On the welfare impacts of an immigration amnesty

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Abstract

This paper aims to assess the effects of an immigration amnesty on agents’ welfare by using a simple two-period overlapping generations model. Given that illegal immigrants play a role in the economy before being regularized, an amnesty differs from new immigration. In the presence of labor market discrimination, capital holders are harmed as the loss of their illegal workforce increases the wage bill that they pay. The net fiscal effect strongly depends on the discrimination that illegal workers face ex-ante. A calibration of the model on Germany and the United Kingdom highlights overall limited economic consequences of amnesty which can be contrasted to the effects of deportation and new legal immigration. In particular, when public welfare expenditures are low, amnesty and new immigration can increase native’s welfare in the long run while deportation might harm less-educated agents.

Policy Points

• In order to quantify the effects of an amnesty, it is crucial to consider the role played by illegal workers in the economy. In particular, the discrimination that they might face on the labor market and the limited access to public transfers are determinant to assess the net effect of a regularization on natives’ utility.
• Given the role that illegal immigrants play in an economy and the relatively low fraction of illegal workers among the total population, an amnesty has quantitatively limited effects.
• The consequences of an amnesty are also likely to be less important than new legal migration or deportation of illegal workers, given that the latter already influence the economic outcome ex-ante.

Keywords: illegal immigration, amnesty, regularization, discrimination

JEL Classification: F29, J61, J68

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1 Introduction

In recent years, illegal immigration\(^1\) has been an issue for numerous countries all over the world (OECD, 2006). Table 1 provides estimates of the illegal population in the EU15 in 2002. The authorities and the public opinion regularly debate on how to tackle this problem and shape the immigration policy.

The policies defined by national authorities often focus on a selective choice of immigrants allowed to enter the country (e.g. the points systems in Australia and Canada\(^2\)) or on the means to be used in order to control the borders and the inflow of foreigners on the national soil. However, several governments have conducted, under certain specific circumstances, a regularization (also referred to as legalization or amnesty) of the illegal population present in their country. An amnesty for illegal immigrants can be defined as a governmental pardon for violating regulations related to immigration, which might include forgiving individuals for using false documentation such as social security numbers or identification cards, in order to remain in the country and/or gain employment. This procedure confers permanent residency in the host country to those illegal immigrants who respect the criteria for application.

In general, an amnesty is a “one-off” political decision without fixed institutional framework, although some countries have permanent programs such as France and the United Kingdom (see Levinson, 2005). Several political or social reasons may justify the organization of a regularization. Without being exhaustive, these can include: the improvement of illegal workers’ life conditions, the increase in labor market transparency or the strengthening of knowledge and control over illegal immigration (see Levinson, 2005). Various application criteria are also recurrent in these procedures: the attribution of legal status might be based on duration of residence, on participation in the labor market or on socio-political reasons\(^3\) (Levinson, 2005).

In opposition to new immigrants, unauthorized residents already play a role in the society and the economy: they might work (in the shadow economy), perceive different sorts of subsidies, pay the value added tax on consumption and their children are educated in the national education system. Therefore, an amnesty has a different impact on the economy than the admission of new immigrants. Several countries have provided amnesties, among which the largest, in terms of applicants, was the Immigration Reform and Control Act (IRCA) of 1986 in the U.S. (OECD, 2008).

The literature on amnesties is quite limited and a large part of the attention has been focused on the IRCA and its consequences. This is due to the importance of this

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\(^1\) An illegal immigrant can be defined as a foreigner who has either entered the country illegally or violated the terms of legal admission (e.g. by overstaying the duration of a tourist visa).

\(^2\) In these systems, applicants receive points for different characteristics like education, work experience, language skills and job prospects (a guaranteed employment contract). To be eligible for a visa, a certain number of points must be obtained (CIC, 2011).

\(^3\) One of the possible criteria for legalization in the Belgian procedure of 2009 was indeed the excessive time that the responsible administrations took to treat applications for asylum (SPF Intérieur, 2009)
experience but also to the lack of data regarding other regularization cases. However, some studies focus on the European countries (Pastore, 2004; Levinson, 2005; Marx et al., 2008; Papantonio-Frangouli and Leventi, 2000, Baldwin-Edwards and Kraler, 2009 for the EU27 and Reyneri, 2001 for the Mediterranean countries).

The theory of amnesty has been treated in different ways by the authors who addressed this question. Generally, it has been viewed as part of a larger immigration control strategy, including border control and internal inspections (Chau, 2001, 2003). Mayr et al. (2012) study the implementation of amnesty in a federation with spillover effects due to onward migration. Karlson and Katz (2003) argued that the prospect of an amnesty also provides incentives for potential immigrants needed as labor force in the host country. In Epstein and Weiss (2001) an amnesty is considered as a means to reduce the burden on the government of illegal immigrants, who could not be prevented from establishing in the country. Magris and Russo (2012) explore the tradeoff faced by governments between increasing the country’s fiscal base and reducing its migrant stock. The optimal timing and the reasons for the implementation of an amnesty have also received some attention (Epstein and Weiss, 2001, 2011; Casarico et al., 2012).

Part of the literature focuses on the effects of an amnesty on migrants’ welfare and the dynamics of immigration (Gang and Yun, 2006; Epstein and Weiss, 2001). The consequences of an amnesty (mainly the IRCA) for the legalized immigrants or the labor market in general have been empirically assessed in several papers (Borjas and Tienda, 1993; Kaushal, 2006; Amuedo-Dorantes et al., 2007; Barcellos, 2010; Amuedo-Dorantes and Bansak, 2011). However, the findings of this literature vary considerably and depend largely on the estimation methods and samples used (Borjas and Tienda, 1993).

The main objective of this paper is to assess the economic impact of an amnesty on different categories of agents. It is important to stress out that illegal agents already play a role in the economy through their labor market participation and net impact on the public budget. Thus, their presence is not neutral prior to the amnesty, which is rarely underlined in the existing literature. Using a simple overlapping generations (OLG) model as framework allows to separate the effects on high- and less-educated workers and capital owners (retired individuals). To our knowledge, this type of model has not yet been used to analyze the regularization of illegal immigrants. An amnesty yields contradicting effects for agents belonging to different generations. In the short run, at constant capital stock and workforce, profits are reduced and the interest rate falls if illegal workers are discriminated on the labor market. Hence, the old generation embodying the capital owners suffers a welfare loss. Simultaneously, the effects on the public budget are uncertain and depend on the number of illegal workers and country characteristics (e.g. skill structure of the labor market and fiscal policy). A decrease in the income tax rate can benefit the whole workforce in the economy. In the long run, capital accumulation might undo the negative short run effects on the interest rate. The consequences on native low-educated individuals remain limited. When a shock on the population size and structure is considered (either by allowing deportation or new immigration inflows), several additional ambiguities arise.
A parameterization of the model on two different countries (Germany and United Kingdom) allows to quantify these changes and particularly to highlight the differences between an amnesty and new immigration. The former generally implies weaker effects than the latter due to the ex-ante role played by the illegal agents in the economy.

The remainder of this paper is organized as follows. The next section presents the two-period OLG model, used to investigate the consequences of a regularization in section 3. Furthermore, the latter analyses the cases of deportation and new legal immigration. Section 4 provides a parameterization of the model to reproduce two different economies and compares the effects of an amnesty with the two alternative policies. Some sensitivity analysis to different parameter values are also provided. Section 5 concludes.

2 Theoretical Framework

In the closed economy considered\(^4\), one good is produced and there are four different types of perfectly foresighted workers \((j = h, n, m, i)\), differentiated by skill and origin, who live for two periods. A high-educated (college graduated) worker\(^5\) is denoted by subscript \(h\) while a low-educated worker is either a native \((n)\), a legal \((m)\) or illegal \((i)\) immigrant. High- and low-educated workers are imperfect substitutes. Orrenius and Zavodny (2004) argue that, although granting legal status might increase the competition between legalized and native workers, the latter keep a certain protection due to their language skills, their higher level of education and their better knowledge of the labor market institutions. Furthermore, the evidence in the literature relating to the substitutability between legal and illegal immigrants is quite scarce and, to our knowledge, no estimates for the elasticity of substitution have so far been obtained. We thus assume that legal and illegal agents are perfect substitutes and are only differentiated by their status while remaining imperfectly substitutable with natives. An immigrant’s productivity is therefore status independent while foreign-born agents might concentrate on different segments of the labor market than natives. However, illegal immigrants might be discriminated on the labor market and only receive a fraction of the (legal) immigrant’s wage and of the public transfers. On the other hand, they are not subject to labor income taxation.

2.1 Utility maximization

Each agent lives for two periods. When young, she supplies one unit of labor inelastically. Her income is either consumed or saved. The savings are used to consume when she becomes old and no bequests are left. The lifetime utility of a \(j\)-type agent, born at time

\(^4\)Appendix D briefly reviews the effects of an amnesty in a small open economy framework.

\(^5\)In order to simplify the analyses, high-educated workers are assumed to be perfect substitutes. A policy shock will therefore have the same effects on high-educated natives than it does on high-educated immigrants.
\( t \) is given by
\[
U^t_j = \ln(c_{j,t}) + \beta \ln(d_{j,t+1}) - S_j \quad \text{where } j=h,m,n,i
\]  
(1)

\( \beta \) is the type-independent discount factor while \( c_{j,t} \) and \( d_{j,t+1} \) represent, for an agent of type \( j \), the consumption of the single good at time \( t \) and \( t + 1 \). \( S_j \) is a fixed cost that the illegal status imposes on immigrants without proper documentation. Thus, \( S_i > 0 \) while \( S_j = 0 \) for \( j = n,m,h \). This cost might reflect a variety of aspects like the discomfort due to the irregular situation, the fear to be caught or limitations in the daily life that the absence of legal status imposes (e.g. impossibility to have a driving license). Given that she lives for two time periods, the lifetime budget constraint of a \( j \)-type agent can be written:
\[
\psi_{j,t} = c_{j,t}(1 + v) + \frac{d_{j,t+1}(1 + v)}{R_{t+1}}.
\]  
(2)

where \( v \) is a constant value added tax (VAT) rate on consumption and \( R_{t+1} \) is the return on savings. The disposable income of a \( j \)-type agent is given by \( \psi_{j,t} \) with:
\[
\begin{align*}
\psi_{j,t} &= w_{j,t}(1 - \tau_t) + g \\
\psi_{i,t} &= \gamma w_{m,t} + \Theta g
\end{align*}
\]  
(3)

(4)

where \( w_{j,t} \) is the \( j \)-type worker’s wage, \( \tau_t \) the income tax rate and \( g \) the constant public transfer provided by the government to legal workers. The fractions of the low-education wage and transfers that an undocumented individual receives are respectively denoted by \( \gamma \) and \( \Theta \). In the literature, several reasons are provided to explain the lower wages of illegal workers. Among the most common are a lower productivity of the illegal immigrants (Chiswick, 1988), the risk of employer sanctions passed on to workers (Chau, 2001) or discrimination due to the status (Rivera-Batiz, 1999), which is retained in the model. Furthermore, even though illegal workers do not pay taxes, they might be able to apply for specific public assistance programs and their children might integrate the public education system. Therefore, they impose a cost on the public budget.

