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 undocumented 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 undocumented workforce increases the wage bill that they pay. The net fiscal effect strongly depends on the discrimination that undocumented workers face ex-ante. A calibration of the model to the United States in 2011 highlights overall limited economic consequences of an amnesty. These can be contrasted to slightly higher effects of deportation and new legal immigration. In particular, when public welfare expenditures are low, amnesty and legal immigration can increase native's welfare in the long run while deportation might harm less-educated agents.

Keywords: Undocumented immigration, Amnesty, Regularization, Discrimination.

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1 Introduction

In recent years, unauthorized immigration\(^1\) has been an issue for numerous countries all over the world, brought regularly to the attention of the general public by the media. In the beginning of October 2013, more than 350 undocumented immigrants drowned at the shores of Lampedusa (Italy), as their boat took fire. This event received a lot of attention in the media and revived the debate among public authorities and the civil society on how to control migration flows and shape immigration policy in Europe.

The policies defined by national authorities often focus on a selective choice of immigrants allowed to enter the country, both in terms of the number (e.g. by fixing quotas) and category of people (e.g. the points based 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 undocumented population present in their country. An amnesty for unauthorized 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 fake social security numbers or identification cards, in order to remain in the country and/or gain employment. This procedure confers legal residency status in the host country to those unauthorized immigrants who respect the criteria for application. A new amnesty program is currently discussed in the United States under the “Border Security, Economic Opportunity, and Immigration Modernization Act” which was passed by the (democrat-dominated) Senate but is still blocked by the (republican-dominated) House of Representatives (as of August 2014).

In general, an amnesty is a “one-off” political decision without a fixed institutional framework. Several political or social reasons may justify a regularization of undocumented workers. Without being exhaustive, these can include the improvement of undocumented workers’ life conditions or the increase in labor market transparency. The presence of an important number of undocumented immigrants might also be seen as undermining the authority of the public institutions who are unable to fully endorse their laws. Hence, an amnesty can also strengthen the knowledge and control over unauthorized immigration and increase the

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\(^1\)An undocumented (or unauthorized) immigrant can be defined as a foreigner who has either entered the country without legal permission or violated the terms of legal admission (e.g. by overstaying the duration of a tourist visa). There is a large literature assessing the welfare impacts of unauthorized immigration which will not be addressed in this paper (see the seminal paper by Ethier, 1986 and Palivos, 2009 among others). See also OECD (2006) on the importance of undocumented immigration.

\(^2\)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).
perception of safety among the population (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 (Levinson, 2005).

Contrary to new immigrants, unauthorized residents already play a role in the host country and its economy: they might work (in the shadow economy), receive different sorts of subsidies, educate their children in the national education system and pay certain taxes (e.g. the value added tax on consumption). In the US, there is evidence that some employers report and pay taxes on the wages paid to undocumented workers (either knowingly or unknowingly). Using firm’s Unemployment Insurance wage reports for the State of Georgia, Hotchkiss and Quispe-Agnoli (2008) check the validity of the workers Social Security Number (SSN) and find that 0.39% of them (or the equivalent of “just over one million workers”) are invalid and used by undocumented immigrants. Therefore, an amnesty is likely to have a different impact on the economy than the admission of new immigrants. Several countries have used amnesties, among which the largest, in terms of applicants, was the one that followed the Immigration Reform and Control Act (IRCA) of 1986 in the US (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 experience but also to the lack of data regarding other regularization cases. However, some studies focus on European countries (Levinson, 2005; Marx et al., 2008; Papantoniou-Frangouli and Leventi, 2000, Baldwin-Edwards and Kraler, 2009 for the EU27 and Reyneri, 2001 for the Mediterranean countries). The design and implications of an amnesty have been studied in different theoretical frameworks. Djajić (1997) analyzes the consequences of unauthorized immigration and amnesty in a stylized two-sector economy. He finds that, in the long run, illegal immigration can be beneficial for native workers (both skilled and unskilled) and that a legalization therefore has no positive effect on natives’ real income. The existing literature has often considered amnesty 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 workforce in the host country. In Epstein and Weiss (2001) an amnesty is considered as a means to reduce the burden on the government of undocumented immigrants, who could not be prevented from establishing in the country.

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3 One of the possible criteria for legalization in the Belgian procedure of 2009 was the excessive time required by the responsible administrations to process asylum applications (SPF Intérieur, 2009).
4 See also Becerra et al. (2012) and the Congressional Budget Office (2007) report on the fiscal impact of undocumented migrants and the studies reviewed therein.
Magris and Russo (2012) explore the trade off faced by governments between increasing the country’s fiscal base and reducing its migrant stock by expelling rejected applicants. 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 study closest to our approach is Benítez-Silva et al. (2011) who also develop an overlapping generations (henceforth OLG) model in order to assess the impact of an immigration amnesty in the United States. In their multi-period OLG model, the authors assume that differences in productivity and in savings behavior between legal and illegal immigrants are key. Based on survey data, they calculate that, on average, undocumented immigrants remit 62 percent of their savings whereas this proportion is around 40 percent for legal immigrants. They assume that a legalization changes the saving behavior of regularized agents who contribute substantially to capital accumulation after an amnesty by keeping a larger fraction of their income in the host country. This element is absent in our model, where capital accumulation occurs only through higher wages of the legalized agents, rather than a change in savings behavior. The authors find that legalizing half of the unauthorized population would slightly reduce natives’ welfare by 0.2% and former legal migrants’ by 0.1%. The substantial improvement of the legalized agents’ welfare would however more than compensate this loss and lead to an average rise in welfare of 0.34%.

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 unauthorized agents already play a role in the economy through their labor market participation and net impact on the government budget. Thus, their presence is not neutral prior to the amnesty, a fact that

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5Even though we acknowledge the potential importance of the remittance channel, the essential role attributed to it in Benítez-Silva et al. (2011) might be challenged. In particular, remittances could remain important if the transaction costs to remit, which are high for immigrants (see Beck and Peria, 2011 for a discussion on the factors that influence costs to remit), are lower for legal immigrants (i.e. due to an easier access to official transaction channels). Furthermore, the calibration of this channel poses serious challenges which are not yet completely solved by the existing literature (e.g. reason to remit and preference intensity...). This simplification should allow a higher tractability in our two-period model in contrast to the multi-period model developed by Benítez-Silva et al. (2011). Our framework can also be easily applied to compare an amnesty to legal migration and deportation of undocumented immigrants.
is rarely underlined in the existing literature. Using a simple OLG model as framework allows to separate the effects on high- and less-educated workers and capital owners (retired individuals) and account for different effects through-out the agent’s life cycle. In the short run (i.e. the period at which the shock occurs), at constant capital stock and workforce, profits are reduced and the return on savings falls if undocumented workers are ex-ante discriminated on the labor market. Hence, the old generation embodying the capital owners suffers a welfare loss. At the same time, the effects on the government budget are uncertain and depend on the number of unauthorized workers and country characteristics (e.g. skill structure of the labor market and fiscal policy). A decrease in the income tax rate could benefit the whole workforce in the economy. In the long run, capital accumulation might compensate for the negative effects implied by the decrease in the returns to savings observed in the short run.

A parameterization of the model on the US allows to quantify the welfare impact of providing legal status to the undocumented workers in the country (as considered by the “Border Security, Economic Opportunity, and Immigration Modernization Act”). Our benchmark considers a liberalization of the entire illegal workforce and shows that skilled and unskilled natives would suffer a slight decrease in their welfare of approximately 0.5% in the long run. Varying several identifying parameters keeps the impact of an amnesty in a range between -1.5% and +1% of native’s welfare. Overall, the results show that the impact of an amnesty should be limited, in particular relative to the size of the shock. Contrasting an amnesty to legal immigration and deportation allows to highlight the differences between these migration policies. Due to the ex-ante role played by the undocumented agents in the economy, an amnesty leads to less pronounced welfare effects in the short run.

