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Immigration, Legal Status and Fiscal Impact

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Immigration, Legal Status and Fiscal Impact

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Abstract

How do legal and illegal immigrants affect the fiscal balance and welfare of natives in the host country? To answer this question we develop a general equilibrium model with search frictions in the labor market that accounts for both the direct net contribution of immigrants to the fiscal balance and their indirect fiscal effects through their labor market impact. We calibrate the model to the US economy and find that legal immigrants increase native welfare, mainly due to their positive direct net contribution to the fiscal balance. On the other hand, illegal immigrants' positive welfare impact stems mainly from their positive effect on job creation, which helps improve the fiscal balance, but also increases income to natives and in turn consumption. A legalization program leads to a fiscal gain and increases native welfare and it is more beneficial to the host country's citizens than a purely restrictive immigration policy that reduces the illegal immigrant population.

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1 Introduction

Over the last few decades, many developed countries have witnessed rising immigrant inflows. In the United States, for instance, the number of foreign-born residents has increased from around 19 million to over 43 million between 1990 and 2015. During the same period, the number of illegal immigrants has grown even more rapidly, from 3 million to over 11 million. The rapid inflow of (legal and illegal) immigrants has spurred heated debate over its economic consequences, such as it's potential impact on native workers' wages and employment opportunities. Another important concern in the debate on immigration is about its fiscal effects. Do immigrants improve or worsen the fiscal balance in their host country?

The answer to this question depends crucially on two factors. First, immigrants can directly raise government revenues by paying taxes. However, the tax contributions they make hinge on their legal status. Illegal and legal immigrants pay different taxes and impose differently on public services. Those in favor of immigration emphasize the tax revenue from legal immigrants. On the other hand, opponents of immigration argue that the inflow of illegal immigrants increases welfare dependency. Second, immigrants can also indirectly contribute to the host country's fiscal balance by affecting income and overall tax contributions, including those of natives. In this case, immigrants' labor marker impact, which also depends on the legal status, becomes important. Immigrants can influence the host country's wages and employment opportunities, output and firm profits and in turn the fiscal balance. The overall impact of immigrants on natives' welfare hinges on both of these interrelated dimensions: their labor market impact, which indirectly affects the fiscal balance, and their direct fiscal impact. A few recent papers study the welfare effects of immigration by simultaneously accounting for both of these dimensions. However, the distinction between legal and illegal immigration has been largely overlooked in this literature. To our knowledge, there is no previous study on the fiscal and welfare effects of illegal immigration. This paper begins to fill this gap.

We investigate the welfare and fiscal impacts of legal and illegal immigration, and also examine the effects of related policies, such as a legalization program, by employing a dynamic general equilibrium model that explicitly takes into account the job-creation effect of immigration. Specifically, our benchmark economy consists of native, legal and illegal immigrant households, firms and the government. Households' preferences are defined over their consumption of private goods. They pay taxes on income from wages, dividends, capital and bonds, and also pay consumption taxes. They use their after-tax income for consumption, investment, and government bonds. Besides providing unemployment benefits, the government also provides pure and impure public goods. The government finances its expenditure

and debt services by collecting taxes and new bond issuance. But for the government debt to be sustainable, the government must raise revenues to finance any fiscal deficit that immigrants generate through a lump-sum tax imposed on the legal citizens of the host country. On the production side, firms rent capital, hire native, legal and illegal immigrant workers to produce output and pay payroll taxes.

Distinguishing illegal from legal immigrants is important, as they differ in many aspects, thus affect the labor market and tax base differently, and also contribute to the fiscal balance in different ways. First, there are several reasons why illegal immigrants may have a stronger positive effect on firm profits and job creation incentives than legal immigrants. Illegal immigrants, having limited access to welfare benefits, may have a worse outside option than legal immigrants. If this is the case, bargaining implies that the former are paid less, which in turn implies more profits to firms and stronger incentives to open job vacancies. Illegal immigrants can also avoid paying income taxes, which allows them to settle for a lower wage, while firms that employ them can avoid paying payroll taxes. These also imply that firms employing illegal immigrants can save on labor costs, which allows them to open more vacancies and create new jobs. More job entries implies higher employment and capital, larger wages, more profits and higher dividends, which in turn leads to more tax contributions. On the other hand, legal immigrants are more likely to own firms and invest in capital than illegal immigrants. Illegal immigrants may pay less in taxes than legal immigrants whose wages, capital and dividend income are presumably higher, but they also face more restrictions in accessing public services. Lastly, illegal immigrants may be producing a differentiated labor input that compliments natives' production, whereas legal immigrants are more likely to be closer substitutes to natives, thus affect wages and employment opportunities differently, through their differential impact on input prices.

When it comes to the fiscal impact of legal and illegal immigration, there are direct as well as indirect effects. Since legal immigrants pay all types of taxes, and in addition, are more likely to own capital and firms, their direct fiscal impact is more obvious than that of illegal immigrants who are more likely to avoid paying taxes. But, on the other hand, an inflow of immigrants can have an indirect fiscal effect through the job creation channel. Illegal immigrants can perhaps generate more firm profits and a stronger job creation effect and hence a larger positive fiscal effect than legal immigrants in this case. The overall effect of each of the two types of immigrants on natives' welfare depends on both of these dimensions. A larger positive indirect fiscal effect, means also larger income to natives and higher consumption, whereas a stronger direct positive fiscal effect implies a smaller fiscal burden on natives.