Maximizing (1) subject to (2) yields per capita consumption and savings, which given the logarithmic utility function, are a constant fraction of the disposable income:
\[
\begin{align*}
c_{j,t} &= \frac{\psi_{j,t}}{(1 + v)(1 + \beta)} \\
s_{j,t} &= \psi_{j,t} - c_{j,t}(1 + v) = \frac{\beta}{1 + \beta} \psi_{j,t} \\
d_{j,t+1} &= \frac{\beta}{1 + \beta} \psi_{j,t} R_{t+1} / (1 + v).
\end{align*}
\]

With \( T_{j,t} \) being the total number of \( j \)-type workers at time \( t \) and the aggregate disposable income defined as \( \Psi_t = \sum_{j=h,n,m,i} T_{j,t} \psi_{j,t} \), the corresponding consumption and savings

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*A useful reference guide for OLG models can be found in de la Croix and Michel (2002).*
aggregates become:

\[ C_t = \frac{\Psi_t}{(1 + v)(1 + \beta)}, \quad S_t = \frac{\beta \Psi_t}{1 + \beta}, \quad D_t = \frac{R_t S_{t-1}}{1 + v}. \]

2.2 Labor market structure

At each period \( t \), the constant workforce (expressed in efficient labor units) consists of two types of agents, who live for two periods: high-educated workers \( Q_{h,t} \) and low-educated workers \( Q_{l,t} \) whereby high education is considered to be any tertiary degree (or assimilated). A low-educated \( j \)-type agent is distinguished through her origin, where \( N_t \) is the fixed stock of native workers, \( M_t \) and \( I_t \) the fixed stocks of legal and illegal immigrants present in the labor market. The low-educated immigrants are all perfect substitutes, the only difference being the illegal status for a fraction of them. The parameter \( \theta_n \) represents the relative labor productivity level of native workers and \( \sigma_N \) is the elasticity of substitution between the native and immigration workforce. As in a recent strain of the immigration literature (see Ottaviano and Peri, 2008, 2012; Docquier et al., 2010) the low-educated labor force is represented by a nested CES function. This allows to take into account imperfect substitution between immigrants and native workers. Low-educated labor, \( Q_{l,t} \), is thus:

\[ Q_{l,t} = \left[ \theta_n N_t^{\sigma_N^{-1}} + (1 - \theta_n) (M_t + I_t)^{\sigma_N^{-1}} \right]^{\sigma_N^{-1}} \]

In order to remain consistent, high-educated workers are also expressed in efficient labor units. It is assumed that highly-educated natives \( (N_{h,t}) \) and immigrants \( (M_{h,t}) \) are perfect substitutes with:

\[ Q_{h,t} = [\theta_e N_{h,t} + (1 - \theta_e) (M_{h,t})] \]

In order to simplify the analyses, both types of agents have the same productivity \((\theta_e=0.5)\) and are therefore paid the same wage rate. The total number of high-educated workers is henceforth denoted as \( H_t = N_{h,t} + M_{h,t} \). Following Docquier et al. (2010), total labor is expressed in efficiency units as a nested CES function of the high-\( (Q_{h,t}) \) and low-educated workers \( (Q_{l,t}) \):

\[ Q_t = \left[ \theta_h Q_{h,t}^{\sigma_H^{-1}} + (1 - \theta_h) Q_{l,t}^{\sigma_H^{-1}} \right]^{\sigma_H^{-1}} \]

with \( \theta_h \) being the relative productivity of high-educated workers and \( \sigma_H \) the elasticity of substitution between the two education groups (which are imperfect substitutes).

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7Given the structure of the OLG models and the constant population assumption, the number of retired agents living in the economy at each period \( t \) equals the number of working-age agents.
2.3 Profit maximization

The production is represented by a Cobb-Douglas function, using capital \( K_t \) and the labor quantity expressed in efficient units \( Q_t \). Capital is given by the total savings of the previous period such that \( K_{t+1} = S_t \) and full depreciation is assumed.

\[ Y_t = AK_t^\alpha Q_t^{1-\alpha} \]

The representative firm maximizes profits, which are then distributed to the capital owners in order to remunerate their savings.

\[ \max_{N_h, M_h, N, M, I} \pi = AK_t^\alpha Q_t^{1-\alpha} - w_{h,t}H_t - w_{n,t}N_t - w_{m,t}(M_t + \gamma I_t) - R_t K_t \]

Legal workers are assumed to be completely mobile such that the respective segments of the labor market are perfectly competitive. On the other hand, illegal workers might be restrained on their mobility due to the lack of proper documentation, lower information about employment possibilities or networks concentrated in certain sectors (Massey, 1987). Thus, the market for illegal immigrants might not be perfectly competitive and the latter can be paid a fraction \( \gamma \leq 1 \) of the legal immigrant’s wage rate. Hence, when \( \gamma < 1 \), the illegal worker receives a remuneration below her marginal productivity such that her employer extracts a marginal profit on her. This allows to account for the assumption that illegal immigrants can be exploited by their employer and receive a lower wage due to their illegal status (Rivera-Batiz, 1999). In the absence of controls and sanctions for hiring illegal immigrants, the firm thus hires the complete fixed stock.

\[ \text{Ottaviano and Peri (2008) argue that the implication of the Cobb-Douglas functional form leading to the same degree of substitutability between capital and each type of workers can be defended. They find that the results of Krusell et al. (2000) (who state that physical capital complements highly educated and substitutes lower educated workers) would imply the income share of capital to increase over time following “the large increase in supply and income share of highly educated” in the U.S. (Ottaviano and Peri, 2008). This, they say, has however not been observed.} \]

\[ \text{The capital market is assumed to be perfect in the sense that the savings of illegal agents serve the capital accumulation. In other words, it is assumed that illegal agents can place their savings at an interest factor} R_t \text{. This rather strong assumption does not influence the intuition of the results. In the short term, capital is fixed and thus assuming imperfect access to capital markets only implies a level effect. In the long run, the capital stock does, in that case, not only change due to the variations in disposable income but also due to the additional capital belonging to the regularized. An amnesty therefore has one additional positive effect in the presence of imperfect capital market access.} \]

\[ \text{In fact, Kossoudji and Cobb-Clark (2002) state that the IRCA’s amnesty provisions impacted on the wages of legalized workers mainly by improving their labor mobility, allowing them to access better-paid jobs.} \]

\[ \text{As mentioned previously, the discrimination of the illegal workers is operated through two parameters: lower wage earned given by the fraction} \gamma \text{ and constrained access to public funding} \Theta \text{. Furthermore, they are not subjected to labor income taxation.} \]
of illegal workers. The wage rates\textsuperscript{12} are given by the following first order conditions:

\begin{align*}
  w_{h,t} &= 0.5 (1 - \alpha) \theta_h \frac{Y_t}{Q_t} \left( \frac{Q_{l,t}}{Q_{h,t}} \right)^{\frac{1}{\sigma_H}} \\
  w_{n,t} &= (1 - \alpha) (1 - \theta_h) \theta_n \frac{Y_t}{Q_t} \left( \frac{Q_{l,t}}{N_t} \right)^{\frac{1}{\sigma_H}} \\
  w_{m,t} &= (1 - \alpha) (1 - \theta_h) (1 - \theta_n) \frac{Y_t}{Q_t} \left( \frac{Q_{l,t}}{M_t + I_t} \right)^{\frac{1}{\sigma_H}} \\
  w_{i,t} &= \gamma w_{m,t}
\end{align*}

Profit is redistributed to the capital owners such that the interest factor can be defined as:

\begin{equation}
  R_t = \frac{Y_t}{K_t} \left( \alpha + (1 - \alpha) (1 - \gamma) (1 - \theta_h) \left( \frac{Q_{l,t}}{Q_{l}} \right)^{\frac{\sigma_H-1}{\sigma_H}} (1 - \theta_n) \left( \frac{M_t + I_t}{Q_{l,t}} \right)^{\frac{1}{\sigma_N}} I_t \right)
\end{equation}

If the firms pay illegal immigrants below their marginal productivity, the interest factor (which can be written as \( R_t = \frac{\alpha Y_t (1-\gamma) (1-w_{m,t})}{K_t} \)) has a premium over the factor that would prevail with a perfectly competitive labor market, \( R_t = \alpha \frac{Y_t}{K_t} \) (with \( \gamma = 1 \)).

2.4 The public budget

Income taxation and the value added tax on consumption, collected at the respective rates of \( \tau_t \) and \( v \), constitute the public resources. The VAT rate is assumed to be constant over time whereas the income tax rate is adjusted in order to maintain a budget balance at every period \( t \textsuperscript{13} \). Public expenditures consist of constant structural spendings \( G \) and per capita transfers \( g \). Thus, rearranging the constraint yields the income tax rate that balances the budget:

\begin{equation}
  \tau_t = \frac{g (H_t + N_t + M_t + \Theta I_t) + G - v (C_t + D_t)}{H_t w_{h,t} + N_t w_{n,t} + M_t w_{m,t}}.
\end{equation}

The presence of illegal workers in the economy is not neutral to the public budget. In fact, although these agents do not pay income taxes, they contribute through the value added tax collected on consumption. On the other hand, they perceive some public transfers, even though they are only entitled to a fraction (\( \Theta \)) of the legal agents’ transfers.

\textsuperscript{12}Note that high-educated workers receive the same wage rate with no distinction of origin such that \( w_{h,t} = \frac{\delta N_{h,t}}{N_{h,t}} = \frac{\delta N_{n,t}}{N_{n,t}} \).