The remainder of the 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 the United States in 2011 and compares the effects of an amnesty with the two alternative policies. A sensitivity analysis is also carried out. Section 5 concludes.

2 Theoretical Framework

In the closed economy considered\(^6\), 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

\(^6\)Appendix F briefly reviews the effects of an amnesty in a small open economy framework.
two periods. A high-educated (e.g. any tertiary degree or assimilated) worker is denoted by subscript \( h \) while a low-educated worker is either a native \( (n) \), a legal \( (m) \) or undocumented \( (i) \) immigrant. Undocumented immigrants are all assumed to be low-educated and to work in the shadow economy. High- and low-educated workers are complements.

### 2.1 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 \( Q_{l,t} \).\(^8\) A low-educated \( j \)-type agent is distinguished by her origin, where \( N_t \) is the fixed stock of native workers, \( M_t \) and \( I_t \) the fixed stocks of legal and undocumented immigrants present in the labor market. The legal and undocumented low-educated immigrants are assumed to have the same productivity and to be perfect substitutes, the only difference being the absence of legal status for a fraction of them. 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 undocumented immigrants is quite scarce and, to our knowledge, no estimates for the elasticity of substitution have been obtained so far. We thus assume that legal and undocumented agents are perfect substitutes and are only differentiated by their status\(^9\) 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.

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., 2013) the low-educated workforce is represented by a nested CES function. This allows to take into account imperfect substitution between immigrants and native workers.

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\(^7\)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.

\(^8\)Given 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. A useful reference guide for OLG models can be found in de la Croix and Michel (2002).

\(^9\)This assumption reflects a situation where legal and undocumented migrants fulfill similar jobs with identical productivity (e.g. construction workers, gardeners, personal services etc...). For a discussion on the relaxation of this assumption, see Appendix C.
Low-educated labor, $Q_{l,t}$, is thus:

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

High-educated labor is also expressed in efficient labor units. It is assumed that high-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, we assume that 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. (2013), total labor is expressed in efficiency units as a nested CES function of the high-($Q_{h,t}$) and low-educated labor ($Q_{l,t}$):

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

with $\theta_h$ being the relative productivity of high-educated labor and $\sigma_H$ the elasticity of substitution between the two education groups.

### 2.2 Profit maximization

The production is represented by a Cobb-Douglas function, using capital $K_t$ and labor expressed in efficient units $Q_t$.

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10Ottaviano 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 US (Ottaviano and Peri, 2008). This, they say, has however not been observed.
such that $K_{t+1} = S_t$ and full depreciation is assumed.\footnote{The capital market is assumed to be perfect in the sense that the savings of undocumented agents serve the capital accumulation. In other words, it is assumed that undocumented agents can place their savings at an interest factor $R_t$. 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 individuals. An amnesty therefore has one additional positive effect in the presence of imperfect capital market access. This channel is reinforced in Benítez-Silva et al. (2011), who assume that the savings behavior of regularized immigrants changes substantially (i.e. with more savings and less remittances).}

\begin{equation}
Y_t = AK_t^\alpha Q_t^{1-\alpha}
\end{equation}

In the literature, several reasons are provided to explain the lower wages of undocumented workers. Among the most common are a lower productivity of the undocumented immigrants (Chiswick, 1988), the risk of employer sanctions passed on to workers (Chau, 2001) or discrimination due to the illegal status (Rivera-Batiz, 1999). If the lower wages are due to the risk of sanction passed on to undocumented immigrants, the representative firm maximizes profits as follows:

$$
\max_{N_h,M_h,N,M,I} \pi = AK_t^\alpha Q_t^{1-\alpha} - w_{h,t}H_t - w_{n,t}N_t - w_{m,t}M_t - w_{i,t}I_t - \varsigma I_t - R_t K_t
$$

where $\varsigma$ represents the cost for hiring one undocumented worker (e.g. a sanction). Legal workers are therefore paid at their marginal productivity, while undocumented workers’ wage rate is below theirs.\footnote{There is no unemployment or firm heterogeneity in this framework. The standard expressions for the wage rates can be found in Appendix A.} Given that legal and undocumented workers have the same productivity, this can be rewritten:

$$
w_{i,t} = w_{m,t} - \varsigma = \gamma w_{m,t}
$$

Alternatively, it can be assumed that the illegal status limits the mobility of workers who are thereby constrained in their employment opportunities.\footnote{Rivera-Batiz (1999) finds that undocumented immigrants receive substantially lower wages than legal workers even after controlling for all possible observable characteristics. Undocumented workers might moreover 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). 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. Palivos (2009) uses the same assumption and provides an alternative explanation based on a Nash bargaining model for the wages. An undocumented migrant has typically an outside option far below the legal migrants’ wage rate and could therefore accept to work for a discounted wage which still exceeds the wage in her source country.} In this case, the representative firm can be thought to extract a rent $\varsigma I_t$ from paying undocumented workers below
their marginal productivity. Thus, the market for undocumented 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 undocumented worker’s wage is below her marginal productivity such that her employer extracts a marginal profit on her. Both interpretations lead to a wage below marginal productivity for undocumented immigrants. The difference is that while the money collected through sanctions would go to the government budget, the rent is distributed directly to the retired agents (the capital owners) through an interest factor which exceeds the one that would prevail in a competitive equilibrium. In the absence of controls and sanctions for hiring undocumented immigrants, the firm thus hires the complete fixed stock of undocumented workers. While the micro foundation might be clearer in the case of a fine, it is hard to argue that an amnesty would lead to a decrease in budgetary revenues through the lower amount of sanctions collected, given that these are rarely imposed in practice.\(^{14}\)

If the firms pay undocumented immigrants below their marginal productivity, the total amount to be distributed is equal to the rent captured on each undocumented worker multiplied by the total number of workers $(1 - \gamma)I_t w_{m,t}$. This rent is then redistributed to capital holders through the interest factor:\(^{15}\)

$$R_t = \frac{\alpha Y_t + (1 - \gamma)I_t w_{m,t}}{K_t}$$ \hspace{1cm} (1)

In the absence of rents (with $\gamma=1$) the interest factor takes its competitive equilibrium value.

### 2.3 Utility maximization

Each agent lives for two periods. When young, she supplies one unit of labor inelastically.\(^{16}\) 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 $t$ is given by:

$$U^t_j = \ln(c_{j,t}) + \beta \ln(d_{j,t+1}) - V_j \quad \text{where } j=h,m,n,i$$ \hspace{1cm} (2)

\(^{14}\)Following Lofstrom et al. (2013), less than 1,000 final sanction orders were emitted per year during the 90’s while this figure dropped below 200 for most of the period 2000-2010.

\(^{15}\)Instead of changing the interest factor, the explicit payment of a dividend could have been included in the model. This would have increased the complexity of exposure of the model by adding one additional variable.

\(^{16}\)Passel (2007) estimated that labor market participation in 2005 among undocumented men aged 18-64 years was 94% against 86% among legal migrants and 83% among natives in the United States. Thus, labor market participation should not increase further with an amnesty while a significant decrease is also unlikely under a weak social welfare system.
\( \beta \) 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 \( t+1 \). \( V_j \) is a fixed cost that the illegal status imposes on immigrants without proper documentation. Thus, \( V_i \geq 0 \) while \( V_j = 0 \) for \( j = n, m, h \).\(^{17}\) This cost might reflect a variety of restrictions imposed by the illegal status, 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. We assume that this disutility is so strong that every undocumented immigrant would prefer to be legalized and would thus apply for an amnesty.\(^{18}\) Given that she lives for two time periods, the lifetime budget constraint of a \( j \)-type agent can be written:

\[
\psi_{j,t} = c_{j,t}(1 + v) + \frac{d_{j,t+1}(1 + v)}{R_{t+1}}. \tag{3}
\]

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 worker is given by \( \psi_{j,t} \) with:

\[
\psi_{j,t} = w_{j,t}(1 - \tau_t) + g \quad \text{for } j=h,m,n \tag{4}
\]

\[
\psi_{i,t} = \gamma w_{m,t} + \Theta g \tag{5}
\]

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. Undocumented workers are assumed to work in the shadow economy and do not pay income taxes. However, they contribute to the public budget through value added taxes on consumption and are eligible for specific public expenditures (e.g. urgent medical care, public education for their children). Therefore, they impose a cost on the government budget and the fraction of the transfers that an undocumented individual receives is denoted by \( \Theta \).