We calibrate the model to the U.S. economy and compute the labor market effects and

net fiscal and welfare gains or losses with respect to legal as well as illegal immigration. We take into account all these differences between legal and illegal immigrants. We allow for differences in outside options and tax contributions. We allow natives' and immigrants' consumption of impure public goods to differ, reflecting the different restrictions they might face in the use of public services. We also allow legal and illeal immigrants to differ in terms of firm, capital and debt ownership. In the baseline model, we assume that the three types of labor (native, legal and illegal) are perfect substitutes, but we also consider imperfect substitutability between native and illegal immigrant workers. We use our simulations to investigate whether, despite their fewer tax contributions, illegal immigrants can have a positive impact on fiscal balance and/or increase native welfare and also examine the effects of a legalization program.

Our quantitative exercises show that although an increase in (legal or illegal) immigration raises government expenditure on impure public goods, an increase in either type immigrants leads to a net positive contribution to the fiscal balance and raises the consumption and, hence, the welfare of the host country's citizens. However, for legal immigration, the main reason for the increase in native welfare is their direct positive impact on the fiscal balance, which reduces the tax burden on natives. That is, their tax contributions greatly exceed their consumption of impure public goods. In fact, their net fiscal contribution is that large that even if we eliminate their positive effect on job creation, their impact on native welfare remains positive. Unlike legal immigrants, illegal immigrants' positive welfare and fiscal impact stems mainly from their positive effect on job creation. Under an alternative parameterization in which immigrants' public-good consumption is at the highest, illegal immigrants' fiscal impact turns negative, meaning that in this case illegal immigrants increase government expenditure in excess of tax revenues. However, even in this case, their impact on native consumption is positive. While they might impose a tax burden on natives, they also increase natives' income from dividends capital and wages, and this second effect dominates, allowing natives to increase their consumption.

We find that both legal and illegal immigrants increase native welfare. We can therefore conclude that a legalization program that replaces illegal with legal immigrants is more beneficial to natives than a purely restrictive immigration policy that decreases the number of illegal immigrants. In our calibrated model the positive job creation effect of illegal immigrants dominates over that of legal immigrants, whereas the direct net fiscal contribution of the latter dominates over that of the former. As a result, the legalization of illegal immigrants has a negative impact on natives labor market outcomes (wages, employment, dividends and capital holdings) but a positive impact on the fiscal balance. Our simulations show that the second effect dominates and the legalization program leads to an increase in

native welfare when firm and capital ownership is only restricted to natives. In our calibrated model with legal immigrants and natives being identical in terms of firm, capital and bond ownership, it has a small, but negative impact on native consumption, while it still improves the fiscal balance.

Besides the baseline model, in which we consider perfect substitutability between native and illegal immigrants and keep the provision of the public good constant, we also consider two modifications. First, we allow for illegal immigrants to be imperfect substitutes to natives and legal immigrants and also consider the possibility that illegal immigrants participate in a segmented labor submarket. One could argue that illegal immigrants produce a differentiated labor input or even that they do not compete for the same jobs as legal immigrants or natives. We explore this possibility. The same quantitative exercises are repeated under the alternative set-up and we show that our main results carry through. In a second extension we explore the possibility that immigrants can reduce native welfare by reducing the amount of services available to natives. That is, we allow for the possibility that immigrants "congest" the public good by reducing its provision. Simulation exercises show that our results are robust to this alternative set up. Both types of immigrants increase native welfare as they increase native private consumption, and also the amount public good allocated to each native.

Although the literature on the effects of immigration is vast, the number of studies in this literature that center on the fiscal effect of immigration is relatively small. Lee and Miller (2000) estimate the net fiscal impact of raising net immigration into the United States and conclude that is quite small. Dustmann and Frattini (2014) examine the fiscal impact of immigration on the UK economy and find an overall positive effect. There is only a small number of theoretical studies on this topic. Earlier studies employ an overlapping generations framework to analyze whether immigration is helpful to public finances. Storesletten (2000, 2003) finds that admitting more immigrants can result in net fiscal gains when new immigrants are young and in working age and have high employment rates. These overlapping generations models can easily accommodate age structure and fertility of the immigrant and native populations. However, they exclude immigrants' potential impact on labor market outcomes and welfare of native workers. Studies in this literature adopt mainly an accounting approach by attempting to estimate net government gains of admitting more immigrants based on empirical estimates of tax receipts and public expenditure outlays, but abstract from job creation responses and welfare effects.

Recent studies, such as Chassamboulli and Palivos (2014), Chassamboulli and Peri (2015, 2020) and Liu, Palivos and Zhang (2017), suggest that immigration can induce the entry of new firms and this job-creation effect of immigration can be substantial and should not

be overlooked. The key feature behind the job creation channel emphasized in these papers is immigrants' inferior outside option, which forces them to accept lower wages, thereby increasing firm profits and job creation incentives. These papers, by using models with search and matching frictions, account for the impacts of immigration that work through the conventional complimentarily and labor market competition channel, but also the job creation channel. They abstract, however, from the fiscal effects of immigration.

