous migration rate $\beta$ is equal to the income differential $\upsilon$ for $0 \leq \upsilon \leq 1$ according to (24), which according to (26) and Proposition 1 is equal to the following:

If $a = 0$, $e_B = 0$, $e_A > 0$:

$$\beta = \frac{A_B \gamma}{N_B^{1-\gamma}} - \frac{A_A \gamma (1 - t_A)}{N_A^{1-\gamma}} - 1,$$

if $a = 0$, $e_B = 0$, $e_A = 0$:

$$\beta = \frac{A_B \gamma}{N_B^{1-\gamma}} - \frac{A_A \gamma (1 - t_A)}{N_A^{1-\gamma}} - \frac{A_A \gamma t_A N_A^{\gamma}}{N_A + M},$$

if $a = 1$, $e_B > 0$, $e_A > 0$:

$$\beta = \frac{A_B \gamma^2}{(N_B + \beta M)^{1-\gamma}} - \frac{A_A \gamma^2}{(N_A + (1-\beta) M)^{1-\gamma}} + \frac{1 - 2\beta}{\beta(1-\beta)},$$

if $a = 1$, $e_B = 0$, $e_A > 0$:

$$\beta = \frac{A_B \gamma}{(N_B + \beta M)^{1-\gamma}} - \frac{A_A \gamma^2}{(N_A + (1-\beta) M)^{1-\gamma}} - \frac{1}{1-\beta},$$

if $a = 1$, $e_B = 0$, $e_A = 0$:

$$\beta = \frac{A_B \gamma}{(N_B + \beta M)^{1-\gamma}} - \frac{A_A \gamma (1 - 2t_A)}{(N_A + (1-\beta) M)^{1-\gamma}},$$

with $e_B$ and $e_A$ given by Proposition 1.

Country A decides for or against an amnesty depending on whether income is greater with or without an amnesty according to (10). The utility gain from an amnesty is increasing in the migration rate $\beta$ (compare Corollary 1). We can therefore rewrite the amnesty decision as a function of $\beta$ as follows:

$$a = \begin{cases} 1 & \text{if} \quad \beta \geq \tilde{\beta} \\ 0 & \text{if} \quad \beta < \tilde{\beta}, \end{cases} \tag{31}$$

where $\tilde{\beta}$ is equal to the rate of migration at which country A is just indifferent between an amnesty or no amnesty according to (27)-(30).

■

## C. Utility with endogenous migration in Lemmas 4 and 5

We derive utility in country A for $\beta \geq \tilde{\beta}$ using (8) together with (6) and (9) as well as Proposition 4:

$$U_A = \begin{cases} \frac{A_A \gamma^2}{(N_A+(1-\beta)M)^{1-\gamma}} + \frac{1}{1-\beta} & \text{if} \quad e_A > 0 \\ \frac{A_A \gamma}{(N_A+(1-\beta)M)^{1-\gamma}} & \text{if} \quad e_A = 0 \end{cases} \tag{32}$$

and, likewise, utility in country B for $\beta \geq \tilde{\beta}$ using (14) together with (7), (15) and Proposition 4:

$$U_B = \begin{cases} \frac{A_B \gamma^2}{(N_B+\beta M)^{1-\gamma}} + \frac{1}{\beta} & \text{if} \quad e_B > 0 \\ \frac{A_B \gamma}{(N_B+\beta M)^{1-\gamma}} & \text{if} \quad e_B = 0 \end{cases} \tag{33}$$

where $e_A$ and $e_B$ are as given in Appendix B.

From (32) it follows that $\frac{\partial U_A}{\partial \beta} > 0$ and $\frac{\partial^2 U_A}{\partial^2 \beta} > 0$. From (33) it follows that $\frac{\partial U_B}{\partial \beta} < 0$ and $\frac{\partial^2 U_B}{\partial^2 \beta} > 0$.