Maximizing (2) subject to (3) yields per capita consumption and savings, which given

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\(^{17}\)A positive utility cost as a function of the (total or relative) stock of undocumented workers could be considered for legal workers (with \( V_j(I_t) > 0 \) for \( j = n, m, h \)) in order to account for non-economic costs imposed by the presence of illegal workers. A regularization would thus decrease this term and increase the welfare of legal workers through non-economic factors. The calibration of this term would however raise some additional questions (i.e. the measure to use for the size of the illegal workforce, the channels through which utility is affected, differences between natives/legal immigrants and low-/high-educated workers etc.).

\(^{18}\)We therefore abstract here from deriving an incentive compatibility constraint for undocumented immigrants which would not add any substance to the question we want to address in the paper.
the logarithmic utility function, are a constant fraction of the disposable income:

\[ c_{j,t} = \frac{\psi_{j,t}}{(1 + v)(1 + \beta)} \]

\[ s_{j,t} = \psi_{j,t} - c_{j,t}(1 + v) = \frac{\beta}{1 + \beta} \psi_{j,t} \]

\[ d_{j,t+1} = \frac{\beta}{1 + \beta} \frac{R_{t+1}\psi_{j,t}}{1 + v} . \]

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 aggregates become:

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

### 2.4 The government budget

Income taxation and the value added tax on consumption, collected at the respective rates of \( \tau_t \) and \( v \), constitute the government’s revenue. The VAT rate is assumed to be constant over time whereas the income tax rate is adjusted in order to maintain a balanced budget at every period \( t \).\(^{19}\) 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:

\[ \tau_t = \frac{g (H_t + N_t + M_t + \Theta I_t) + G - v (C_t + D_t)}{H_t w_{h,t} + N_t w_{n,t} + M_t w_{m,t}} . \]  \hspace{1cm} (6)

The presence of undocumented workers in the economy is not neutral to the government budget. In fact, although these agents do not pay income taxes, they contribute through the value added tax collected on consumption.\(^{20}\) On the other hand, they are only entitled to a fraction (\( \Theta \)) of the legal agents’ transfers.

\(^{19}\)In the presence of fines for hiring undocumented workers, this additional income source would be added. 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 intuition of the results. A change in the income tax rate (which is identical for high- and low-educated workers) implies a higher additional contribution to the budget (in value) by high wage earners compared to low wage earners. On the other hand, a change in the lump-sum transfer would affect low wage earners proportionally more given that the transfer represents a higher fraction of their income (see Facchini and Mayda, 2009). 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.

\(^{20}\)If they (partially) paid income taxes, this would increase their ex-ante contribution to the budget and thus reduce the fiscal contribution implied by an amnesty.
2.5 Definition of the equilibrium

Definition 1. The temporary equilibrium:
Given a capital stock $K_t$, expectations about interest rates ($R_{t+1}$), a temporary equilibrium is a vector \( \{c_t, d_t, s_t, \tau_t, Y_t, H_t, N_t, M_t, I_t, w_{ht}, w_{nt}, w_{mt}, w_{i,t}, R_t\} \) such that:

- The young worker’s level of consumption \((c_t)\) and level of savings \((s_t)\) are such that she maximizes her utility.

- The old worker’s level of consumption \((d_t)\) is such that she maximizes her utility.

- Firms maximize their profit by choosing labor demands \((H_t, N_t, M_t, I_t)\) and capital demand \((K_t)\). The combination of these factors defines the level of aggregate production \((Y_t)\).

- The legal wages \((w_{ht}, w_{nt}, w_{mt})\) are such that the labor markets for the legal workers clear. The wage for the undocumented immigrants \((w_{i,t})\) is set as a fraction of the legal immigrant’s wage.

- The gross interest rate \((R_t)\) is such that profits are distributed.

- The income tax rate \((\tau_t)\) is such that the government budget is balanced.

The inter-temporal equilibrium:

Given a level of capital \((K_t)\) an inter-temporal equilibrium with perfect foresight is characterized by a sequence of temporary equilibria such that:

- The capital stock is given by: \(K_{t+1} = S_t\)

3 The effects of an amnesty, immigration and deportation

This section focuses on the consequences of an amnesty, which allows undocumented (young) workers, who already play a role in the economy (through the labor market and the government budget) to regularize their illegal situation.\(^{21}\) In order to extend the analysis to

\(^{21}\)In order to simplify the analysis, the disutility caused by the illegal status is assumed to be so high that the representative undocumented agent always prefers to be legalized (see equation (2)). All the undocumented workers thus apply, allowing to study the upper bound effects of a general regularization. Note that an amnesty is applied to young workers only. In this simple framework, the old generation does not take any additional decision such that an amnesty on retired agents would have no effect. Finally, we do not explicitly model the reasons that lead the government to implement the migration policy. This would complicate the exposure of the model without substantially improving the analysis of the consequences of a specific migration policy.
the legal immigration and deportation cases, a general notation for the exogenous change in the foreign-born workforce is used. The economy is assumed to start at the steady state, denoted $ss$ (which can 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 unexpected policy shock. 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 undocumented workers respectively. $\epsilon$ allows to express an increase in legal migrant workers as a fraction of the stock present at the initial steady state. The benchmark amnesty model is recovered when $\delta = \epsilon = 0$ and an exogenous fraction $0 < \eta \leq 1$ of the undocumented workers is legalized.\textsuperscript{22} Thus, the size of the workforce remains unaffected in the case of an amnesty. If legalized, a formerly undocumented worker earns a higher gross wage (if she was being paid below her marginal productivity) and receives more transfers but simultaneously becomes subject to income taxation.

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 B). The extreme case of a deportation of all the undocumented 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 low-skilled immigration by setting $\eta = \delta = 0$ and $\epsilon > 0$. Furthermore, these different scenarios could also be merged to analyze an “attraction effect” of amnesty e.g. a fraction of undocumented immigrants is legalized ($\eta > \epsilon = 0$) but additional undocumented workers enter the economy ($\delta < 0$). However, given that this is a particular combination

\textsuperscript{22}As individuals are homogeneous, it follows that if one undocumented 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.
of an amnesty and an “inverted” deportation, the analysis of this scenario is not developed further.\textsuperscript{23}

The impact of an amnesty on the lifetime utility of a representative \(j\)-type agent born in period \(T\) is given by:\textsuperscript{24}

\[ \Delta U_{j,T} = U_{j,T} - U_{j,ss} \]

This can be rewritten as:

\[ \Delta U_{j,T} = (1 + \beta) \ln \left( 1 + \frac{\Delta \psi_{j,T}}{\psi_{j,ss}} \right) + \beta \ln \left( 1 + \frac{\Delta R_{T+1}}{R_{ss}} \right) - \Delta V_{j,T} \quad \text{where } j=h,m,n,i \quad (9) \]

\( \Delta \psi_{j,T} \) measures the \(j\)-type worker’s net income change, while the second term in expression (9) captures the variation in the interest factor. The change in a regularized worker’s net income can be shown to be a positive function of ex-ante discrimination \((\gamma, \Theta)\) and a negative function of the ex-post income tax rate \(\tau_T\). In the benchmark scenario, where \(\eta > \delta = \epsilon = 0\), the amnesty is implemented in period \(T\) and no deportation occurs.