The paper most closely related to ours is Battisti et al. (2018). They extend the above-mentioned line of research to analyze the welfare effects of immigration by incorporating a welfare state into the model. Their analysis accounts for the skill composition of immigrants and the distributional effects on high- and low-skill native workers, and covers, in addition, 20 OECD countries. However, they do not distinguish between legal and illegal immigration. In our framework, besides outside options, differences in tax payments between natives and legal and illegal immigrants can be an additional reason why their wages, and thus their job creation effects, differ. Moreover, they consider an over-simplified government that balances its budget by collecting taxes on labor income. We allow for a more realistic structure for the government budget, welfare state and tax system, which allows for the government to collect not only taxes on labor income, but also capital and dividend income and also collect consumption and payroll taxes, and in addition, allows for the government to finance expenditure through debt issuance. We also consider workers that are risk averse and take into account consumption-saving decisions. While they assume that all capital is owned by natives, we also consider the possibility that legal immigrants and natives are identical in terms of firm, debt and capital ownership.

Besides allowing for heterogeneity in immigrants' legal status, a key difference between our approach and that of Battisti et al. (2018) is that we take into account the tax contributions of immigrants and natives as well as their consumption of public good, and how these might differ by immigrants' legal status, by calibrating our model to match data on US government tax revenues and expenditures. We combine, in a sense, the "accounting approach" that focuses mainly on the direct fiscal impacts of immigrants, with the general equilibrium approach that takes into account indirect labor market impacts. While in the Battisti et al. paper a proportional labor income tax imposed equally on both natives and immigrants is allowed to adjust to cover fiscal deficits or surpluses created by immigration-induced labor market changes, we also take also into account immigrants' and natives' direct tax contributions, prior to measuring their final fiscal and welfare effects.

A few more recent contributions employ similar models with search and matching frictions and a government that collects taxes and redistributes income to analyse the welfare effects of immigration. Ikhenaode (2018) extends the Battisti et al. model to allow natives to

endogenously adjust their skill in face of migration, and also distinguishes between young and retired workers, who contribute differently to the fiscal balance. Fiaschi et al. (2019) examine the welfare effects of a low-skill immigration inflow in Italy, by adopting a novel approach that accounts for the impact of immigration on prices of final goods. Both studies do not differentiate between legal and illegal immigration.

The rest of the paper is organized as follows. Section 2 presents the model, describes the workings of its main mechanisms, and provides intuition for its main results. Section 3 presents analytical comparative static results for how legal and illegal immigration affect job creation and native consumption, which lie at the heart of the quantitaive analysis that follows. Section 4 describes the parameterization of the model, and shows and compares the fiscal and welfare effects obtained by increasing legal and illegal immigration and the effects of a legalization program. Section 5 presents the results of the two model extensions, the one in which illegal immigrants perform a different productive role that compliments that of legal immigrants or natives, and the one that allows for public good to be congested by the presence of immigrants. Section 6 concludes.

2 The model

Consider an economy inhabited by a continuum of three types of households: the native households of measure $n > 0$, the legal immigrant households of measure $l > 0$, and the illegal immigrant households of measure $m > 0$. The number of members in each household is normalized to 1. All individuals supply their labor inelastically to the labor market. If employed, they produce, while if unemployed, they search for jobs. Only unemployed workers search for jobs. With a certain probability, an unemployed worker will be matched with a vacant job. But it is also possible that the agent cannot find a job and has to remain unemployed for some time. As a result, individuals face uncertainty in income, consumption and leisure. Following Lucas (1990), we assume that all members in the same household will pool their resources together in order to maximize the household's utility. There is one final goods sector, one intermediate goods sector and a government. The government collects taxes and issues government bonds to finance unemployment benefits and expenditure on pure and impure public goods.

2.1 The household's problem

Each household seeks to maximize utility from consumption of private goods. The household's discounted lifetime utility is given by:

$$\sum_{t=0}^{\infty} \beta^t \log c_{i,t}, \tag{1}$$

where $c_{i,t}$ is the household's private consumption, with $i = [n, l, m]$ indexing native, legal and illegal immigrant, respectively, and t indexing time. The parameter $\beta > 0$ is the discount factor. The household's problem is to choose the time paths $\{c_{i,t}, k_{i,t+1}\}_{t=0}^{\infty}$ subject to a budget constraint. The budget constraint differs depending on the type of the household. In particular, for $i = [n, l]$,

$$(1+\tau_c)c_{i,t} + k_{i,t+1} - k_{i,t} + d_{i,t+1} - d_{i,t} = (1-\tau)(w_{i,t}e_{i,t} + r_t k_{i,t} + r_t d_{i,t} + \pi_{i,t}) + b_i u_{i,t} - f_t \tag{2}$$

where b_i is the unemployment benefit, r_t is the rate of return on capital, $w_{i,t}$ is the wage rate, $u_{i,t}$ and $e_{i,t}$ are the numbers of unemployed and employed, respectively, household members, $d_{i,t}$ is the household's holdings of government bonds, $k_{i,t}$ is capital owned by the households and $\pi_{i,t}$ denotes dividend distributed by the firms. Natives and legal immigrants can accumulate capital, hold government bonds and own firms. Hence, besides labor income they might also receive dividends and capital income and returns from holding government bonds. A no-arbitrage condition requires that the return to capital, r_t, equals the return to government bonds. The unemployment benefit, b_i, is allowed to differ depending on the worker type, to allow for the possibility that immigrants, and especially illegal immigrants have limited access to welfare benefits. In particular, we assume $b_n \geq b_l \geq b_m$.[1] The natives and the legal immigrants, besides consumption taxes, they also pay income taxes and a lump-sum tax. The consumption tax rate is τ_c, the income tax rate is τ and f_t is the lump-sum tax. We assume that each native or legal immigrant household pays the same amount of lump sum tax. That is, $f_t(n + l) = F_t$, where F_t is the aggregate amount of lump-sum taxes the government needs to collect for its debt to be sustainable.