\textsuperscript{13}Instead of modeling the fiscal adjustment through a variation in the income tax rate, we could consider that public transfers adjust at a given tax rate without affecting the intuitions of the results. Furthermore, instead of assuming a fiscal impact concentrated on the young, it would be possible to consider a pay-as-you-go pension system. In this case, retired agents' welfare would be affected through the impact on the returns to savings and on the level of pension benefits. On the other hand, at constant income tax rate, legal workers would only be affected by a potential change in the wage rates.
3 The effects of an amnesty, immigration and deportation

This section focuses on the consequences of an amnesty, which allows illegal workers, who already play a role in the economy (through effects on the labor market and the public budget) to apply for a regularization of their illegal situation\(^{14}\). In order to extend the analysis to the legal immigration and deportation cases, a general notation for the change in the foreign-born workforce is used. The economy is assumed to start at the steady state, denoted \(ss\) (which can also be interpreted as period \(T - 1\)). Given the structure of the two-period OLG model, the immigrant population affected by the shock in period \(T\) is not the same as the one present at the initial steady state. However, contrasting the effects of an amnesty on workers in period \(T\) with the steady state regime allows to highlight the different effects induced by this policy. Stated differently, two alternative outcomes are compared for the generations living in \(T\): the outcome with amnesty is contrasted with the steady state, in which the agents born in \(T\) would live, had the amnesty not occurred. Starting with a (constant) immigrant population of \(M_{ss} + I_{ss}\), a policy shock occurs at the beginning of period \(T\):

\[
M_T = M_{ss} + \epsilon M_{ss} + \eta I_{ss} \quad \text{and} \quad I_T = I_{ss} (1 - \eta - \delta)
\]

and thus the total foreign-born workforce is given by,

\[
M_T + I_T = M_{ss} (1 + \epsilon) + I_{ss} (1 - \delta)
\]

\(\eta\) and \(\delta\) are the fractions of legalized and deported illegal workers respectively. \(\epsilon\) allows to express an increase in legal migrant workers as a fraction of the stock present at initial the steady state. The benchmark amnesty model is recovered when \(\delta = \epsilon = 0\) and an exogenous fraction \(0 < \eta \leq 1\) of the illegal workers is legalized\(^{15}\). Thus, the size of the workforce remains unaffected in the case of an amnesty. If legalized, a formerly illegal worker earns a higher gross wage (if she was being paid below the marginal productivity) and receives more transfers but simultaneously becomes subject to income taxation. A possible extension is to consider that a fraction of the illegal workers is deported. With \(\epsilon = 0\) and \(\delta > 0\) (while \(\eta\) might take any value as long as \(\eta + \delta \leq 1\)), deportation occurs and labor in efficient units decreases (see Appendix A). The extreme case of a deportation of all the illegal workers can be obtained with \(\delta = 1, \eta = 0\). The model can also be used in a third scenario to contrast the effects of an amnesty with the effects of an increase in legal unskilled immigration by setting \(\eta = \delta = 0\) and \(\epsilon > 0\). Furthermore, these different scenarios could also be merged to analyze a “magnet effect” effect of amnesty e.g. a fraction of illegal immigrants is legalized \((\eta > \epsilon = 0)\) but additional illegal workers enter the economy \((\delta < 0)\). However, given that this is a particular

\(^{14}\)In order to simplify the analysis, the disutility caused by the illegal status is assumed to be high enough for the representative illegal agent to always prefer to be legalized (see equation (1)). All the illegal immigrants thus apply, allowing to study the upper bound effects of a general regularization.

\(^{15}\)As individuals are homogeneous, it follows that if one illegal worker applies for amnesty, so do all the others. However, only an exogenous fraction \(\eta\) is successful and without loss of generality, it can be assumed that individuals are chosen randomly until this fraction is met.
combination of an amnesty and an “inverted” deportation (δ < 0 implies an inflow of additional illegal workers), the analysis of this scenario is not developed further\textsuperscript{16}.

3.1 Short run effects of an amnesty with constant population\textsuperscript{17}

The impact of an amnesty can be assessed by analyzing the impact on the lifetime utility of a representative $j$-type agent born in period $T$ with\textsuperscript{18}:

$$\Delta U_{j,T} = U_{j,T} - U_{j,ss}$$

This can be rewritten as:

$$\Delta U_{j,T} = (1 + \beta)\ln \left(1 + \frac{\Delta \psi_{j,T}}{\psi_{j,ss}}\right) + \beta \ln \left(1 + \frac{\Delta R_T+1}{R_{ss}}\right) - S_j \quad \text{where } j = h, m, n, i \quad (10)$$

$\Delta \psi_{j,T}$ measures the $j$-type worker’s net income change, while the second term in expression (10) captures the variation in the interest rate. In the benchmark scenario, where $\eta > \delta = \epsilon = 0$, the amnesty is implemented in period $T$ and no deportation occurs. Proposition 1 states the incentive compatibility constraint for an illegal worker to prefer a regularization to the illegal status, given the interest factor.

**Proposition 1.** Assuming the absence of a non-monetary utility cost of illegal status $S_i=0$, each illegal worker applies to amnesty if she can expect an increase in her net income:

$$\Delta \psi_{i,T}^\ell > 0 \Rightarrow \omega_{m,T} > \frac{(1 - \Theta)}{1 - \tau_T - \gamma} \quad (11)$$

The change in a regularized worker’s net income can be shown to be a positive function of ex-ante discrimination ($\gamma, \Theta$)\textsuperscript{19} and a negative function of the ex-post income tax rate ($\tau_T$). Even if condition (11) does not hold, the illegal workers have an incentive to regularize if $S_i$ is large enough.

In order to study the effects of an amnesty on a legal $j$-type agent’s intertemporal utility, the different channels affecting welfare (see equation (10)) are detailed below\textsuperscript{20}.

\textsuperscript{16}Intuitively, regularizing illegal workers while simultaneously increasing the total stock of illegal workers in the economy should mitigate the total effects of an amnesty.

\textsuperscript{17}The detail for the subsequent results can be found in Appendix B.

\textsuperscript{18}All the following analysis compare the amnesty scenario (in $T$) to the starting steady state in period $ss$. Thus, the impact of an amnesty on any variable $x$ is measured by the difference between its value before and after amnesty $\Delta x_T = x_T - x_{ss}$.

\textsuperscript{19}Note that the higher are the values of the two parameters, the lower is the discrimination faced by the illegal workers.

\textsuperscript{20}The effects of an amnesty depend on several parameters and their combination, making it difficult to extract clear-cut theoretical results. Several numerical exercises, allowing to quantify the effects of amnesty, are presented in section 4.
previous period. Due to the constant population size, there is no change in the production or in the wage rates (given the assumption of perfect substitutability). However, the fraction $\eta$ of immigrants, whose situation is regularized, now receives the same wage and transfers as the legal immigrants (instead of the fraction $\gamma$ they would perceive as illegal workers) which leads to a change in the interest factor (through relation (6)):

$$\Delta R_T = -\frac{\eta(1-\gamma)I_{ss}w_{m,T}}{K_T}$$

(12)

The numerator in (12) captures the profit decrease caused by an amnesty, which is exclusively due to the elimination of wage discrimination against the legalized immigrants. In the presence of status discrimination on the labor market (with $\gamma < 1$), the interest factor is certain to decrease. In the case of perfectly competitive markets (with $\gamma = 1$), profits are unaffected and the interest factor is unchanged. Thus, the discrimination that illegal workers face on the labor market plays an important role: the less discriminative is the labor market against legal status (the higher is $\gamma$), the less profits are affected by the amnesty. Moreover, the higher is the number of regularized illegal workers $\eta I_{ss}$, the stronger is the negative impact on the return factor. Note that an amnesty affects agents retired at period $T$ only through the change in their savings’ return. Thus, in presence of status discrimination on the labor market, the retired agents are certain to suffer a welfare loss$^{21}$.

In the short term, given the constant population, the disposable income of a legal $j$-type worker changes only due to the variation in the income tax rate, $\Delta \tau_T$ (since $w_{j,T} = w_{j,ss}$):

$$\Delta \psi_{j,T} = -\Delta \tau_T w_{j,T}$$

(13)

The impact of the amnesty on the tax rate is given by the net fiscal cost of the legalized individuals and the policy’s impact on revenues collected from the value added tax on consumption:

$$\Delta \tau_T = \frac{\eta I_{ss}(g(1-\Theta) - \tau_T w_{m,ss}) - v(\Delta C_T + \Delta D_T)}{W_{ss}},$$

(14)

with $W_{ss} = H_{ss}w_{h,ss} + N_{ss}w_{n,ss} + M_{ss}w_{m,ss}$ being the steady state taxable income base. The change in total consumption ($\Delta C_T + \Delta D_T$) depends on the variation in the aggregate disposable income ($\Delta \Psi_T$) and the interest factor ($\Delta R_T$):

$$\Delta C_T + \Delta D_T = \frac{\Delta \Psi_T}{(1+\beta)(1+v)} + \frac{\Delta R_T S_{ss}}{1+v}$$

(15)

$^{21}$In expression (10), the first term is 0 while the second term is negative. The model implies, by construction, that the fiscal effect concerns only the workers and not the retired agents: the workers pay an income tax and perceive public transfers. Intergenerational transfers could have been considered at the cost of increasing the complexity of the model. In the presence of a pay-as-you-go pension system, retired agents could benefit from the fiscal contribution of the regularized agents, which would counterbalance the negative effect on the returns to savings.
The change in aggregate disposable income depends on the improvement of illegal immigrants’ revenues and its impact on income taxation:

\[
\Delta \Psi_T = \eta I_{ss} \left[ (1 - \tau_T - \gamma) w_{m,T} + g(1 - \Theta) \right] - \Delta \tau_T (W_{ss}) \]

\[
\frac{\eta I_{ss} w_{m,T}(1 - \gamma)(1 + \beta)}{(1 + \beta + \beta v)} \tag{16}
\]

Expression (16) shows that the aggregate disposable income is certain not to decrease, even under the circumstance of a higher tax rate. A potential decrease in the (formerly) legal workforce’s aggregate disposable income (due to higher income taxation) is thus more than compensated by the rise in legalized workers’ income. The change in total consumption (equation (15)) is a priori ambiguous, given the decrease in the return factor (equation (12)) and the increase in the aggregate disposable income (equation (16)). However, combining equations (12), (16) and (15), total consumption can be shown to decrease. This implies that the decrease in the retired agents’ consumption can not be compensated by a rise in the workers’ consumption:

\[
\Delta C_T + \Delta D_T = -\frac{\eta I_{ss} \beta (1 - \gamma) w_{m,ss}}{(1 + \beta + \beta v)}. \tag{15'}
\]

Thus, the income tax rate decreases only if the income tax collected on the regularized workers is high enough to compensate for the additional transfers they perceive and the decrease in value added tax income. Using (15') in (14) allows to rewrite the income tax rate change as:

\[
\Delta \tau_T = \frac{\eta I_{ss}}{W_{ss}} \left( g(1 - \Theta) + w_{m,ss} \left( \frac{v \beta (1 - \gamma)}{(1 + \beta + \beta v)} - \tau_T \right) \right) \tag{17}
\]

If this condition does not hold (and \(\Delta \tau_T\) is positive), all the legal workers in the economy are likely to suffer a welfare loss given that a lower disposable income is added to a lower post-amnesty interest factor. The higher is pre-amnesty discrimination (the lower is \(\Theta\) or \(\gamma\)), the higher is the regularization’s effect on the income tax rate. The intuition behind this finding suggests that a higher ex-ante discrimination implies a higher fiscal burden of amnesty through two channels. Firstly, the additional transfers perceived by illegal workers are more important and secondly the loss for capital holders, which is reflected in the value added tax revenue, is higher. Note that in the absence of wage discrimination (with \(\gamma = 1\)), the second effect dissipates and the income tax rate only evolves due to the regularized workers’ net fiscal effect.