### 3.1 Short run effects of a policy shock

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 (9)) are detailed below.\textsuperscript{26} In the short term, the capital stock \(K_T\) is determined by the agents’ savings of the previous period. The impact of the different migration policies differs in how it affects the population structure and composition. Given the assumptions of the model, the retired agents in period \(T\) (born in \(T - 1\)) are only affected by the policy shock through the impact that it has on the return

\textsuperscript{23}This subject is still debated in the literature. Karlson and Katz (2003) argue that the prospect of an amnesty can be used by the government to attract illegal low-educated workers that are needed in the economy. However, Orrenius and Zavodny (2003) find that the IRCA did not affect the long term patterns of illegal migration and reduced apprehensions at the border right after the implementation of the law. This could be due to lower new entries but also to reduced circular migration caused by fears of increased border surveillance. In order to fully account for these mechanisms, migration would need to be endogenized in a more sophisticated dynamic framework. This is beyond the scope of this paper. Intuitively, regularizing undocumented workers while simultaneously increasing the total stock of undocumented workers in our framework would mitigate the total effects of an amnesty.

\textsuperscript{24}All the following analyses 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 an amnesty \(\Delta x_T = x_T - x_{ss}\).

\textsuperscript{25}Note that the higher are the values of the two parameters, the lower is the discrimination faced by the unauthorized workers.

\textsuperscript{26}The effects of a policy shock 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 a migration policy shock are presented in Section 4.
that they receive on their savings:

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

(10)

The first term in the numerator captures the effect on total production due to the change in the composition of the workforce. The second term captures the change in profit made with the undocumented workforce. Rearranging, it can be shown that the latter is positive if 

$$
\frac{w_{m,ss}}{w_{m,T}} < 1 - \eta - \delta \quad \text{(i.e. if the change in profit made on the remaining illegal workers exceeds the loss implied by a potentially lower number of undocumented workers) and negative otherwise.}
$$

In the case of an amnesty (with $\eta > \delta = \epsilon = 0$) and under the perfect substitutability between legal and undocumented migrants, the population structure is unaffected, leaving production and wages constant. 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 receive as undocumented workers) which leads to a change in the interest factor. Equation (10) simplifies to:

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

(11)

The numerator in (11) 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 undocumented 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 undocumented workers $\eta I_{ss}$, the stronger is the negative impact on the return factor. Given that an amnesty affects agents retired at period $T$ only through the change in their savings’ return, in the presence of status discrimination on the labor market, the retired agents are certain to suffer a welfare loss.\(^{27}\)

A migration policy affects the working age (young) agents’ utility through its impact on their net income when they are young in addition to the effect on the interest factor when

\(^{27}\)In expression (9), 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 receive 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.
they are old:

\[
\Delta \psi_{j,T} = (1 - \tau_T)\Delta w_{j,T} - \Delta \tau_T w_{j,T} \quad \text{for } j \neq i^f
\]

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

(12)

where \(\Delta w_{j,T} = w_{j,T} - w_{j,ss}\) represents the change in the wage rates implied by a change in the population structure with a fixed capital stock. The following assumption is made on the values of the elasticities of substitution:

**Assumption 1.** Given the values provided by the existing literature, we assume that \(\sigma_h < 1/\alpha < \sigma_n\). This ensures that 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 B):

\[
\frac{\partial w_{n,t}}{\partial (M_t + I_t)} < 0; \quad \frac{\partial w_{m,t}}{\partial (M_t + I_t)} < 0; \quad \frac{\partial w_{h,t}}{\partial (M_t + I_t)} > 0
\]

A \(j\)-type worker’s net income is therefore affected by the potential change in her gross wage rate and the net fiscal effect of the migration policy (reflected in the change of the income tax rate \(\Delta \tau_T\)).

In the case of an amnesty, the constant population size and the assumption of perfect substitution imply constant wage rates (with \(\Delta w_{j,T} = 0\)) such that the legal workers’ net income is only affected by the net fiscal impact of the amnesty (the second term in equation (12)). The legalized agent’s income changes due to the elimination of the discrimination on the wage \((1 - \gamma)\) and access to public transfers \((1 - \Theta)\) and the obligation to pay income taxes.\(^{28}\)

Using the general notation, a migration policy affects the income tax rate paid by the legal workers:

\[
\Delta \tau_T = \frac{g(\epsilon M_{ss} + \eta I_{ss} - (\delta + \eta)\Theta I_{ss}) - \tau_T \Delta W_T - \nu(\Delta C_T + \Delta D_T)}{W_{ss}}
\]

(13)

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 first term in the numerator captures the change in the composition of the population entitled to transfers. The second term accounts for the change in the taxable income base in presence of a change in the population structure given by \(\Delta W_T\) (with \(\Delta W_T = H_{ss}\Delta w_{h,T} + N_{ss}\Delta w_{n,T} + M_{ss}\Delta w_{m,T} + (\epsilon M_{ss} + \eta I_{ss})w_{m,T}\)). The third term captures the change of revenues collected from the value added tax on consumption. The fiscal impact of a migration policy results from the effects implied by the change in the population structure on these three channels.

\(^{28}\)Formally, this can be written as: \(\Delta \psi_{i,T} = (1 - \tau_T - \gamma)w_{m,T} + (1 - \Theta)g\).
It is however clear that a larger taxable income base (with \( \Delta W_T > 0 \)) reduces the income tax rate.

In the case of an amnesty, it can be shown that total consumption and thus the income collected through the value added tax on consumption cannot increase (see Appendix D). This is due to the fact that the decrease in retired agent’s consumption is not completely compensated by a rise in workers’ consumption: in the absence of bequests, retired agents consume their entire net income while workers save a fraction of it. 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 receive and the decrease in value added tax income. The change in the income tax rate can be rewritten as:

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

(14)

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. First, the additional transfers received by undocumented workers are more important and second 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.\(^{29}\)

**Proposition 1.** 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 (i.e. a decrease in the income tax rate sufficiently strong to compensate for a potentially lower interest rate and/or wage rate):

\[
\Delta \tau_T < \frac{\psi_{j,ss}}{w_{j,ss}} \frac{\beta}{1 + \beta} \frac{\Delta R_T}{R_{ss}} + \frac{1 - \tau_T}{w_{j,ss}} \frac{\Delta w_T}{w_{j,ss}}
\]

(15)

Using expression (9), 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

\(^{29}\)Note that if undocumented agents were subject to income taxation (as assumed in Benítez-Silva et al., 2011), the increase in the fiscal base would be exclusively due to potentially higher wages earned by regularized workers.
decreases unambiguously (see equation (11)).

**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 (i.e. a decrease in the income tax rate which is high enough to compensate for the lower interest rate; see equation (14)).

$$\Delta\tau_T < \frac{\psi_{j,ss}}{w_{j,ss}} \beta \frac{\Delta R_{T+1}}{R_{ss}}$$  \hspace{1cm} (16)

**Proof.** The expression is obtained by substituting equation (12) in a first order Taylor approximation of equation (9).

Note that retired agents face an unambiguous decrease in their utility, given that they receive a lower return on their savings. They are not affected with a change in the income tax rate and the interest rate is the only channel through which their utility changes. 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 made by capital owners (e.g. retired agents). Workers on the other hand might benefit from a lower income tax rate, which can compensate the lower interest rate received at retirement (if the net fiscal contribution of a regularized worker is sufficiently positive).

The aggregate disposable income in the economy can be shown to increase (see Appendix D). 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 Migration policies affecting the population size

Two scenarios changing the population size are considered in this paper: deportation, when a fraction $\delta > \epsilon = 0$ (while $\eta$ might take any value as long as $\eta + \delta \leq 1$) of the undocumented workers are caught and expelled and new low-educated immigration, where $\epsilon > \delta = 0$ and $0 \leq \eta \leq 1$. These policies can be contrasted to the effects of an amnesty.

#### 3.2.1 The case of deportation

The deportation$^{30}$ of a fraction $\delta$ of the undocumented workers decreases labor in efficient units, $Q_T$. This implies, under assumption (1), a decrease (increase) in the high-educated

$^{30}$Note that no cost is incurred to search for and expel undocumented immigrants and, in that case, the latter keep a utility $\bar{U}$ (which is lower than the utility of remaining in the country). Without loss of generality, $\bar{U}$ can be set to 0.
(low-educated) workers’ wage rate. For the less educated workers, the decrease in the less educated workforce 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 government budget than in the benchmark case (illustrated by the first term in the numerator of equation (13)). In particular, this is true if it is assumed that no undocumented 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 (13).