Below we consider two different cases as to how capital, bonds, and dividends are distributed among natives and legal immigrants. In the benchmark case, we follow a common

[1] Since the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) of 1996 many federal government benefits (Food stamps, TANF, AFDC and others) were restricted to US citizens only. Hence non-naturalized legal immigrants' income while unemployed was significantly lower. In the 2000's some but not all, states re-instated some of them. Illegal immigrants cannot access any unemployment insurance at all.

assumption in the literature (e.g. Battisti et al. 2018) and assume that only natives invest or own firms, so that all income from bonds, capital and dividends is distributed evenly among natives only. This means setting $\pi_{l,t} = d_{l,t} = k_{l,t} = 0$ and $\pi_{n,t} = \frac{\Pi_t}{n}$, $d_{n,t} = \frac{D_t}{n}$, $k_{n,t} = \frac{K_t}{n}$, where Π_t, D_t and K_t are total firm profits, government debt and capital in the economy, respectively, and are specified below. In the second case we assume that dividends, bonds and capital are all distributed evenly among natives and legal immigrants, which means setting $\pi_{n,t} = \pi_{l,t} = \frac{\Pi_t}{n+l}$, $d_{n,t} = d_{l,t} = \frac{D_t}{n+l}$ and $k_{n,t} = k_{l,t} = \frac{K_t}{n+l}$.

Illegal immigrants, on the other hand, pay only consumption taxes and the only income they earn is from supplying labor.[2] For $i = m$ the budget constraint is therefore given by:

$$(1 + \tau_c)c_{m,t} = w_{m,t}e_{m,t} + b_m u_{m,t}, \tag{3}$$

Solving the native's and legal immigrant's utility maximization problem yields the standard Euler equation:

$$\frac{c_{i,t+1}}{c_{i,t}} = \beta \left[1 + (1 - \tau)r_{t+1}\right].$$

whereas, it is straightforward from (1) and (3) that, since illegal immigrants households do not invest, they just consume their total income in each period. Hence,

$$c_{m,t} = \frac{w_{m,t}e_{m,t} + b_m u_{m,t}}{1 + \tau_c}. \tag{4}$$

2.2 Production

Firms operate either in the final or in the intermediate goods sector. Firms in the intermediate sector produce intermediate inputs that are sold in a competitive market. Firms in the final sector buy the intermediate goods and use them together with capital to produce the final consumption good.

[2]Since undocumented immigrants are not authorised to work in the US, they are not eligible for any Social Security benefits, whether they pay into the system or not. Nevertheless, there is evidence that a significant portion of them do work on the books, and pay income and payroll taxes through employers withholding from their paychecks or by the immigrants filing tax returns. For instance, a report from the Institute on Taxation and Economic Policy (ITEP), by Gee et al. (2017), points out that studies have estimated between 50 and 75 percent of undocumented immigrants pay personal income taxes using either false social security (SSN) or individual tax identification (ITIN) numbers. They estimate that undocumented immigrants pay a total of $11.74 billions in state and local taxes a year. While most of this amount is for sales and excise taxes, it includes about $1.1 billion in personal income taxes. Despite these evidence we choose to assume that illegal immigrants make zero income and payroll tax contributions, which represents the worst-case estimate for their overall tax contributions. Storesletten (2000) that also distinguishes between legal and illegal immigrants follows the same approach and assumes that illegal immigrants, although they consume the public good, they pay no income and payroll taxes and receive no transfers.

2.2.1 Final sector

In the final sector, firms use an intermediate labor input, X, and capital, K, to produce the final good Y, according to

$$Y_t = K_t^{\alpha} X_t^{1-\alpha}, \tag{5}$$

The market for capital is competitive, so that we have

$$r_t = \frac{\partial Y_t}{\partial K_t} - \delta, \tag{6}$$

where δ denotes the depreciation rate of capital. Moreover, since the markets for intermediate inputs and capital are competitive, firms in the final sector do not make any profits.

2.2.2 Intermediate sector

The firms in the intermediate sector produce the intermediate input X using a linear technology, which implies that the number of units produced equals the number of individuals employed in the intermediate sector. That is,

$$X_t = E_{n,t} + E_{l,t} + E_{m,t}, \tag{7}$$

where $E_{n,t} = ne_{n,t}$, $E_{l,t} = le_{l,t}$, $E_{m,t} = me_{m,t}$. In the baseline model, we assume that native and (legal and illegal) immigrant workers are perfect substitutes in the production process. We consider a generalized production function in which illegal immigrant workers are imperfect substitutes to natives and legal immigrant workers in Section 5.1. Once produced, the intermediate inputs are sold in a competitive market. So that the price of each unit of intermediate input equals the marginal product. Let p_t denote the price of the intermediate input. Then,

$$p_t = \frac{\partial Y_t}{\partial X_t}. \tag{8}$$

The value of a job filled with a worker of type $i = [n, l]$ is given by the following Bellman equation.

$$J_{i,t} = p_t - (1 + \tau_p) w_{i,t} + \frac{1}{1 + r_{t+1}} \left[(1 - s) J_{i,t+1} + s V_{t+1} \right], \tag{9}$$

where τ_p is a payroll tax rate, s is an exogenous job separation rate, jobs survive into the next period with probability $(1 - s)$ and become vacant otherwise, with value V_{t+1}. We assume that employers do not have to pay payroll tax on employment of illegal immigrants.