Using expression (10), it can be shown that a decrease in the income tax rate is a necessary condition for the legal workers to benefit from the regularization, given that the interest rate decreases unambiguously (see equation (12)).

**Proposition 2.** A regularization has a positive impact on a \(j\)-type legal worker’s intertemporal utility if and only if the amnesty leads to an increase in net income (e.g. a decrease in the income tax rate (see equation (17)) which is high enough to compensate for the lower interest rate).
\[ \Delta \tau_T < \frac{\psi_{j,ss}}{w_{j,ss}} \frac{\beta}{1+\beta} \frac{\Delta R_{T+1}}{R_{ss}} \]  \hspace{1cm} (18)

Proof. The expression is obtained by substituting equation (13) in a first order Taylor approximation of equation (10).

Note that retired agents face an unambiguous decrease in their utility, given that they receive a lower return on their savings. They are not concerned by a change in the income tax rate and the interest rate is the only channel through which their utility is affected. Thus, when \( \gamma < 1 \), an income redistribution occurs from the old to the young generation through the higher wages paid to the legalized workers in exchange of a lower profit perceived by capital owners. Workers on the other hand might benefit from a lower income tax rate, which can compensate the lower interest rate perceived at retirement. Finally, the aggregate disposable income in the economy is certain to increase (see equation (16)). Given that savings are a constant fraction of the aggregate disposable income, capital accumulates in the long run which triggers new dynamics in the model (see section 3.3).

3.2 Short run effects with a shock on the population

This section discusses the consequences of a migration policy (affecting the population size) on a \( j \)-type agent’s intertemporal utility (see equation (10)). A shock on the population size and structure has an impact on the wage rates (represented by \( \Delta w_{j,T} = w_{j,T} - w_{j,ss} \)) even though the capital stock remains constant in the short run. Two scenarios changing population size are considered: deportation, when a fraction \( \delta > \epsilon \) (while \( \eta \) might take any value as long as \( \eta + \delta \leq 1 \)) of the illegal workers are caught and expelled and new low-educated immigration, where \( \epsilon > \delta = 0 \) and \( 1 \geq \eta \geq 0 \). In order to contrast these scenarios with the benchmark case, it is necessary to reconsider the previous section’s results. More specifically, wages are no longer constant when population size varies and the change in the regularized agents’ disposable income is given by:

\[ \Delta \psi_{i,T} = (1 - \tau_T - \gamma)w_{m,T} + \gamma \Delta w_{m,T} + (1 - \Theta)g. \]

For the legalized workers, the effects of a policy shock are reflected by a change in the wage and the net transfers perceived. The legalized worker’s wage depends on two factors: the impact on the marginal productivity, which is common to all workers, and the potential suppression of wage discrimination (if \( \gamma < 1 \)).

Assumption 1. If \( \frac{1}{\sigma_n} < \alpha < \frac{1}{\sigma_h} \) low-educated workers’ wage rates decrease with the size of the foreign workforce \( (M_t + I_t) \) while the high-educated wage rate increases (see Appendix A):

\[ \frac{\partial w_{n,t}}{\partial (M_t + I_t)} < 0; \quad \frac{\partial w_{m,t}}{\partial (M_t + I_t)} < 0; \quad \frac{\partial w_{h,t}}{\partial (M_t + I_t)} > 0. \]
The remaining $j$-type agents (for $j \neq i^L$) face a change in disposable income depending on the migration policy’s impact on the income tax rate and on the wage rate (captured by an additional term compared to (13))

$$\Delta \psi_{j,T} = (1 - \tau_T)\Delta w_{j,T} - \Delta \tau_T w_{j,T}.$$ 

**Proposition 3.** A migration policy changing the population structure (deportation or immigration) has a positive impact on a $j$-type legal worker’s intertemporal utility if and only if it leads to an increase in net income (e.g. a decrease in the income tax rate (see equation (17)) sufficiently strong to compensate for a potentially lower interest rate and/or wage rate):

$$\Delta \tau_T < \frac{\psi_{j,ss} \beta (1 - \tau_T)\Delta w_{T}}{w_{j,ss} R_{ss}} + \frac{(1 - \tau_T)\Delta w_{T}}{w_{j,ss}}.$$  \hspace{1cm} (19)

Given the predetermined capital stock, the return factor is affected by ambiguous effects:

$$\Delta R_T = \frac{\Pi_T - \Pi_{ss}}{K_T} = \frac{\alpha(Y_T - Y_{ss}) + (1 - \gamma)\Omega_{ss}[\Delta w_{m,T} - (\eta + \delta)w_{m,T}]}{K_T}.$$ \hspace{1cm} (20)

Compared to equation (12), the first term in the numerator captures the effect on total production due to the change in the number of workers. The second term captures the change in benefits made with the illegal workforce. Rearranging, it can be shown that the latter is positive if

$$w_{m,ss} < 1 - \eta - \delta$$

and negative otherwise. The benchmark expression (12) is recovered when the population structure is unaffected (with $\eta > \delta = \epsilon=0$, production and wages are constant).

In the presence of a population size effect, the income tax rate changes with:

$$\Delta \tau_T = \frac{g(\epsilon M_{ss} + \eta I_{ss} - (\delta + \eta)\Theta_{ss}) - \tau_T \Delta W_T}{H w_{h,ss}} + \frac{\nu(\Delta C_T + \Delta D_T)}{N w_{n,ss} + M w_{m,ss}}.$$  \hspace{1cm} (21)

In contrast to equation (14), the change in the taxable income base is accounted for by $\Delta W_T$ (with $\Delta W_T = H_{ss}\Delta w_{h,T} + N_{ss}\Delta w_{n,T} + M_{ss}\Delta w_{m,T} + (\epsilon M_{ss} + \eta I_{ss})w_{m,T}$). Moreover, the first term in the numerator has to be readjusted to capture the change in the composition of the population entitled to transfers. Further conclusions depend particularly on the evolution of the efficient labor units, $Q_T$, and thereby on the scenario considered. However, it is clear that a larger taxable income base (with $\Delta W_T > 0$) reduces the income tax rate.

### 3.2.1 The case of deportation

The deportation\footnote{Note that no cost is incurred to search for and expel illegal immigrants and, in that case, the latter keep a utility $U_0$ which is lower than the utility of remaining in the country. Without loss of generality, $U_0$ can be set to 0.} of a fraction $\delta$ of the illegal workers decreases labor in efficient units, $Q_T$. This implies, under assumption (1), a decrease (increase) in the high-educated (low-educated) workers’ wage rate(s). For the less educated workers, the decrease in efficient
labor is compensated by a higher marginal productivity due to the lower number of close substitutes on the labor market. The income tax rate is affected by a potentially lower additional burden on the public budget than in the benchmark case (illustrated by the first term in the numerator of equation (21)). In particular, this is verified if it is assumed that no illegal immigrants are regularized but some are deported (e.g. \( \eta = 0 \) and \( \delta > 0 \)). A priori, nothing allows to discuss the variation in taxable income \( \Delta W_T \) and total consumption reflected in the third term of equation (21).

The interest factor decreases and even more so than in the case of an amnesty due to the negative effect of deportation on production. The first term in the numerator of equation (20) is negative, as production increases with efficient labor. The sign of the second term depends on the population structure but can be shown to be negative in the case of full deportation \( (\delta=1) \). Thus, if all the illegal workers are expelled, profits are lower than in the case of an amnesty. Capital holders are therefore particularly harmed by a deportation of illegal workers. The policy’s effect on a \( j \)-type worker’s intertemporal utility is however not clear. The outcome depends on the population structure and the combination of wage and fiscal effects. Numerical examples are provided in section 4 to allow for clearer insights.

3.2.2 The case of new legal immigration

The case of new immigration with \( \epsilon > \eta=\delta=0 \) implies a positive shock on the size of the legal foreign low-educated workforce (while the number of illegal workers remains unchanged). The efficient labor increases and, under assumption (1), a positive (negative) effect is observed on the high-educated (low-educated) wage rate(s).

The interest factor in this scenario increases, given that the rise in the production is higher than the profit loss in the use of illegal workers (the first term in (20) dominates the second). The latter is due the decrease in the illegal workers’ marginal productivity, caused by a higher number of perfect substitutes on the labor market. The old generation living in the period of the immigration shock is better off in the case of new legal immigration, which contrasts with the decrease in utility observed in the case of an amnesty.

The effect on the income tax rate is again ambiguous due to the new immigrants’ access to complete transfers but simultaneous contribution through taxation. The additional burden on the public budget is higher than in the benchmark, given that the formerly illegal workers were already perceiving part of the transfers. The effect on total consumption is ambiguous and it is not clear whether the taxable income base increases more than in the case of an amnesty which depends on the skill repartition of the population (see section 4 for numerical examples).

3.3 Long run effects

Any of the shocks considered in the previous subsections is by assumption a one-time shock (“one-shot” policy) and no further changes in the population occur after the
shock. Thus, the long run effects in any of the three scenarios depend solely on the capital dynamics caused by the policy. The difference in the intertemporal utility of two subsequent generations is therefore exclusively due to the different capital levels and its implications (on income and taxation).

In the post-shock periods the disposable income of a $j$-type agent adjusts compared to the previous generation:

$$\Delta \psi_{j,T+p} = (1 - \tau_{T+p}) \Delta w_{j,T+p} - \Delta \tau_{T+p} w_{j,T+p-1} \quad \text{with} \ p \geq 2 \quad (22)$$

The change in the wage rate (the interest factor) is positively (negatively) correlated to the evolution of the capital level, given the constant population assumption. In the benchmark amnesty scenario, capital was shown to increase in equation (16), leading to a higher gross wage and a lower interest factor for the following generations. The effect on the tax rate however remains ambiguous. Even if gross wages increase, the old generation faces a lower interest factor such that the evolution of their consumption remains uncertain:

$$\Delta D_{T+p} = \frac{\Delta R_{T+p} S_{T+p-1} + R_{T+p-1} \Delta S_{T+p}}{1 + v} \quad (23)$$

Consequently, the change in the income tax rate remains ambiguous (see Appendix B.5):

$$\Delta \tau_{T+p} = -\frac{v(\Delta C_{T+p} + \Delta D_{T+p}) + \tau_{T+p-1} \Delta W_{T+p}}{W_{T+p}}$$

The income tax rate decreases if the taxable income base increases and the rise in the young generation’s consumption outweighs the potential decrease in the old generation’s consumption. The evolution of a $j$-type agent’s disposable income (given by equation (22)) is therefore undetermined.

### 4 Simulations

The combination of the multiple effects presented in section 3 impedes a clear analytical analysis of the different policies’ welfare impacts on the agents’ utility. Therefore, this section provides a series of numerical simulations in order to illustrate the theoretical results. One period is assumed to last 30 years. The discount factor is $\beta = 0.3$ (which amounts to a quarterly discount factor of 0.99) and the capital’s share of output, $\alpha$, is set to 0.3 as it is common in the literature. The data used was gathered from OECD datasets and the reference year is 2002 due to restrictions on data availability (in particular for relative wages and the distribution of immigrant’s educational attainments).