The interest factor decreases more than in the case of an amnesty due to the negative effect of deportation on production. The first term in the numerator of equation (10) 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 undocumented workers are expelled, profits are lower than in the case of an amnesty. Capital holders are therefore particularly harmed by a deportation of undocumented 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 undocumented 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.

The interest factor in this scenario increases, given that the rise in the production is higher than the profit loss in the use of undocumented workers (the first term in (10) dominates the second). The latter is due to the decrease in the undocumented 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 government budget is higher than in the benchmark, given that the formerly undocumented workers were already receiving 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
3.3 Long run effects

Each shock 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. Given the constant population structure, the labor market discrimination faced by undocumented workers (the value of $\gamma$) therefore does not influence the results after period $T$. 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:

$$\Delta \psi_{j,T+p} = (1 - \tau_{T+p}) \Delta w_{j,T+p} - \Delta \tau_{T+p} w_{j,T+p-1} \quad \text{with } p \geq 2$$  \hspace{1cm} \text{(17)}

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 amnesty scenario, capital can be shown not to decrease (see Appendix D), 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:

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

Consequently, the change in the income tax rate remains ambiguous:

$$\Delta \tau_{T+p} = -v(\Delta C_{T+p} + \Delta D_{T+p}) + \tau_{T+p-1} \Delta W_{T+p} \quad \text{with } p \geq 2$$  \hspace{1cm} \text{(18)}

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 (17)) is therefore undetermined.
Combining the multiple effects presented in Section 3 into equation (9) yields the welfare impact of the different policies. However, it can easily be seen that the analytical results are dependent on the structure of the economy. We therefore apply our model to the United States\footnote{In a previous version of the paper, the model was calibrated on Germany and the United Kingdom (Machado, 2012).}, based on data for the year 2011, in order to illustrate the theoretical results. One period is assumed to last 30 years.

Data relative to the composition of the workforce by country of birth was gathered from the latest issue of the “Statistical Portrait of the Foreign-Born Population in the United States” (Motel and Patten, 2011).\footnote{Their estimates are based on the Census Bureau’s 2011 American Community Survey (ACS) and are publicly available online: http://www.pewhispanic.org/2013/01/29/} The workforce is given by the number of employed workers and is composed of 152,888,364 natives and 28,425,238 immigrants (from a total of 40,381,574 foreign born, i.e. 70.4% of the foreign born population). Passel et al. (2013) estimated the size of the undocumented population in early 2012 to be 11.7 million. In the benchmark case we will assume that the distribution regarding employment is identical between legal and undocumented workers, which implies a number of 8,236,800 undocumented (low-skilled) workers (i.e. 4.5% of the total workforce) and 20,188,438 legal immigrant workers. This rather strong assumption implies that almost one foreign-born person in five is an undocumented worker. The dataset also provides the educational attainment of the resident population aged 25+. We make the assumption that the distribution of the educational attainment is the same among the workforce, except for undocumented workers who are all assumed to have no tertiary education. Defining high-skill as some tertiary education, we obtain that 60% of natives have at least some college education (leading to a total of 91,464,910 high-skilled and 61,423,454 low-skilled native workers) while 46% of immigrants do so (i.e. a total of 13,130,804 high-skilled and 15,294,434 low-skilled foreign-born workers).

As a robustness check, we will consider different structures of the workforce.

GDP data and public sector information is provided by the OECD Economic Statistics Tables (OECD, 2014). The discount factor $\beta$ is fixed to 0.6 in order to replicate the share of resident consumption, 66% of GDP, provided by OECD (2014). Total tax revenue is used as a proxy for government expenditures and amounts to 25.1% of the GDP in 2011 (OECD, 2014). Public funds are either distributed under the form of transfers or used for structural expenditure (i.e. public consumption), 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 proxied by the total social spending...
as percentage of GDP (with φ equal to 19.7% in OECD, 2014) and is thus written:

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

(19)

The value added tax rate is calibrated in order to proxy tax income on goods and services (which represents 4.6% of the GDP) provided by OECD (2014). The value added tax rate obtained is 6.7%. Finally, the income tax rate is set to maintain the budget equilibrium and is therefore expected to exceed the rate observed in reality given that the model abstracts from capital taxation and does not include public debt. As shown in Table 1, the resulting value is 30.1%.

The capital’s share of output \( \alpha \) is set to 0.3 and the elasticities of substitution are 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 skill 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\(^{33}\) to infinity (Borjas et al., 2008) are found. Our benchmark estimation is done with the intermediate values for the elasticities with respectively \( \sigma_H = 1.5 \) and \( \sigma_N = 20 \) while robustness checks in Section 4.3 highlight the impact that this choice has on our results. The relative productivity parameters for highly educated agents (\( \theta_h \)) and native low-educated agents (\( \theta_n \)) are calibrated in order to replicate the tertiary education wage premia of male workers, estimated to be 94.6% by Strauss and de la Maisonneuve (2007). Simultaneously, we consider the existence of a small wage premium for citizenship close to 5% in order to take into account easier labor market access due to language proficiency and better adaptation to the labor market conditions.\(^{34}\) The resulting values are \( \theta_h = 0.687 \) and \( \theta_n = 0.522 \).

Two further important parameters are the wage discrimination and the undocumented workers’ access to public transfers. In the literature, which often focuses on the United States, the estimation of wage functions for legalized and legal foreign-born population allows to extract the role of the legal status in the wage formation. Kossoudji 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

\(^{33}\)For workers without tertiary education in Germany, Brücker 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.

\(^{34}\)Pastor and Scoggins (2012) find a wage premia of citizenship between 8% when controlling for differences in observable characteristics and 11% when in addition accounting for the sectoral distribution of employment. Given that we have two skill groups and that natives are on average more educated than foreign-born workers, we use a smaller wage premium.
Tienda (1993) find that the legal workers earn up to 30% higher wages in similar positions. Our estimate is based on the figure provided by Rivera-Batiz (1999) who state that less than half of the 41.8% wage premia that legal immigrants have over undocumented immigrants can be explained by observable characteristics. In a recent study using New Immigrant Survey data, Lofstrom et al. (2013) analyze how acquiring Legal Permanent Resident status influences labor market outcomes for previously undocumented workers. They do not find evidence of improved employment outcomes attributable to legal status for the low-skilled, which might however partly be due to a lower observable time frame (i.e. outcomes among the previously unauthorized immigrants are only observed during the first year after status change). Palivos (2009) set this value to 0.71, assuming that migrants and natives earn the same wage. We use $\gamma = 0.79$. As discussed in the theoretical section, the extent of status discrimination, and in particular the proportion of transfers to which an undocumented agent qualifies for, are of crucial importance. The latter is hardly quantifiable as, by definition, undocumented immigrants are in general not entitled to public support. Nevertheless, in many developed countries several exceptions exist like urgent medical care provision or children’s school enrollment. However, fear of being reported by public servants may reduce the application of undocumented immigrants to benefits they could in theory benefit from. In order to reflect the idea that undocumented immigrants impose a cost on the budget, $\Theta = 0.3$ is used and the extent of support availability is varied in Section 4.3 as a robustness check. In the benchmark case it is assumed 100% of the undocumented workers are regularized ($\eta = 1; \delta = \epsilon = 0$). Even though a hundred percent legalization rate is never observed in reality (Levinson, 2005), this scenario allows to highlight the potential upperbound effects of an amnesty. Table 1 summarizes the country’s characteristics and the model’s predictions.