Thus, the value of a job filled with an illegal immigrant worker is given by

$$J_{m,t} = p_t - w_{m,t} + \frac{1}{1+r_{t+1}}\left[(1-s)J_{m,t+1} + sV_{t+1}\right]. \tag{10}$$

Unemployed workers and job vacancies are matched via a stochastic technology represented by the matching function $M_t = M(v_t, U_t)$, where v_t is the total number of vacancies, $U_t \equiv U_{n,t} + U_{l,t} + U_{m,t}$ is the total number of unemployed workers. Vacancies are filled with probability $q_t = \frac{M_t}{v_t} = M(1, \frac{1}{\theta_t})$ and workers find jobs with probability $\mu_t = \frac{M_t}{U_t} = M(\theta_t, 1)$, where the tightness of labor market is defined as $\theta_t = \frac{v_t}{U_t}$. Firms cannot create vacancies for only native or immigrant workers. In other words, vacancies cannot be targeted towards specific worker types. Hence, natives and immigrants (legal or illegal) all find jobs at rate μ_t.[3]

The evolution of the number of household members that are unemployed is given by:

$$u_{i,t+1} = (1-\mu_t)u_{i,t} + se_{i,t}, \tag{11}$$

where $e_{i,t} = 1 - u_{i,t}$.

There is a flow cost κ of posting a vacancy. The Bellman equation for the value of a vacancy is given by

$$V_t = -\kappa + \frac{1}{1+r_{t+1}}\left\{q_t\left[\phi_t J_{n,t+1} + (1-\phi_t)(\lambda_t J_{l,t+1} + (1-\lambda_t)J_{m,t+1})\right] + (1-q_t)V_{t+1}\right\}, \tag{12}$$

where, as mentioned above, q_t is the probability that a vacant firm will locate a searching worker. Since vacancies cannot be targeted towards a particular worker type, the firm does not know ex-ante whether the vacancy will be filled by a native or immigrant (legal or illegal) worker. It matches with either a native worker, with probability ϕ_t, a legal immigrant worker, with probability $(1-\phi_t)\lambda_t$ and an illegal immigrant worker, with probability $(1-\phi_t)(1-\lambda_t)$, where $\phi_t \equiv \frac{nu_{n,t}}{nu_{n,t}+lu_{l,t}+mu_{m,t}}$ is the share of natives in total searching population and $\lambda_t = \frac{lu_{l,t}}{lu_{l,t}+mu_{m,t}}$ is the share of searching immigrants that are legal.

The number of vacancies v_t is endogenously determined by free entry. Setting $V_t = 0$ yields the free-entry condition:

$$\frac{\kappa}{q_t} = \frac{1}{1+r_{t+1}}\left[\phi_t J_{n,t+1} + (1-\phi_t)(\lambda_t J_{l,t+1} + (1-\lambda_t)J_{m,t+1})\right] \tag{13}$$

[3]In Section 5.1, where we allow for illegal immigrants to be imperfect substitutes to natives and legal immigrants, we also explore the possibility that the labor market is segmented, and illegal immigrants search for jobs in a separate submarket.

As explained further below, wages are determined by a bargain between the firm and the worker. Workers are not paid their marginal product, thus firms in the intermediate sector make profits. In particular, the profits net of vacancy-posting costs are given by

$$\Pi_t = [p_t - (1+\tau_p)w_{n,t}]\, E_{n,t} + [p_t - (1+\tau_p)w_{l,t}]\, E_{l,t} + (p_t - w_{m,t})E_{m,t} - \kappa v_t. \tag{14}$$

The value to a worker of being unemployed ($Z_{i,t}$) satisfies:

$$Z_{i,t} = b_i - x_i + \frac{1}{1+r_{t+1}}\left[\mu_t W_{i,t+1} + (1-\mu_t)Z_{i,t+1}\right] \tag{15}$$

The flow value of unemployment is equal to the unemployment benefit b_i which is determined by the unemployment insurance replacement ratio minus a search cost x_i representing a utility cost from being unemployed and searching for a job. We assume that immigrants, and especially illegal immigrants, suffer larger utility cost of searching for a job, reflecting factors such as their lack of social network, limited knowledge of labor market institutions and language proficiency.[4] We standardize the search cost of a native worker to 0 and set $x_n = 0$, and we presume $x_m \geq x_l \geq 0$.

The value to a worker of being employed ($W_{i,t}$) satisfies:

$$W_{i,t} = (1-\tau)w_{i,t} + \frac{1}{1+r_{t+1}}\left[(1-s)W_{i,t+1} + sZ_{i,t+1}\right] \text{ for } i = [n,l], \text{ and} \tag{16}$$

$$W_{m,t} = w_{m,t} + \frac{1}{1+r_{t+1}}\left[(1-s)W_{m,t+1} + sZ_{m,t+1}\right] \tag{17}$$

Notice that the value of being employed changes for illegal immigrants to take into account that they do not pay income taxes.