---

23 Given the constant population structure, the labor market discrimination faced by illegal workers (the value of $\gamma$) does not influence the results after period $T$. 

The workforce size is estimated by OECD’s labor force data (OECD, 2010a) which distinguishes agents by origin and educational attainment. The estimates for the illegal workers are taken from the report of Kovacheva and Vogel (2009b). A value between the extrema shown in Table 1 is taken for the UK while in the case of Germany, a recent downward correction suggests that the number of illegal workers is well below the maximum reported in Table 1 (Kovacheva and Vogel, 2009a). The number of illegal workers is varied in section 4.3 in order to highlight its impact.

The elasticities of substitution used are those provided by the literature. The estimates for \( \sigma_H \) range from 1.3 (Borjas, 2003) and 1.5 (Katz and Murphy, 1992) to 2 (Angrist, 1995). Similarly, the substitutability between native and foreign agents belonging to the same group is largely debated in the literature. Depending on the assumptions and data used, values ranging from 6 (Manacorda et al., 2008) over 20 (Ottaviano and Peri, 2012; Card, 2009 for the US and D’Amuri et al., 2010 for Germany) to infinity (Borjas et al., 2008) are found. Our benchmark estimation is done with the intermediary values for the elasticities with respectively \( \sigma_H = 1.5 \) and \( \sigma_N = 20 \), as a high but imperfect substitutability seems to better fit the European (and particularly the German) labor market.

The relative productivity parameters for highly educated agents (\( \theta_h \)) and native low-educated (\( \theta_n \)) are calibrated in order to replicate the tertiary education wage premia of male workers (of 46.3 % in Germany and 62.9 % in the UK) provided by Strauss and de la Maisonneuve (2007). Simultaneously, we consider the existence of a small wage premium for citizenship in order to take into account easier labor market access due to language proficiency and better adaptation to the labor market conditions. The resulting values for Germany (\( \theta_{DH} = 0.41; \theta_{DN} = 0.53 \)) allow a citizenship premia of 6 % while the parameters (\( \theta_{UK}^{DH} = 0.439; \theta_{UK}^{DN} = 0.54 \)) yield a premia of 4.8 % in the UK. Economic data for the year 2002, like the gross domestic product, is obtained from OECD (2011). Total tax revenue provided by OECD (2010d) is used as proxy for the governmental expenditures. Public funds are either distributed under the form of transfers or used for structural spending, which does not directly affect the agents’ income and utility. A generous transfer system implies a lower structural expenditure (in percentage terms).

The constant per capita transfer is assessed by using data from OECD (2010b) on the total social spending as percentage of GDP (\( \phi \)) and is thus written:

\[
g_t = \frac{\phi Y_t}{H_t + M_t + N_t + \Theta I_t} \tag{24}
\]

The value added tax rate is calculated in order to proxy tax income on goods and services (in % of GDP) provided by OECD (2010c). The value added tax rates obtained are

\[24\]The educated agents are those classified as LIS5/6 in OECD datasets, which represents tertiary education. Workers for which the education level is known but not the citizenship are counted as immigrants. Given the structure of the OLG-model, the population size at period \( t \) is equal to the sum of the workforce and the old generation, born one period earlier. The total population is thus assumed to have the same skill-structure as the workforce.

\[25\]For workers without tertiary education in Germany, Brückler and Jahn (2011) estimate the elasticity of substitution between 3 and 18 depending on the education level considered while Felbermayr et al. (2008) find values ranging from 7 to 28.
13.6% and 16.2% for Germany and the UK respectively. Finally, the income tax rate is set to maintain the budget equilibrium. It is therefore expected to exceed the rates observed in reality given that the model abstracts from capital taxation and does not include public debt. As shown in Table 2, the resulting values are 36.79% for Germany and 33.76% for the United Kingdom.

Two further important parameters are the wage discrimination and the illegal workers’ access to public transfers. The first is set to γ = 0.726. In order to reflect the idea that illegal immigrants impose a cost on the budget, Θ = 0.3 is used.

As discussed in the theoretical section, the extent of status discrimination, and in particular the proportion of transfers to which an illegal agent qualifies for, are of crucial importance. The latter is hardly quantifiable as, by definition, illegal immigrants are in general not entitled to public support. Nevertheless, in many western countries several exceptions exist like urgent medical care provision or children’s school enrollment. However, some countries like Germany impose their public workers to report any information about illegal immigrants that would occur to them, whereas this is not the case in Belgium or France (PICUM, 2011). This kind of regulation is very likely to discourage illegal immigrants from applying for public support. In order to highlight its impact, the extent of support availability is varied in section 4.3.

In the benchmark case it is assumed that all the countries regularize 100% of their illegal workers (η = 1; δ = ϵ = 0). Even though a hundred percent legalization rate is never observed in reality (Levinson, 2005), this scenario allows to highlight the potential upper bound effects of an amnesty. Table 2 summarizes the countries’ characteristics and the model’s prediction.

[Insert Table 2 here]

4.1 The effects of an amnesty on the native population

In the following section, the elasticities of substitution considered are σ_H = 1.5 and σ_N = 20. In section 4.3 the sensitivity of the results to these parameters is assessed. Figure 1 shows the evolution of the utility, normalized to a constant lifetime consumption. More specifically, utility is monetarized by computing the constant amount of consumption z_t that generates the lifetime utility level $U^t$ for each $j$-type agent born in period $t$:

$$U^t = ln(z) + βln(z)$$

$$z = exp^{U^t}$$

In the literature, which often focuses on the United States, the estimation of wage functions for legalized and legal foreign-born population permits to extract the role of the legal status in the wage formation. Kossondj and Cobb-Clark (2002) estimate, from panel data on legalized immigrants, a wage penalty of 14% to 24% for undocumented workers due to their status. Taking into account national origins, Borjas and Tienda (1993) find that the legal workers earn up to 30% higher wages in similar positions while this figure rises to 41.8% in Rivera-Batiz (1999).

Further details and country specific analysis of illegal immigrants’ basic rights are provided on the web page of the Platform For International Cooperation On Undocumented Migrants (PICUM, 2011).
and is normalized to an index 100 for the steady state value (e.g. an agent born and retired in a steady state regime).

In general, an amnesty has limited effects on the native population, with the variation of lifetime consumption remaining between -0.3 % and +0.1 % and -0.5 % and 0 % for the UK and Germany respectively. Independently of the country considered and the agent’s education level, the old generation living at the period of the shock (which is the generation born in ss) suffers a welfare loss due to the lower interest factor (see equation (12)). However, a difference is observed for the agents born in period \( T \). In the UK, their utility is slightly higher than the previous generation’s because the positive contribution of the regularized agents to the public budget partially compensates the lower interest factor that the amnesty causes. In Germany, this does not occur and the utility of the agents born in period \( T \) is lower than their predecessors’. At the new equilibrium, native agents are better off in the UK while German natives have a welfare level around 0.1 % to 0.2 % below the initial steady state.

It can be seen that an amnesty decreases the income tax rate in both countries by close to 0.3 percentage points (pp.) (see Figure 2). Thus, the regularized agents reduce the tax burden on native agents in the given examples. Nevertheless, this positive effect on the tax rate is not enough to compensate for the lower return on savings in Germany such that native agents still suffer from a slightly lower utility (as shown in Figure 1). The conclusions for the high-and low-educated agents are quite similar, although the effects on the former are more pronounced. A possible explanation is that the high-educated agents perceive higher wages and thus benefit from a stronger disposable income increase when the (agent-type independent) income tax rate falls.

4.2 Amnesty versus new immigration and deportation

The effects of a regularization are contrasted with the scenarios of new legal immigration and deportation of low-educated workers. The cases of Germany and the UK are represented in Figure 3. The change in the total number of workers at time \( T \) constitutes the difference between the benchmark model and these two extensions. The shocks considered are of the same magnitude, in order to improve comparability. In the deportation case, it is assumed that the whole illegal population is expelled (with \( \eta=\epsilon=0 \) and \( \delta=1 \)). In the immigration case, the illegal workforce remains constant and the legal immigrant workforce is increased by the size of the illegal workforce with \( \delta=\eta=0 \) and \( \epsilon=F \).

In both countries, the three different policies generate similar trends in the short run. Introducing deportation decreases the size of the workforce which increases the wages paid to low-educated workers and simultaneously reduces the wages of the high-educated agents. The profit decreases more than in the benchmark case, such that the shock on the interest factor is stronger than with amnesty (as expected from equation (20)). The contraction of the workforce outweighs the increase in the low-education wage rates and
the potential decrease in the income tax rate in both countries. Thus, the low-educated agents are worse off at the new steady state.

In contrast, an immigration inflow pushes up the profit and the interest factor, which benefits the capital holders in period $T$ (e.g. individuals born in $ss$). However, the wages paid to the low-educated workers decrease due to the additional competition on the labor market such that the generation born in $T$ is harmed. In the long run, capital accumulation induced by the new immigrants leads to a higher steady-state utility level for natives in the UK while in Germany the welfare is below the starting value. Overall, the three shocks have effects of low magnitude.

4.3 Sensitivity analysis

Figure 4 depicts how changing various key parameters of the model affects the results for German low-educated natives. This allows to capture the role played individually by each parameter. Panel 4a shows the importance of illegal immigrants’ (pre-amnesty) social transfer access. As mentioned previously, the higher is availability of public support prior to legal status, the lower will be the effects of regularization given the lower additional fiscal burden but higher taxable income base. If illegal workers were to receive only 1% of the transfers prior to regularization, the low-educated natives would lose at most 1.6% of their welfare with regularization. The role of wage discrimination is shown in panel 4b. In the absence of wage discrimination (with $\gamma = 1$), amnesty has a pure fiscal effect by reducing the labor income tax rate and hardly changes the natives’ welfare. On the other hand, high wage discrimination leads to a higher profit contraction (and thus a higher shock on the interest factor). In the long run, capital accumulation is intensified given a higher increase of the total income. Even in the presence of high discrimination, the low-educated natives’ utility is therefore reduced by less than 0.5% at the new steady state.

Panel 4c highlights the effects of amnesty for different values of transfers (expressed as % of GDP). The 0% line shows the case where no public funds are transferred to the agents while 35.4% captures the case where the whole public budget is redistributed to the agents. In the latter case, the new steady state utility is close to 0.5% below the initial value. On the other hand, if the whole budget is spent on public consumption (and does not enter the utility function of a representative agent), the natives benefit from the amnesty as each regularized immigrant pays a positive contribution to the budget (given that structural expenses are constant). Panel 4d indicates that a higher value added tax rate leads to a slightly worse effect on the native’s utility. The illegal immigrants already pay the value added tax on their consumption ex-ante. The higher is the tax rate, the lower is their additional marginal contribution after regularization. Panel 4e shows how the results change if the number of illegal workers present in the economy varies. As the intuition would suggest, a low number of illegal workers (100,000 in our example) reduces the effects. On the other hand, if the number of illegal workers is doubled (up to 2,000,000), the welfare loss amounts to at most 0.3% at the new steady state.
state. Nevertheless, the old generation living at the time of amnesty suffers a welfare decrease close to 0.8% of the initial steady state.