Table 1: Data used in the model for the United States

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP (billion $)</td>
<td>466.014</td>
</tr>
<tr>
<td>High-educated workers</td>
<td>104.595.714</td>
</tr>
<tr>
<td>Low-educated natives workers</td>
<td>61.423.454</td>
</tr>
<tr>
<td>Low-educated foreign-born legal workers</td>
<td>20.188.438</td>
</tr>
<tr>
<td>Undocumented immigrant workers</td>
<td>8.236.800</td>
</tr>
<tr>
<td>Size of the government tax revenue (% of GDP)</td>
<td>25.1</td>
</tr>
<tr>
<td>Social spending (% of GDP)</td>
<td>19.7</td>
</tr>
<tr>
<td>Value added tax income [OECD] (% of GDP)</td>
<td>4.7 [4.6]</td>
</tr>
<tr>
<td>Value added tax rate (in %)</td>
<td>6.7</td>
</tr>
<tr>
<td>Wage premia [Strauss et al. 2007] (in %)</td>
<td>94.5 [94.1a]</td>
</tr>
<tr>
<td>Income tax rate (in %)</td>
<td>30.1</td>
</tr>
</tbody>
</table>

*aValue for 2005; Sources: OECD (2014), Strauss and de la Maisonneuve (2007).*
4.1 The effects of an amnesty on the native population

In this section and in Section 4.2, the elasticities of substitution considered are $\sigma_H = 1.5$ and $\sigma_N = 20$. In Section 4.3 the sensitivity of the results to these parameters is assessed. Figure 1a shows the evolution of the lifetime utility, normalized to a constant lifetime consumption, for a low- and high-skilled native respectively.\textsuperscript{35}

In general, given that the present simulations imply the legalization of a number of workers equivalent to more than 4.5% of the labor force, an amnesty has limited effects on the native population. The variation of lifetime utility is equivalent to a change in consumption which remains between -0.5% and -0.6% for the high- and low-skilled natives respectively. Independent of her education level, an old agent living at the period of the shock (born in $T - 1$) suffers a welfare loss due to the lower interest factor (see equation (11)). The agents born in period $T$, when the shock occurs, suffer a stronger welfare reduction, implied by the slightly negative contribution of the regularized agents to the government budget. Note that this negative effect on the income tax rate dissipates as capital accumulates (Figure 1b). However, native agents are slightly worse off at the new equilibrium (with a welfare loss of approximatively 0.5%). Thus, the regularized agents slightly reduce the tax burden on native agents in the long run. Nevertheless, this beneficial effect on the tax rate is not enough to compensate for the lower return on savings such that native agents still suffer from a slightly lower utility. The conclusions for the high-and low-educated agents are quite similar, although the effects on the former are more pronounced. This is due to the fact that high-educated agents earn higher wages and thus benefit from a stronger increase in their disposable income when the income tax rate falls.

4.2 Amnesty versus new immigration and deportation

The effects of a regularization can also be contrasted with those of new legal immigration and deportation of low-educated workers (see Figure 2). The change in the total number of workers at time $T$ constitutes the difference between the benchmark model and these two extensions. In order to improve comparability, the shocks considered are of the same magnitude, e.g. the same number of workers either enters the economy legally or is deported. Thus, in the deportation case, it is assumed that the whole undocumented population is expelled

\textsuperscript{35}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 $t$:

$$U_t = \ln(z) + \beta \ln(z) \quad \text{with} \quad z = \exp^{U_t/\beta}$$

and is normalized to an index 100 for the steady state value (e.g. an agent born and retired in a steady state regime).
Figure 1: Effects of an amnesty

(a) Impact on welfare

(b) Impact on the income tax rate

Note: Effect of an amnesty on the normalized constant lifetime consumption of a low- and high-educated native agent born in period \( t \) (indicated on the horizontal axis) and on the tax rate \( \tau \). The amnesty occurs at time \( T \) and the reference steady state utility belongs to the generation born in period \( T - 2 \).

(with \( \eta = \epsilon = 0 \) and \( \delta = 1 \)). In the immigration case, the undocumented workforce remains constant and the legal immigrant workforce is increased by the size of the undocumented workforce with \( \delta - \eta = 0 \) and \( \epsilon = \frac{I}{M} \).

Decreasing the size of the workforce through a deportation of the whole undocumented workforce 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 (10)). The rise in the low-educated wage rates outweighs the contraction of the workforce and the slight negative fiscal impact of the new immigrants (see Figure 1b). In the long run, lower capital accumulation implies a slight increase in the income tax rate which remains however below the initial level. Thus, the low-educated agents are still better off at the new steady state (see Figure 2a). In contrast, the high-educated agents’ lower wage, caused by the deportation in the short run and by lower capital accumulation in the long run, is not compensated by the slightly lower income tax rate. Thus, the high-educated agents are worse off with a deportation in the long run (see Figure 2b).

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 while at the same time the income tax rate increases slightly (see Figure 1b) such that the generation born in \( T \) is harmed (see Figure 2a). In the long run, despite a higher income
tax rate, capital accumulation induced by the new immigrants raises low-educated natives’ welfare, which remains however below the initial steady state (see Figure 2a). Low-educated immigration benefits the high-educated natives, who despite the higher income tax rate are more than compensated by a higher wage rate. In the long run, capital accumulation increases wages further while also reducing the income tax rate, which leads to a higher welfare at the new steady state (see Figure 2b).

Figure 2: Comparing an amnesty with legal low-educated immigration and deportation

4.3 Sensitivity analysis

Figure 3 depicts how changing various key parameters of the model affects the results for high-educated natives. This allows to capture the role played individually by each parameter. Panel 3a shows the importance of undocumented 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 a regularization given the lower additional fiscal burden but higher taxable income base. If undocumented workers were to receive only 1% of the transfers prior to regularization ($\Theta=0.01$), the high-educated natives would lose at most 0.9% of their welfare with regularization. On the other hand, the absence of discrimination on the access to public transfers ($\Theta=1$) would lead to a pure increase in the fiscal base and the high-educated natives’ welfare would increase by almost 0.5% at the new steady state.

The role of wage discrimination is shown in panel 3b. In the absence of wage discrimination (with $\gamma = 1$), amnesty has a pure fiscal effect by affecting the labor income tax rate. Given that the majority of US workers are high-educated, we focus our analysis on this group. The results for low-educated natives are qualitatively identical and can be obtained upon request.
and hardly changes the natives’ welfare. On the other hand, high wage discrimination leads to a higher profit loss (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. In the presence of high discrimination ($\gamma=0.5$), the high-educated natives’ utility is therefore reduced by slightly more than 1% at the new steady state.

Panel 3c highlights the effects of an 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 25.1% captures the case where the whole government budget is redistributed to the agents. In the latter case, the new steady state utility is close to 0.8% 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). In this case, high-educated agents would increase their welfare by 1% at the new steady state.

Panel 3d indicates that a higher value added tax rate leads to a slightly worse effect on the native’s utility. The undocumented immigrants already pay the value added tax on their consumption ex-ante. Therefore, the higher is the tax rate, the lower is their additional marginal contribution after regularization.

Panel 3e shows how the results change if the number of undocumented workers present in the economy varies. As the intuition would suggest, a low number of undocumented workers (1.000.000 in our example) reduces the effects (the welfare loss is around 0.1%). On the other hand, if the number of undocumented workers is increased (up to 15.000.000), the welfare loss still amounts to less than 1% at the new steady state. Nevertheless, the old generation living at the time of amnesty suffers a welfare reduction close to 1.3% of the initial steady state. Similarly, instead of varying the number of undocumented immigrants, we can adjust the proportion of those legalized in the benchmark case. Panel 3f shows that regularizing 50% of the 8.236.800 undocumented workers would reduce high-educated natives welfare by less than 0.3%.