Wages satisfy the standard Nash bargaining conditions. Let $\eta \in (0,1)$ denote the worker's share of surplus (or bargaining parameter). Then the wage rate $w_{i,t}$, $i = [n,l]$, must satisfy

$$(1-\eta)(1+\tau_p)\left[W_{i,t} - Z_{i,t}\right] = \eta(1-\tau)\left[J_{i,t} - V_t\right] \tag{18}$$

and the wage rate $w_{m,t}$ for illegal immigrant workers must satisfy

$$(1-\eta)\left[W_{i,t} - Z_{i,t}\right] = \eta\left[J_{i,t} - V_t\right] \tag{19}$$

[4]The higher utility cost of unemployment of immigrants has already been pointed out in Chasssamboulli and Palivos (2014). Chasssamboulli and Peri (2015, 2020) and Battisti et al. (2018) employ similar assumptions.

2.3 Government

The government is subject to the following constraint in which deficits are financed by increases in government bonds. Government bonds evolve according to:

$$D_{t+1} = D_t(1+r_t)+G_t+\sum_i b_i U_{i,t}-(\tau+\tau_p)\left(w_{n,t}E_{n,t}+w_{l,t}E_{l,t}\right)-\tau(r_tK_t+r_tD_t+\Pi_t)-\tau_c\sum_i C_{i,t}-F_t,$$

where, $C_{i,t}$ is the aggregate private consumption of households of type i, $U_{i,t}$ is the total number of type-i unemployed workers and G_t is government expenditure on public goods. In particular, we have $C_{n,t} = nc_{n,t}$, $C_{l,t} = lc_{l,t}$, $C_{m,t} = mc_{m,t}$, and $U_{n,t} = nu_{n,t}$, $U_{l,t} = lu_{l,t}$, $U_{m,t} = mu_{m,t}$.

Government expenditure on public goods G_t is divided into two parts: expenditure on pure public goods, denoted by G_t^p and expenditure on impure public goods, denoted by G_t^c. Formally, we have $G_t = G_t^p + G_t^c$. To capture the notion of pure public goods, we assume that expenditure G_t^p is independent of the number of immigrants and natives. On the contrary, the expenditure on impure public goods is influenced by native, legal and illegal immigrant workers' consumption of public goods, which is allowed to differ. In particular a type-i household consumes an amount g_i^c of the impure public good. The total government expenditure on impure public goods is then given by: $G_t^c = ng_n^c + lg_l^c + mg_m^c$.

The government's fiscal policy $(f_t, \tau_c, \tau, \tau_p)$ must be feasible in the sense that the present value of the stock of public debt goes to zero in infinity (no Ponzi game). The current government debt must therefore equal the net present value of future deficits and surpluses, which gives the following condition:

$$D_t = \frac{\sum_z \left[T_{t+z} + F_{t+z} - \tilde{G}_{t+z}\right]}{\prod_z \left[1 + r_{t+z}(1-\tau)\right]}, \tag{20}$$

where $T_{t+z} \equiv (\tau+\tau_p)\left(nw_{n,t+z}e_{n,t+z} + lw_{l,t+z}e_{l,t+z}\right) + \tau n(r_{t+z}k_{n,t+z} + \pi_{n,t+z}) + \tau l(r_{t+z}k_{l,t+z} + \pi_{l,t+z}) + \tau_c\sum_i ic_{i,t+z}$, $F_{t+z} = (n+l)f_{t+z}$, $\tilde{G}_{t+z} \equiv G_{t+z} + \sum_i ib_iu_{i,t+z}$ and $G_{t+z} \equiv G_{t+z}^c + G_{t+z}^p$.

2.4 Equilibrium

An equilibrium for this economy consists of a sequence of allocations $\{c_{i,t}, k_{i,t}, \pi_{i,t}, d_{i,t}, f_t\}_{t=0}^{\infty}$, a sequence of prices $\{p_t, r_t, w_{i,t}\}_{t=0}^{\infty}$ and a sequence of matching probabilities $\{\mu_t, q_t\}_{t=0}^{\infty}$ such that:

1. the free-entry condition in equation (13) is satisfied;

2. the allocations $\{c_{i,t}, k_{i,t+1}\}_{t=0}^{\infty}$ solve the native, legal and illegal immigrant household's problem;

3. the rate of return on capital r_t satisfies equation (6);

4. the price of intermediate input p_t satisfies equation (8);

5. the wage rates satisfy equations (18) and (19);

6. total dividends satisfy equation (14);

7. The government's set of policies $(f_t, \tau_c, \tau, \tau_p)$ is feasible and the government debt D_t equals the net present value of future deficits and surpluses (equation (20)).

2.5 Steady State

In the rest of the paper we focus on the steady state equilibrium and examine the long-run consequences of changes in the size and composition of immigrant population. The steady state equilibrium is given by:

$$\beta\left[1+(1-\tau)r\right]=1, \tag{21}$$

$$(1+\tau_c)c_i=(1-\tau)(w_i e_i+rk_i+rd_i+\pi_i)+b_i u_i-f, \text{ for } i=[n,l] \tag{22}$$

$$(1+\tau_c)c_m=w_m e_m+b_m u_m, \tag{23}$$

$$D=\frac{T+F-\tilde{G}}{r(1-\tau)}, \tag{24}$$

where $T\equiv(\tau+\tau_p)\left(nw_n e_n+lw_l e_l\right)+\tau(rK+\Pi)+\tau_c\sum_i ic_i$ and $\tilde{G}\equiv G+\sum_i ib_i u_i$. The total amount of lump sum tax, F, imposed by the government to keep debt sustainable is derived from (24) and is paid by natives and legal immigrants in equal proportions so that $f=\frac{F}{n+l}$. Notice that we assume that any fiscal burden imposed by illegal immigrants is born by legal citizens (natives or immigrants).