The last panel (4f) uses different values for the elasticities of substitution found in the literature (see Table 2 in Docquier et al. (2010)). The benchmark choice \( (\sigma_H = 1.5, \sigma_N = 6) \) is contrasted to a high complementary case \( (\sigma_H = 2, \sigma_N = 6) \) and a high substitutability case \( (\sigma_H = 1.3, \sigma_N = +\infty) \)\(^{28}\). The substitutability between native and foreign workers \( (\sigma_N) \) is of particular importance. High- and low-educated workers remain highly complementary \( (\text{with } \sigma_H \in [1.3, 2]) \), whereas the substitutability among low-educated groups is considered more dispersedly \( (\text{with } \sigma_N \in [6, +\infty]) \). It is thus not surprising that the change in \( \sigma_N \) accounts for most part of the variability observed in Figure 4f. In the examples provided, the immigrants’ wage rate decreases with native-foreign substitutability (see Appendix C for detailed results). The intuition behind this suggests that with a higher substitutability, a change in the low-educated workforce has a stronger short run impact on the wages.

5 Conclusion

Discarding from displacement effects on the labor market and assuming that illegal immigrants bear a certain cost on the government’s budget (without contributing through income taxation), an amnesty leads to a decrease in capital owners’ welfare through a reduction in the return to investment. The effect on the public budget depends on the net contribution of the legalized agents. The crucial question is whether a potentially lower income tax rate is strong enough to compensate for lower returns on savings. Furthermore, the model predicts that, in general, consequences remain quite limited. In particular, comparing the amnesty to an inflow of legal immigrants allows to show that legalization has quantitatively lower effects than immigration. Additionally, under the studied framework, a decrease in the total workforce, due to the deportation of illegal workers, is likely to harm native individuals. Moreover, the more native and foreign workers are complementary, the more likely an amnesty can benefit the former. Concluding, the model highlights the trade-off between harming capital-owners in the short run and potentially increasing native agents’ welfare in the long run. The outcome depends particularly on the structure of the population, the economic role of the government and the discrimination level that illegal immigrants face prior to the regularization.

\(^{28}\)Note that all the estimates for the elasticities of substitution and their combination respect assumption (1).
References


OECD (2006). International Migration Outlook. SOPEMI.

— (2008). Management of Low-Skilled Labour Migration. SOPEMI.


**Figure 1:** Effect of an amnesty on the normalized constant lifetime consumption of a low-and high-educated native agent born in period $t$ in the United Kingdom (a) and Germany (b). The amnesty occurs at time $T$ and the reference steady state utility belongs to the generation born in period $T - 2$.  

(a) Results for the United Kingdom  
(b) Results for Germany

**Figure 2:** Evolution of the income tax rate ($\tau$), with amnesty occurring in $T$  

(a) Results for the United Kingdom  
(b) Results for Germany
Figure 3: Comparison of an amnesty with new immigration and deportation on the normalized constant lifetime consumption of a low-educated native agent born in period \( t \) (the policy shock occurs at time \( T \)).

(a) Results for the United Kingdom

(b) Results for Germany
Figure 4: Sensitivity of a German low-educated native’s (born in period $t$) welfare to a change in different parameters with amnesty occurring at time $T$

(a) Change in $\Theta$

(b) Change in $\gamma$

(c) Change in social transfers (as % of GDP)

(d) Change in VAT rate

(e) Change in the number of illegal workers

(f) Change in $\sigma$
Table 1: Illegal immigration (estimates for the year 2002) in EU15 countries (% of total immigrants)

<table>
<thead>
<tr>
<th>Country</th>
<th>minimum estimates</th>
<th>maximum estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU15</td>
<td>3059095 (14.5)</td>
<td>5310889 (25.2)</td>
</tr>
<tr>
<td>Austria</td>
<td>29660 (4)</td>
<td>86964 (11.9)</td>
</tr>
<tr>
<td>Belgium</td>
<td>90000 (10.6)</td>
<td>150000 (17.7)</td>
</tr>
<tr>
<td>Denmark</td>
<td>1000 (0.4)</td>
<td>5000 (1.9)</td>
</tr>
<tr>
<td>Finland</td>
<td>8000 (8.1)</td>
<td>12000 (12.2)</td>
</tr>
<tr>
<td>France</td>
<td>3000000 (9.2)</td>
<td>5000000 (15.3)</td>
</tr>
<tr>
<td>Germany</td>
<td>1000000 (13.7)</td>
<td>15000000 (20.5)</td>
</tr>
<tr>
<td>Greece</td>
<td>3200000 (42)</td>
<td>4800000 (63)</td>
</tr>
<tr>
<td>Ireland</td>
<td>20416 (10.9)</td>
<td>37538 (20)</td>
</tr>
<tr>
<td>Italy</td>
<td>702156 (52.6)</td>
<td>10000000 (74.9)</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>2143 (1.3)</td>
<td>4959 (2.9)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>77721 (11.3)</td>
<td>179876 (26)</td>
</tr>
<tr>
<td>Portugal</td>
<td>40000 (17.8)</td>
<td>200000 (88.9)</td>
</tr>
<tr>
<td>Spain</td>
<td>150000 (7.6)</td>
<td>572551 (29)</td>
</tr>
<tr>
<td>Sweden</td>
<td>8000 (1.7)</td>
<td>12000 (2.5)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>310000 (11.2)</td>
<td>5700000 (20.7)</td>
</tr>
</tbody>
</table>

Source: Kovacheva and Vogel (2009b)
Table 2: Data used in the model

<table>
<thead>
<tr>
<th>Country</th>
<th>Germany</th>
<th>U.K.</th>
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<tbody>
<tr>
<td>GDP (billion $)</td>
<td>2275.4</td>
<td>1713.7</td>
</tr>
<tr>
<td>High-educated Workers</td>
<td>8708855</td>
<td>6629768</td>
</tr>
<tr>
<td>Low-educated Natives</td>
<td>21300623</td>
<td>18583598</td>
</tr>
<tr>
<td>Low-educated Immigrants</td>
<td>5133470</td>
<td>1477352</td>
</tr>
<tr>
<td>Illegal immigrants</td>
<td>1000000</td>
<td>430000</td>
</tr>
<tr>
<td>Size of the government tax revenue (% of GDP)</td>
<td>35.4</td>
<td>34.6</td>
</tr>
<tr>
<td>Social spending (% of GDP)</td>
<td>27.4</td>
<td>19.4</td>
</tr>
<tr>
<td>Wage premia [Strauss et al. 2007] (in %)</td>
<td>46.24 [46.3]</td>
<td>62.86 [62.9]</td>
</tr>
<tr>
<td>Value added tax rate (in %)</td>
<td>13.6</td>
<td>16.2</td>
</tr>
</tbody>
</table>

*Values for 2001; Sources: Kovacheva and Vogel (2009b), OECD (2007; 2010a,b,c,d; 2011), Strauss and de la Maisonneuve (2007)*

Appendix

A  Effect of a population shock on the wage rates

In order to analyze the consequences of the change in the number of foreign workers on the wage rates consider first the following results:

\[
\frac{\partial Q_l}{\partial (M+I)} = (1 - \theta_n)Q_l^{\frac{1}{\sigma_N}} (M_t + I_t)^{\frac{1}{\sigma_N}}
\]

\[
\frac{\partial Q}{\partial (M+I)} = (1 - \theta_h)Q^{\frac{1}{\sigma_H}} Q_l^{\frac{1}{\sigma_H}} \frac{\partial Q_l}{\partial (M+I)}
\]

These results allow to conclude the following impact on the wage rates:

\[
\frac{\partial w_h}{\partial (M+I)} = (1 - \alpha) \left( \frac{1}{\sigma_H} - \alpha \right) \theta_h AK^\alpha Q_h^{\frac{1}{\sigma_H}} Q_l^{\frac{1}{\sigma_H}} \alpha - 1 \frac{\partial Q}{\partial (M+I)}
\]

and thus \( \text{sign} \left( \frac{\partial w_h}{\partial (M+I)} \right) = \text{sign} \left( \frac{\partial Q}{\partial (M+I)} \right) \). The population shock changes the wage of a national low-educated agent as follows:

\[
\frac{\partial w_n}{\partial (M+I)} = Z_1 \left[ \left( \frac{1}{\sigma_H} - \alpha \right) Q_l \frac{\partial Q}{\partial (M+I)} + Q \left( \frac{1}{\sigma_N} - \frac{1}{\sigma_H} \right) \frac{\partial Q_l}{\partial (M+I)} \right]
\]

\[
= Z_1 Q^{\frac{1}{\sigma_N}} \frac{\partial Q_l}{\partial (M+I)} \left[ \left( \frac{1}{\sigma_H} - \alpha \right) (1 - \theta_h) Q_l^{\frac{\sigma_H - 1}{\sigma_H}} + Q^{\sigma_H - 1} \left( \frac{1}{\sigma_N} - \frac{1}{\sigma_H} \right) \right]
\]
obtained using (26) and with \( Z_1 = (1 - \alpha)(1 - \theta_h)\theta_n AK^{\alpha}N^{\frac{1}{\alphaN}} Q^{\frac{1}{\alphah} - \alpha - 1} Q^{\frac{1}{\alphaN} - \frac{1}{\alphaH} - 1} \).