Figure 4 underlines the impact of different values for the elasticities of substitution found in the literature (see Table 3 in Docquier et al. (2013)) on the high- and low-educated natives welfare respectively. The benchmark case ($\sigma_H = 1.5$, $\sigma_N = 20$) is contrasted to a high complementary case ($\sigma_H = 2$, $\sigma_N = 6$) and a high substitutability case ($\sigma_H = 1.3$, $\sigma_N = +\infty$).\textsuperscript{37} The substitutability between native and foreign workers ($\sigma_N$) is of particular importance for low-educated workers, as they face the competition of low-educated undoc-

\textsuperscript{37}Note that all the estimates for the elasticities of substitution and their combination respect Assumption (1).
umented workers. High- and low-educated workers remain highly complementary (with \( \sigma_H \in [1.3, 2] \)), whereas the substitutability among low-educated groups is considered more dispersedly (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 Figures 4a and 4b. In the examples provided, the low-educated migrants’ wage rate decreases with native-foreign substitutability (see Appendix E 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. While high-educated natives are only marginally affected (note that the scale differs in both figures), low-educated natives’ welfare decreases with the migrant-native substitutability (\( \sigma_N \)). In particular, when foreign-born and native low-educated workers are perfect substitutes, the latter’s welfare can decrease up to 1.4% in the long run.

5 Conclusion

Disregarding displacement effects on the labor market and assuming that undocumented immigrants impose a certain cost on the government 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 government budget depends on the net contribution of the legalized agents, which remains a highly debated issue. The crucial question in our OLG framework is whether the potentially positive effect on the 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, given that undocumented immigrants already play a role in the economy. Additionally, under the studied framework, a decrease in the total workforce, due to the deportation of undocumented workers, is likely to harm native high-educated individuals. Moreover, the less native and foreign workers are substitutable, the less an amnesty is harmful to the former.

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 undocumented immigrants face prior to the regularization. An application to the United States shows overall limited effects for the native workers, considering the high number of regularized undocumented workers. Their welfare would decrease by 0.5% in the benchmark calibration case. Our sensitivity analysis shows that varying several important features of the model does not substantially affect the results.
which would remain between -1.5% and +1%. Our stylized model disregards non-economic benefits, such as the perception of increased safety, increased government control, higher respect of laws or empathy for undocumented workers. These elements could justify an amnesty even in the presence of a slight negative economic impact.

The model could be extended in several ways. In particular, the consideration of firm heterogeneity might increase the insights on the distribution of the effects inside an economy. Moreover, dynamic effects of migration policies could be considered (e.g. attraction of new undocumented immigrants due to the prospect of a new amnesty) but are left for future research.
Figure 3: Robustness to a change in parameters

(a) Access to transfers discrimination ($\Theta$)  
(b) Wage discrimination ($\gamma$)  
(c) Social transfers (as % of GDP)  
(d) VAT rate  
(e) Nb. of undocumented workers  
(f) Proportion of regularized

Note: Sensitivity of a high-educated native’s (born in period $t$) welfare to a change in different parameters with amnesty occurring at time $T$. 

30
Figure 4: Robustness to the elasticity of substitution

(a) Change in $\sigma$ (high-educated natives)  
(b) Change in $\sigma$ (low-educated natives)

Sensitivity of a high- and low-educated native’s (born in period $t$) welfare to a change in the elasticity of substitution with amnesty occurring at time $T$. 
References


OECD (2006). International Migration Outlook. SOPEMI.

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


Appendices

Appendix Chapter 4

A Wage Rates

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

\[
\begin{align*}
  w_{h,t} &= (1 - \alpha) \theta_e \theta_p \frac{Y_t}{Q_t} \left( \frac{Q_t}{Q_{h,t}} \right)^{\frac{1}{\sigma_H}} \\
  w_{n,t} &= (1 - \alpha)(1 - \theta_h) \theta_n \frac{Y_t}{Q_t} \left( \frac{Q_t}{Q_{l,t}} \right)^{\frac{1}{\sigma_H}} \left( \frac{Q_{l,t}}{N_t} \right)^{\frac{1}{\sigma_N}} \\
  w_{m,t} &= (1 - \alpha)(1 - \theta_h)(1 - \theta_n) \frac{Y_t}{Q_t} \left( \frac{Q_t}{Q_{l,t}} \right)^{\frac{1}{\sigma_H}} \left( \frac{Q_{l,t}}{M_t + I_t} \right)^{\frac{1}{\sigma_N}} \\
  w_{i,t} &= \gamma w_{m,t}, \text{ with } 0 < \gamma \leq 1
\end{align*}
\]

(A.1)

B 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:

\[
\begin{align*}
  \frac{\partial Q_l}{\partial (M + I)} &= (1 - \theta_n)Q_l^{\frac{1}{\sigma_N}} (M_t + I_t)^{-\frac{1}{\sigma_N}} \\
  \frac{\partial Q}{\partial (M + I)} &= (1 - \theta_h)Q_l^{\frac{1}{\sigma_H}} Q_l^{\frac{1}{\sigma_H}} \frac{\partial Q_l}{\partial (M + I)}
\end{align*}
\]

(B.1) \hspace{1cm} (B.2)

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 if we impose $\alpha < \frac{1}{\sigma_H}$ (which the literature suggests) $\text{sgn} \left( \frac{\partial w_n}{\partial (M+I)} \right) = \text{sgn} \left( \frac{\partial Q_l}{\sigma(M+I)} \right)$. The population shock changes the wage of a national low-educated agent as follows:

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

$$= Z_1 Q \frac{1}{\sigma_H} \frac{\partial Q_I}{\partial (M+I)} \left( \frac{1}{\sigma_H} - \alpha \right) (1 - \theta_H) Q_l \frac{\sigma_{H-1}}{\sigma_H} + Q \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{1}{\sigma_N} - \frac{1}{\sigma_H} \right)$$

obtained using (B.2) and with $Z_1 = (1 - \alpha)(1 - \theta_H)\theta_n AK^\alpha N^\frac{1}{\sigma_N} Q \frac{1}{\sigma_H} - \alpha - 1 Q \frac{1}{\sigma_N} - \frac{1}{\sigma_H}$. Substituting for $Q \frac{\sigma_{H-1}}{\sigma_H}$ and using $Z_2 = Q \frac{1}{\sigma_H} Z_1$:

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

$$= Z_2 \frac{\partial Q_l}{\partial (M+I)} \left[ (1 - \theta_H) Q_l \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{1}{\sigma_N} - \alpha \right) + \theta_H Q \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{1}{\sigma_N} - \frac{1}{\sigma_H} \right) \right]$$

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, $\text{sgn} \left( \frac{\partial w_n}{\partial (M+I)} \right) = -\text{sgn} \left( \frac{\partial Q_l}{\partial (M+I)} \right)$. Similarly, for a legal immigrant worker:

$$\frac{\partial w_n}{\partial (M+I)} = Z_3 \frac{\partial Q_I}{\partial (M+I)} \left[ \left( \frac{1}{\sigma_H} - \alpha \right) (1 - \theta_H) Q_l \frac{\sigma_{H-1}}{\sigma_H} + Q \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{1}{\sigma_N} - \frac{1}{\sigma_H} \right) \right]$$

$$- Z_3 \frac{1}{\sigma_N} Q \frac{\sigma_{H-1}}{\sigma_H} \frac{Q_l}{M+I}$$

$$= Z_3 \frac{\partial Q_l}{\partial (M+I)} \left[ (1 - \theta_H) Q_l \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{1}{\sigma_N} - \alpha \right) + \theta_H Q \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{1}{\sigma_N} - \frac{1}{\sigma_H} \right) \right]$$

$$- Z_3 \frac{1}{\sigma_N} Q \frac{\sigma_{H-1}}{\sigma_H} \frac{Q_l}{M+I}$$

with $Z_3 = (1 - \alpha)(1 - \theta_H)(1 - \theta_n) AK^\alpha Q \frac{2}{\sigma_H} - \alpha - 1 Q \frac{1}{\sigma_N} - \frac{1}{\sigma_H} (M+I) \frac{1}{\sigma_N} > 0$. Then using (B.1), it is possible to obtain:

$$\frac{\partial w_m}{\partial (M+I)} = Z_3 \left( \frac{Q_l}{M+I} \right)^{\frac{1}{\sigma_N}} \left\{ - \frac{1}{\sigma_N} Q \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{Q_l}{M+I} \right) \frac{\sigma_{H-1}}{\sigma_N} \right. \right.$$ 

$$+ (1 - \theta_n) \left[ (1 - \theta_H) Q \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{1}{\sigma_N} - \alpha \right) + \theta_H Q \frac{\sigma_{H-1}}{\sigma_H} \left( \frac{1}{\sigma_N} - \frac{1}{\sigma_H} \right) \right]$$
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.