The aggregate capital stock and total dividends are given by

$$K=(ne_n+le_l+me_m)\left(\frac{\alpha}{r+\delta}\right)^{\frac{1}{1-\alpha}}, \tag{25}$$

$$\Pi=\left[p-(1+\tau_p)w_n\right]ne_n+\left[p-(1+\tau_p)w_l\right]le_l+(p-w_m)me_m-\kappa v. \tag{26}$$

As mentioned above, we consider two different cases regarding the distribution of dividends, capital and bonds. In the baseline case we set $d_l=k_l=\pi_l=0$, thus $k_n=\frac{K}{n}$, $\pi_n=\frac{\Pi}{n}$ and

$d_n = \frac{D}{n}$. Alternatively, we assume that legal immigrants are identical to natives in terms of firm, capital and debt ownership and set $k_n = k_l = \frac{K}{(n+l)}$, $\pi_n = \pi_l = \frac{\Pi}{(n+l)}$ and $d_n = d_l = \frac{D}{(n+l)}$.

The unemployment rates of workers of type $i = [n, l, m]$ are given by

$$u_i = \frac{s}{\mu + s} \tag{27}$$

and $e_i = 1 - u_i$.

The free-entry condition can be used to determine the equilibrium value of market tightness, θ, and in turn of μ and q. In particular:

$$\frac{\kappa}{q} = \frac{1}{1+r}\left[\phi J_n + (1-\phi)(\lambda J_l + (1-\lambda)J_m)\right], \tag{28}$$

where

$$J_i = \frac{(1+r)\left[p - (1+\tau_p)w_i\right]}{r+s}, \text{ for } i = [i, n] \tag{29}$$

$$J_m = \frac{(1+r)(p - w_m)}{r+s}. \tag{30}$$

Using (27), we can write

$$\phi = \frac{n}{n+l+m}, \ \lambda = \frac{l}{l+m}. \tag{31}$$

and using (25) we can write the price of the intermediate input as

$$p = (1-\alpha)\left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha}},$$

which is fixed and does not depend on immigrant stock or market tightness, θ. This is due to the fact that we assume that native, legal and illegal immigrant workers are perfect substitutes in the production process. In the extension we consider in Section 5.1, where illegal immigrants are imperfect substitutes for natives or legal immigrants, we have two different intermediate inputs and two different prices, one for each input, that depend on θ and the proportion of illegal immigrants in the labor force.

Wages are given by

$$w_n = \frac{\eta(r+s+\mu)(1-\tau)p + (1-\eta)(1+\tau_p)(r+s)b_n}{(1-\tau)(1+\tau_p)(r+s+\eta\mu)} \tag{32}$$

$$w_l = \frac{\eta(r+s+\mu)(1-\tau)p + (1-\eta)(1+\tau_p)(r+s)(b_l - x_l)}{(1-\tau)(1+\tau_p)(r+s+\eta\mu)} \tag{33}$$

$$w_m = \frac{\eta(r+s+\mu)p + (1-\eta)(r+s)(b_m - x_m)}{r+s+\eta\mu}. \tag{34}$$

In each case, the wage rate is basically a combination of the worker's outside option and productivity. It can be easily verified from (32) and (33) that wages are higher when the income tax rate τ is higher but lower when the payroll tax rate is higher. Bargaining implies that workers will transfer some of the burden of income taxes to the firm by obtaining higher wages and vice versa; the firm will transfer some of payroll cost to the worker by cutting down on wages. Moreover, larger flow unemployment value $(b_i - x_i)$ implies also higher wages as it improves a worker's bargaining position in wage setting. It follows that, despite being equally productive, legal immigrants may bargain for lower wages than natives if they face more restrictions in using welfare benefits than natives or suffer larger disutility while unemployed $(b_n > b_l - x_l)$. Similarly, illegal immigrants may bargain for lower wages than natives or legal immigrants for two reasons. First, they do not pay income taxes and second, they have limited access to welfare benefits and suffer presumably larger utility costs when being without a job meaning that their flow unemployment value is lower $(b_l - x_l > b_m - x_m)$.

With the wages in (32)-(34) substituted in, we can write the surplus of jobs filled by natives, legal and illegal immigrants, respectively as

$$\begin{aligned} J_n &= \frac{(1+r)(1-\eta)\left[p - \frac{1+\tau_p}{1-\tau}b_n\right]}{r+s+\eta\mu} \\ J_l &= \frac{(1+r)(1-\eta)\left[p - \frac{1+\tau_p}{1-\tau}(b_l - x_l)\right]}{r+s+\eta\mu} \\ J_m &= \frac{(1+r)(1-\eta)\left[p - b_m + x_m\right]}{r+s+\eta\mu} \end{aligned} \tag{35}$$

It can be easily verified that since $\tau_p + \tau > 0$, which ensures $\frac{1+\tau_p}{1-\tau} > 1$ then J_m is greater than both J_l and J_n, meaning that firms can extract higher surplus from illegal immigrants, even when immigrants have equal access to unemployment insurance benefits as natives $(b_n = b_l = b_m)$ and face no higher search costs than natives $(x_m = x_l = 0)$. If, in addition, $b_n \geq b_l \geq b_m$ or $x_m \geq x_l \geq 0$, then we can write $J_m > J_l \geq J_n$, and firms can extract lower surplus from natives than from either of the two types of immigrants. As we further

demonstrate in Section 3, this difference in the surplus that firms generate from employing immigrants as opposed to natives is the driving force behind the job-creation channel first emphasized in Chassamboulli and Palivos (2014) and subsequently in Chassamboulli and Peri (2015) and Battisti et al. (2018) among others. In these papers, however, the differences in surpluses are driven mainly by wage gaps between natives and immigrants generated by differences in outside options. In our case, besides the differences in outside options, an additional reason why illegal immigrants may generate larger surplus to firms relates to tax contributions. In particular, firms that employ illegal immigrants can save on labor costs either by avoiding payroll taxes or by offering lower wages to illegal immigrants who do not pay income taxes.