Substituting for \( Q^{\frac{1}{\alphah} - 1} \) and using \( Z_2 = Q^{\frac{1}{\alphah}} Z_1 \):

\[
\frac{\partial w_n}{\partial(M + I)} = Z_2 \frac{\partial Q_l}{\partial(M + I)} \\
= Z_2 \frac{1}{\sigma_N} Q^{\frac{1}{\alphah} - 1} Q_l \\
= Z_2 \frac{1}{\sigma_N} Q^{\frac{1}{\alphah} - 1} Q_l \left(1 - \theta_h\right) Q_t^{\frac{1}{\alphah} - 1} \left(1 - \sigma_N\right) + \theta_h Q_h^{\frac{1}{\alphah} - 1} \left(1 - \sigma_N\right) - \frac{1}{\sigma_H}
\]

where \( Z_2 > 0 \) and the second multiplier is negative given that the possible parameterizations in this paper always lead to \( \frac{1}{\sigma_N} < \alpha \) and \( \frac{1}{\sigma_N} < \frac{1}{\sigma_H} \). Therefore, \( \text{sign}\left(\frac{\partial w_n}{\partial(M + I)}\right) = -\text{sign}\left(\frac{\partial Q_l}{\partial(M + I)}\right) \). Similarly, for a legal immigrant worker:

\[
\frac{\partial w_m}{\partial(M + I)} = Z_3 \frac{\partial Q_l}{\partial(M + I)} \\
= Z_3 \frac{1}{\sigma_N} Q^{\frac{1}{\alphah} - 1} Q_l \\
= Z_3 \frac{1}{\sigma_N} Q^{\frac{1}{\alphah} - 1} Q_l \left(1 - \theta_h\right) Q_t^{\frac{1}{\alphah} - 1} \left(1 - \sigma_N\right) + \theta_h Q_h^{\frac{1}{\alphah} - 1} \left(1 - \sigma_N\right) - \frac{1}{\sigma_H}
\]

with \( Z_3 = (1 - \alpha)(1 - \theta_h)(1 - \theta_n) AK^{\alpha}Q^{\frac{2}{\alphah} - \alpha - 1} Q_t^{\frac{1}{\alphaN} - \frac{1}{\alphaH} - 1} (M + I)^{\frac{1}{\alphaN} > 0} \). Then using (25), it is possible to obtain:

\[
\frac{\partial w_m}{\partial(M + I)} = Z_3 \left(\frac{Q_l}{M + I}\right)^{\frac{1}{\alphaN}} \left\{-\frac{1}{\sigma_N} Q^{\frac{1}{\alphah} - 1} Q_t \left(1 - \sigma_N\right) + \theta_h Q_h^{\frac{1}{\alphah} - 1} \left(1 - \sigma_N\right)\right\}
\]

Given the chosen parameter range, the multiplier in brackets is always negative such that \( \frac{\partial w_m}{\partial(M + I)} < 0 \). If the number of immigrant workers increases, the wage rate paid to the foreign workforce thus decreases while the inverse holds in the case of deportation.

\[ \text{B Effects of a policy shock} \]

In this section the calculations of a policy’s different consequences are provided. Suppose the amnesty occurs in period \( T \) while the steady state is in \( T - 1 \).
B.1 Impact on the interest factor

In the short run capital stock is fixed at \( K_t \). Thus:

\[
R_T - R_{T-1} = \frac{\Pi_T - \Pi_{T-1}}{K_{T-1}}
\]

\[
= \frac{\alpha(Y_T - Y_{T-1}) + (1 - \gamma)(1 - \delta - \eta)I_{T-1}w_{m,T} - (1 - \gamma)I_{T-1}w_{m,T-1}}{K_{T-1}}
\]

\[
= \frac{\alpha(Y_T - Y_{T-1}) + (1 - \gamma)I_{T-1}(\Delta w_m - (\eta + \delta)w_{m,T})}{K_{T-1}}
\]

which in the benchmark case with \( \eta > \delta = 0 \) and no shock on the population size becomes:

\[
\Delta R_T = \frac{-(1 - \gamma)\eta I_T w_{m,T}}{K_T}
\]

B.2 Variation in disposable income

Aggregate disposable income before and after a shock writes:

\[
\Psi_{T-1} = (1 - \tau_{T-1})(H_{T-1} w_{h,T-1} + N_{T-1} w_{n,T-1} + M_{T-1} w_{m,T-1})
+ I_{T-1} \gamma w_{m,T-1} + g(H_{T-1} + M_{T-1} + N_{T-1} + \Theta I_{T-1})
\]

\[
\Psi_T = (1 - \tau_T)(H_{T-1} w_{h,T} + N_{T-1} w_{n,T} + (M_{T-1}(1 + \epsilon) + \eta I_{T-1}) w_{m,T})
+ I_{T-1} \gamma (1 - \delta - \eta) w_{m,T}
+ g(H_{T-1} + M_{T-1}(1 + \epsilon) + N_{T-1} + \eta I_{T-1} + (1 - \delta - \eta) \Theta I_{T-1})
\]

Note that due to the constant population assumption we have \( M_T = M_{T-1}, \; N_T = N_{T-1} \) and \( H_{T-1} = H_T \). In order to simplify the notation, the time index on the variables representing population groups is dropped. Subtracting the former from the latter:

\[
\Delta \Psi = -\Delta \tau (H w_{h,T-1} + N w_{n,T-1} + M w_{m,T-1})
+ \tau_T (H w_{h,T-1} + N w_{n,T-1} + M w_{m,T-1})
(1 - \tau_T)(H w_{h,T} + N w_{n,T} + (M(1 + \epsilon) + \eta I) w_{m,T})
- (H w_{h,T-1} + N w_{n,T-1} + M w_{m,T-1})
+ I_{T-1} \gamma (1 - \delta - \eta) w_{m,T} - I_{T-1} \gamma w_{m,T-1}
+ g(H + M(1 + \epsilon) + N + I(\eta + (1 - \eta \delta) \Theta)) - g(H + M + N + \Theta I)
\]

\[
= -\Delta \tau (H w_{h,T-1} + N w_{n,T-1} + M w_{m,T-1})
+ (1 - \tau_T) [H(w_{h,T} - w_{h,T-1}) + N(w_{n,T} - w_{n,T-1}) + M(w_{m,T} - w_{m,T-1})
+(\epsilon M + \eta I) w_{m,T}] + I \gamma (w_{m,T} - w_{m,T-1} - (\delta + \eta) w_{m,T})
+ g[\epsilon M + I(\eta - \Theta(\delta + \eta))]
\]

\[
=(1 - \tau_T) \Delta W + I \gamma (\Delta w_m - (\delta + \eta) w_{m,T}) + g[\epsilon M + I(\eta - \Theta(\delta + \eta))]
- \Delta \tau (H w_{h,T-1} + N w_{n,T-1} + M w_{m,T-1})
\]
In the benchmark case, with \( \eta > \delta = \epsilon = 0 \) and unchanged population structure this becomes:

\[
\Delta \Psi = ((1 - \tau_T - \gamma)w_{m,T} + g(1 - \Theta))\eta I - \Delta \tau(Hw_{h,T-1} + Nw_{n,T-1} + Mw_{m,T-1}) \quad (28)
\]

### B.3 Variation in total consumption

Total consumption is denoted \( C + D \) and \( S_t \) is the total savings of the generation born in \( t \).

\[
\Delta C + \Delta D = C_T - C_{T-1} + D_T - D_{T-1}
\]

\[
\Delta C = \frac{\Delta \Psi}{(1 + \beta)(1 + v)}
\]

\[
\Delta D = \frac{(R_T S_{T-1} - R S_{T-2})}{1 + v} = \frac{(\Delta R S_{T-1} + R(S_{T-1} - S_{T-2}))}{1 + v} = \frac{\Delta R S_{T-1} + R \Delta S}{1 + v}
\]

In the short run, \( \Delta S = 0 \) as capital is given by the agents’ savings although in the long run, it might no longer be the case. Thus, the short term effect of a shock on total consumption is:

\[
\Delta C + \Delta D = \frac{\Delta \Psi}{(1 + \beta)(1 + v)} + \frac{\Delta R S_{T-1}}{1 + v}
\]

In the case of amnesty and using the previous results:

\[
\Delta C + \Delta D = \frac{\eta I((1 - \tau_T - \gamma)w_{m,T-1} + g(1 - \Theta)) - \Delta \tau(Hw_{h,T-1} + Nw_{n,T-1} + Mw_{m,T-1})}{(1 + \beta)(1 + v)} - \frac{\eta(1 - \gamma)Iw_{m,T-1}}{1 + v}
\]

### B.4 Variation in the income tax rate

The notation used implies that \( M_t = M_{t-1}, N_t = N_{t-1} \) and \( H_t = H_{t-1} \) such that time indexes can be left out on population variables for notational convenience. The budget constraint before and after a policy shock writes:

\[
\tau_{T-1}(Hw_{h,T-1} + Nw_{n,T-1} + Mw_{m,T-1}) = G + g(H + N + M + \Theta I) - v(C_{T-1} + D_{T-1})
\]

\[
\tau_T(Hw_{h,T} + Nw_{n,T} + (M(1 + \epsilon) + \eta I)w_{m,T}) = G + g(H + N + M(1 + \epsilon) + (\eta + (1 - \delta - \eta)\Theta)I) - v(C_T + D_T)
\]
Taking the difference of the former with the latter:

\[
\Delta \tau (H_{wh,T-1} + N w_{n,T-1} + M w_{m,T-1}) = \\
\quad = \tau_T (H_{wh,T-1} + N w_{n,T-1} + M w_{m,T-1}) \\
\quad \quad - \tau_T (H_{wh,T} + N w_{n,T} + (M(1+\epsilon) + \eta I) w_{m,T}) \\
\quad \quad + g(H + N + M(1+\epsilon) + (\eta + (1-\delta - \eta)\Theta)I) - v(C_T + D_T) \\
\quad \quad - (g(H + N + M + \Theta I) - v(C_{T-1} + D_{T-1})) \\
\quad \quad = g(\epsilon M + \eta I - (\delta + \eta)\Theta I) - v(C_T - C_{T-1} + D_T - D_{T-1}) \\
\quad \quad - \tau_T [H(w_{h,T} - w_{h,T-1}) + N(w_{n,T} - w_{n,T-1}) \\
\quad \quad + M(w_{m,T} - w_{m,T-1}) + (\epsilon M + \eta I)w_{m,T}],
\]

leads to the expression:

\[
\Delta \tau = \frac{g(\epsilon M + \eta I - (\delta + \eta)\Theta I) - \tau_T \Delta W - v(\Delta C + \Delta D)}{H w_{h,T-1} + N w_{n,T-1} + M w_{m,T-1}}
\]

\(\Delta W\) expresses the change in the taxable income base. In the benchmark, this is equivalent to \(\eta I w_{m,T-1}\), which is the sum of the legalized immigrants’ wages. Using the developments for \(\Delta W\) and \(\Delta C + \Delta D\) of the previous subsections and \(W_{T-1} = (H_{wh,T-1} + N w_{n,T-1} + M w_{m,T-1})\):

\[
\Delta \tau W_{T-1} = \\
\quad = \eta I (1-\Theta)g - \tau_T \eta I w_{m,T-1} - v \left(\frac{1}{(1+\beta)(1+v)} \Delta \Psi + \frac{\Delta RS_{T-1}}{1+v} \right)
\]

\[
= -\tau_T \eta I w_{m,T-1} + \eta I (1-\Theta)g - \frac{v(1-\gamma)I w_{m,T-1}}{1+v} \\
\quad - \frac{v}{(1+\beta)(1+v)} (\eta I ((1-\tau_T-\gamma)w_{m,T-1} + g(1-\Theta)) - \Delta \tau W_{T-1})
\]