## C Imperfect substitution

If legal and undocumented immigrants are no longer perfect substitutes, the efficient low-skilled labor can be expressed as follows:

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

Thus,

\[
\frac{\partial w_{n,t}}{\partial M_t} \neq \frac{\partial w_{n,t}}{\partial I_t}. \tag{C.2}
\]

given that the marginal effect of an additional undocumented worker on the efficient low-skilled labor units differs from the marginal effect of a legal worker. In particular:

\[
\frac{\partial Q_{l,t}}{\partial M_t} > \frac{\partial Q_{l,t}}{\partial I_t} \iff \frac{\theta_m}{\theta_i} > \left( \frac{M_t}{I_t} \right)_{\frac{1}{\sigma_n}} \tag{C.3}
\]

which can be shown to hold when \( w_{m,t} > w_{i,t} \). This implies that a legalization would decrease a native low-skilled worker’s wage. However, this decrease would be less pronounced than in the case of a new legal immigrant. Given that the regularized worker has an impact on the native wage ex-ante, a legalization increases his marginal productivity and increases the marginal productivity of the remaining undocumented workers. On the other hand, a new immigrant only decreases the marginal productivity of the immigrants already present. Thus, imperfect substitution would add an additional negative effect on the native’s wage which would however be lower than the one implied by an additional legal migrant (see the discussion following equation (12) in the paper).
D Impact of a migration policy on the income collected through the value added taxes on consumption

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 \( \Delta R_T \):

\[
\Delta C_T + \Delta D_T = \frac{\Delta \Psi_T}{(1 + \beta)(1 + v)} + \frac{\Delta R_T S_{ss}}{1 + v} \tag{D.1}
\]

The change in aggregate disposable income can be decomposed in two major parts. First, the migration policy changes the population structure and thereby the wage rates. Second, it affects the income tax rate through its impact on the fiscal base, total consumption and workers’ access to public transfers.

\[
\Delta \Psi_T = (1 - \tau)(H_{ss} \Delta w_{h,T} + M_{ss} \Delta w_{m,T} + N_{ss} \Delta w_{n,T}) \\
- \Delta \tau_T(H w_{h,T} + N w_{n,T} + M w_{m,T}) \\
+ I(\Delta w_{i,T} - (\eta - \delta) w_{i,ss}) + (1 - \tau_T)w_{m,T}(\epsilon M + \eta I) \\
+ g(\epsilon M_{ss} + \eta I_{ss} - (\delta + \eta)\Theta I_{ss}) \tag{D.2}
\]

In the case of an amnesty where the wage rates are unaffected, it can be shown that the net disposable income is certain not to decrease, even if the income tax rate increases.

\[
\Delta \Psi_T = \frac{\eta I_{ss} w_{m,T}(1 - \gamma)(1 + \beta)}{(1 + \beta + \beta v)} \geq 0 \tag{D.3}
\]

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 (D.1)) is a priori ambiguous. In the case of an amnesty, with a decrease in the return factor (equation (11)) and an increase in the aggregate disposable income (equation (D.3)), total consumption can be shown to decrease (by combining equations (11), (D.1) and (D.3)). This implies that the decrease in the retired agents’ consumption can not be compensated by a rise in the workers’ consumption:

\[
\Delta C_T + \Delta D_T = -\frac{\eta I_{ss} \beta(1 - \gamma) w_{m,ss}}{(1 + \beta + \beta v)} \tag{D.1’}
\]
E Sensitivity to the elasticity of substitution

The influence of the different elasticities of substitution can 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,

\[
\frac{\partial w_m}{\partial \sigma_N} = (1 - \alpha)(1 - \theta_h)(1 - \theta_n)AK^\alpha Q^\frac{1}{\sigma_H} - \alpha Q_l^\frac{1}{\sigma_N} - \frac{1}{\sigma_H} (I + M)^\frac{1}{\sigma_N} \\
\left\{ \frac{1}{\sigma_N - 1} \left( -\alpha p_L + \frac{1}{\sigma_N} + \frac{1}{\sigma_H}(p_L - 1) \right) Z_4 + \frac{1}{\sigma_N^2} \ln \left( \frac{M + I}{Q_l} \right) \right\}
\]

where \( Z_4 = \left[ \ln \left( \frac{M+I}{Q_l} \right) + p_N \left( \ln \left( \frac{N}{M+I} \right) \right) \right] \), \( p_N = \frac{\theta_h Q_{N,N}^{\frac{\sigma_N-1}{\sigma_N}}}{Q_l^{\frac{\sigma_N}{\sigma_N-1}}} \) and \( p_L = \frac{(1-\theta_h)Q_{H,H}^{\frac{\sigma_H-1}{\sigma_H}}}{Q_l^{\frac{\sigma_H}{\sigma_H-1}}} \). In our example, the term in brackets is negative. 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.

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

with \( p_H = \frac{\theta_h Q_{h,H}^{\frac{\sigma_H-1}{\sigma_H}}}{Q_l^{\frac{\sigma_H}{\sigma_H-1}}} \). It can be shown that 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.

F 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 return on capital \( \tilde{R} \) is fixed. This
implies that the capital labor ratio is given by:

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

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

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 and adjusts instantaneously to changes in the return to capital. The change in the capital-labor ratio can then be expressed as a function of the change in the rent captured on undocumented workers:

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

with \( J_T = Q_T^{\frac{1}{\sigma_H}} - Q_{lt,T}^{\frac{1}{\sigma_H}} (M_T + I_T)^{\frac{1}{\sigma_N}} \) and \( \Delta J_T = J_T - J_{ss} \).

Given that the return on savings is fixed by the international capital markets, the capital owners living in period \( T \) will not be affected by a shock on the population structure.

In the absence of labor market discrimination against undocumented workers (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 with the efficient labor structure, which depends on the scenario considered (i.e. amnesty, legal immigration or deportation). This implies a change in the income tax rate which introduces a dynamic in the disposable income (similar to the one presented for the closed economy). Therefore, the repartition of the capital used in the economy between residents and foreigners, changes through the net foreign assets. The process continues until a new equilibrium is reached. In the case of an amnesty, which leaves the population structure unaffected, the capital-labor ratio does not change (in the absence of labor market discrimination, with \( \gamma = 1 \)), leaving the capital stock in the period of the shock unchanged. Gross wages therefore remain constant (given the perfect substitutability between legal and illegal immigrants) but natives’ net income is affected by the fiscal effect.

On the other hand, in the presence of labor market discrimination against undocumented workers (with \( \gamma < 1 \)), the capital labor ratio changes in period \( T \) due to the change in the extra rents, as the return on savings must equalize the rate defined by the international markets. From Equation (F.2) 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 workforce expressed in efficient units therefore implies a decrease in the capital
stock in order to reduce the capital-labor ratio. This reduces gross wages. Hence, natives’ utility is affected by a change in their (gross) wages and by a change in the income tax rate (through the regularized agents’ fiscal effect).

Legal 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 the capital stock is undetermined and depends on the structure of the population. In the case of a deportation, a lower capital labor ratio is obtained when $\Delta J_T < \delta J_T$.\(^{38}\) Given that in this case labor in efficient units is below the steady state level, the capital stock must decrease. The consequences of these different policies under the open economy framework with discrimination on the labor market against illegal workers depend on the structure of the population (through the policies’ effects on wages) and the net fiscal effect of a (legal or illegal) immigrant.

In the long run, the capital labor-ratio remains constant but the net foreign assets adjust 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 (13)).

\(^{38}\)In Equation (F.2), the value of $\Delta J_T$ is in general very small 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.