Rearranging:

\[
\Delta \tau W_{T-1} \left(1 - \frac{v}{(1+\beta)(1+v)}\right) = \\
\quad = \eta I w_{m,T-1} \left(-\tau_T(1+\beta)(1+v) - v(1-\tau_T-\gamma) + v(1+\beta)(1-\gamma)\right) \\
\quad + \eta I g \left((1-\Theta) - \frac{v(1-\Theta)}{(1+\beta)(1+v)}\right) \\
\quad \quad + \eta I \left(\frac{\Delta \Psi}{(1+\beta)(1+v)}\right) w_{m,T-1} + \left(\frac{(1+\beta+\beta v)(1-\Theta)}{(1+\beta)(1+v)} g\right)
\]

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Multiplying both sides by \( \left( \frac{(1 + \beta + \gamma)}{(1 + \beta + \gamma)} \right) \) and adding/subtracting \((1 - \gamma)\eta \ell w_{m,T-1}\):

\[
\Delta \tau W_{T-1} = \eta \ell w_{m,T-1} + \eta \ell (1 - \Theta)g + \frac{\beta v(1 - \gamma)\eta \ell w_{m,T-1}}{1 + \beta + \beta v} + (1 - \gamma)\eta \ell w_{m,T-1} - (1 - \gamma)\eta \ell w_{m,T-1} = \eta \ell \left((1 - \gamma - \tau \ell) w_{m,T-1} + (1 - \Theta)g + \frac{(1 - \gamma)\ell w_{m,T-1}((\beta v - (1 + \beta + \beta v))}{1 + \beta + \beta v}\right)
\]

Using \(\Delta \psi^l = (1 - \gamma - \tau \ell) w_{m,T-1} + (1 - \Theta)g\) and rearranging yields:

\[
\Delta \tau = \frac{\eta \ell}{H w_{h,T-1} + N w_{n,T-1} + M \ell w_{m,T-1}} \left(\Delta \psi^l - \frac{(1 - \gamma)(1 + \beta)\ell w_{m,T-1}}{1 + \beta + \beta v}\right)
\]

This convenient expression states that if a regularized individual’s disposable income gain \((g(1 - \Theta) + w_{m,T-1}(1 - \gamma - \tau \ell))\) does not exceed a certain fraction of the legal migrant’s wage \((\ell w_{m,T-1}((1 - \gamma)(1 + \beta))/1 + \beta + \beta v)\), the native workers pay less taxes on their income. Further, this result allows an insight in the evolution of the aggregate disposable income (and thus in the economy’s savings) by substituting it in (28):

\[
\Delta \Psi = \eta \ell ((1 - \tau \ell - \gamma) w_{m,T-1} + g(1 - \Theta)) - \left(\Delta \psi^l - \frac{(1 - \gamma)(1 + \beta)\ell w_{m,T-1}}{1 + \beta + \beta v}\right)
\]

\[
= \frac{\eta \ell (1 - \gamma)(1 + \beta)\ell w_{m,T-1}}{1 + \beta + \beta v}
\]

### B.5 Variation of the income tax rate in the long run

In the long run, the population is constant and the dynamics depend on the capital accumulation. The budget constrains of two succinct periods are:

\[
\tau_{t+p} W_{t+p} + v(C_{t+p} + D_{t+p}) = g(H_{t+p} + N_{t+p} + M_{t+p} + I_{t+p}(\Theta)) + G
\]

\[
\tau_{t+p-1} W_{t+p-1} + v(C_{t+p-1} + D_{t+p-1}) = g(H_{t+p-1} + N_{t+p-1} + M_{t+p-1} + I_{t+p-1}(\Theta)) + G
\]

with taxable wage base is \(W_{t+p} = H_{t+p} w_{h,t+p} + N_{t+p} w_{n,t+p} + M_{t+p} w_{m,t+p}\) Thus, the change \(\Delta \tau_{t+p}\) is:

\[
\tau_{t+p} W_{t+p} + v(C_{t+p} + D_{t+p}) - \tau_{t+p-1} W_{t+p-1} - v(C_{t+p-1} + D_{t+p-1}) = 0
\]

\[
\Leftrightarrow \Delta \tau_{t+p} W_{t+p} + \tau_{t+p-1} W_{t+p} - \tau_{t+p-1} W_{t+p-1} = -v(C_{t+p} + D_{t+p} - C_{t+p-1} - D_{t+p-1})
\]

\[
\Leftrightarrow \Delta \tau_{t+p} = -\frac{\tau_{t+p-1} W_{t+p}}{H_{t+p} w_{h,t+p} + N_{t+p} w_{n,t+p} + M_{t+p} w_{m,t+p}}
\]

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C Sensitivity to the elasticity of substitution

The influence of the different elasticities of substitution can briefly be assessed. As shown below, straightforward conclusions on the wage dependence relative to these parameters are not possible. In fact, the results depend heavily on the population structure as well as the other parameters’ values. For the elasticity of substitution between native and foreign low-educated workers,

$$\frac{\partial w_m}{\partial \sigma_N} = (1 - \alpha)(1 - \theta_h)(1 - \theta_n)AK^\alpha Q^{\frac{1}{\sigma_H}} - \alpha Q^{\frac{1}{\sigma_N}} - \alpha Q^{\frac{1}{\sigma_H}} (I + M)^{\frac{1}{\sigma_N}}$$

$$\left\{ \frac{1}{\sigma_N - 1} \left( -\alpha p_L + \frac{1}{\sigma_N} + \frac{1}{\sigma_H} (p_L - 1) \right) Z_4 + \frac{1}{\sigma_N^2} \ln \left( \frac{M + I}{Q_l} \right) \right\}$$

where $Z_4 = \left[ \ln \left( \frac{M + I}{Q_l} \right) + p_N \left( \ln \left( \frac{N}{M + I} \right) \right) \right]$, $p_N = \frac{\theta_N^\frac{\sigma_N - 1}{\sigma_N} - 1}{\sigma_N^2}$ and $p_L = \frac{(1 - \theta_h)Q_l^{\frac{\sigma_N - 1}{\sigma_H}}}{Q_l^{\frac{\sigma_N - 1}{\sigma_H}}}$.

Thus, $\frac{\partial w_m}{\partial \sigma_N} < 0$ and the higher is the elasticity of substitution between native and foreign low-educated workers, the lower is the wage each one receives.

The same assessment can be made with respect to the elasticity of substitution between the high- and low-educated workers.

$$\frac{\partial w_m}{\partial \sigma_H} = (1 - \alpha)(1 - \theta_h)(1 - \theta_n)AK^\alpha Q^{\frac{1}{\sigma_H}} - \alpha Q^{\frac{1}{\sigma_N}} - \alpha Q^{\frac{1}{\sigma_H}} (I + M)^{\frac{1}{\sigma_N}}$$

$$\left\{ \sigma_H (1 - \alpha) \ln \left( \frac{Q_l}{Q} \right) + (1 - \alpha \sigma_H) p_H \ln \left( \frac{Q_h}{Q_l} \right) \right\}$$

with $p_H = \frac{\theta_H^\frac{\sigma_H - 1}{\sigma_H}}{Q_l^{\frac{\sigma_H - 1}{\sigma_H}}}$. For both countries, the term in brackets is positive, leading to $\frac{\partial w_m}{\partial \sigma_H} > 0$. Thus, the higher the elasticity of substitution between high- and low-educated workers, the higher is the wage of the latter.

D The small open economy

In a small open economy (with no labor mobility between countries), the interest rate is dictated by the international capital markets such that the interest factor $\bar{R}$ is fixed. This implies that the capital labor ratio is given by:

$$\frac{K_t}{Q_t} = \left[ \frac{A}{\bar{R}} \left( \alpha + Z_1 (1 - \gamma) \left( \frac{Q_{lt}}{Q_t} \right)^{\frac{\sigma_H - 1}{\sigma_H}} \left( \frac{M_t + I_t}{Q_{lt,t}} \right)^{\frac{1}{\sigma_N}} I_t^{\frac{1}{\sigma_N}} \right) \right]^{\frac{1}{\alpha}}$$

with $Z_1 = (1 - \alpha) (1 - \theta_h) (1 - \theta_n)$.  

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In this framework, capital flows into or out of the country until the interest rate equalizes the one prevailing on the international capital markets. Thus, the capital stock in a certain period is no longer predetermined by the savings of the previous generation. Instead, capital movements must be taken into account until:

$$K_t = S_{t-1} + B_t$$  \hspace{1cm} (30)

where $B_t$ is the net capital inflow. In a small open economy, an amnesty does not change the interest factor such that the old generation living in period $T$ is not hit by the shock. However, the capital stock is adapted in order to reflect the change in the population structure.

$$\left(\frac{K_T}{Q_T}\right)^{1-\alpha} - \left(\frac{K_{ss}}{Q_{ss}}\right)^{1-\alpha} = Z_1(1 - \gamma)I_{ss}(\Delta J_T - \delta J_T)$$  \hspace{1cm} (31)

with $J_T = Q_T^{\frac{1}{\sigma_H}} - 1 - Q_T^{\frac{1}{\sigma_N}} - M_T + I_T)^{\frac{1}{\sigma_N}}$ and $\Delta J_T = J_T - J_{ss}$.

In the absence of positive profits (with $\gamma=1$), the capital stock adjusts in order to maintain a constant capital labor ratio (in efficient units), whatever the values of $\eta$ and $\delta$. The gross wages nevertheless change depending on the considered scenario’s effect on the efficient labor structure (see equation (5)). The change in the income tax rate introduces a dynamic in the disposable income (which is similar to the one presented for the closed economy). Therefore, the repartition of the capital used in the economy between residents and foreigners, through capital inflow, changes. The process continues until a new equilibrium is reached.

On the other hand, when $\gamma < 1$, the capital labor ratio changes in period $T$ due to the reduction in extra profits thereby affecting the wage rates. From equation (31) it can be inferred that the capital labor ratio decreases in the case of an amnesty (with $\Delta J_T=0$ and $\delta > 0$). An amnesty in a small open economy with a constant labor force expressed in efficient units leads to a lower capital labor ratio and thus a lower capital stock. This in turn reduces gross wages which leads to higher income tax rates. Immigration inflow (with $\Delta J_T < 0$ and $\delta = 0$) reduces the capital labor ratio but the magnitude is lower than in the case of an amnesty. Labor in efficient units is certain to increase while the change in capital stock is undetermined and depends on the structure of the population. In the case of deportation, a lower capital labor ratio is obtained when $\Delta J_T < \delta J_T$, which is to be expected. Given that in this case labor in efficient units is below the steady state level, the capital stock must be lower too.

The consequences of these different policies under the open economy framework depend on the structure of the population (through the policies’ effects on wages perceived) and are thus not defined a priori. In the long run, the capital labor ratio remains constant but the balance of payments adjusts due to the change in income taxation until the new equilibrium is reached. Thus, the temporal dynamic is lead by the income tax rate (see equation (14)).

\footnote{In fact, in equation (31) $\Delta J_T$ is marginal and thus the second term (and the value of $\delta$) should be determinant for the sign and magnitude of the change in the capital labor ratio.}