In the case where $J_m > J_l \geq J_n$, we need to exclude the possibility that a firm that meets a native worker decides not to form an employment relation and continues to search. As shown in Appendix A, for a meaningful equilibrium where natives are employed, the following restriction on the parameter values must hold:

$$p > \frac{1+\tau_p}{1-\tau} b_n.$$

Proposition 1 *Existence and Uniqueness*

The proof of existence and uniqueness is shown in Appendix A.

Using (31) to substitute for ϕ, λ and (35) to substitute for J_n, J_l and J_m in the free-entry condition (13) we obtain:

$$\frac{\kappa}{q} = \frac{1-\eta}{n+l+m}\left[n\left(\frac{p-\frac{1+\tau_p}{1-\tau}b_n}{r+s+\eta\mu}\right)+l\left(\frac{p-\frac{1+\tau_p}{1-\tau}(b_l-x_l)}{r+s+\eta\mu}\right)+m\left(\frac{p-b_m+x_m}{r+s+\eta\mu}\right)\right] \tag{36}$$

This condition equates the expected profits from a new job (RHS) to the average vacancy positing cost (LHS). The left-hand side of above equation is increasing with respect to θ, whereas the right-hand side is decreasing in θ, hence, the steady state exists and is unique.

3 Comparative Static Results

A key feature of our model is that it accounts for the impact of immigration on job creation. Immigration-induced changes in job creation, employment and production can change natives' consumption and welfare through their impact on natives' income (from supplying labor, holding capital or from dividends). At the same time, by affecting households income, immigration can affect the tax base and impact natives' welfare through changes in

the lump-sum tax f. At the heart of these two effects is how immigration affects market tightness. Comparative static results for how changes in the size of immigrant stocks affect market tightness, employment and income are summarized in the following two propositions.

Proposition 2 *An increase in m increases market tightness, wages, capital, dividends and decreases the unemployment rates.*

$$\frac{d\theta}{dm} > 0, \quad \frac{dw_i}{dm} > 0, \quad \frac{de_i}{dm} > 0, \quad \frac{dk_i}{dm} > 0, \quad \frac{d\pi_i}{dm} > 0 \text{ and } \quad \frac{du_i}{dm} < 0.$$

Proof. See Appendix A

As discussed above, a firm generates larger surplus from hiring an illegal immigrant than either a native or a legal immigrant, for three reasons. First, illegal immigrants are willing to accept lower wages because they do not have to pay income taxes ($\tau > 0$). Second, firms can save on labor costs by avoiding to pay payroll taxes on illegal immigrants ($\tau_p > 0$). Third, illegal immigrants may have lower income while unemployed than natives or legal immigrants which forces them to accept lower wages ($b_m - x_m < b_l - x_l \leq b_n$). We can therefore show that an increase in m, which puts a larger weight in the free entry condition on J_m (see equation 28) raises the expected profits of new jobs (right-hand side of 36) and increases θ. In turn, the increase in θ increases the employment rates and wages. With more immigrants and higher employment rates the production of the intermediate input X increases and through production complementarities, capital also increases. Finally, dividends also increase since with a higher share of illegal immigrants in the labor force firms pay on average lower wages and save more on payroll costs, which means larger profits on average.

Consider next an increase in legal immigration l. Legal immigrants may generate larger profits to firms than natives only if they are willing to accept lower wages than natives. This will be the case if their flow unemployment value is lower than that of natives ($b_l - x_l < b_n$). However, for the reasons explained above, employing legal immigrants is still more costly to firms than employing illegal immigrants ($J_m > J_l$). Hence, even if legal immigrants accept lower wages than natives, which ensures $J_l > J_n$ putting larger weight on J_l in condition (13) does not necessarily increase average profits, while if legal immigrants' and natives' wages are equal, which means $J_l = J_n$, then putting larger weight on J_l certainly decreases average firm profits. It follows that the impact of legal immigration on job creation can be either positive or negative. Specifically,

Proposition 3 *If $b_n > b_l - x_l \geq b_m - x_m$ an increase in l has an ambiguous effect on market tightness, wages, capital, dividends and unemployment rates. If $b_n = b_l - x_l \geq b_m - x_m$ an increase in l has a negative effect on market tightness, wages, capital, dividends and unemployment rates.*

Notice that we cannot rule out the possibility that legal immigrants also have a positive job creation effect. A positive effect is more likely when b_n is large relative to $b_l - x_l$, i.e., when natives have a much better outside option compared to immigrants even when immigrants are legal.

3.1 Welfare of native households

In steady state, the lifetime discounted utility of a native household is given by

$$\Phi = \frac{1}{1-\beta} \log c_n.$$

and

$$(1+\tau_c)c_n = (1-\tau)(w_n e_n + r k_n + r d_n + \pi_n) + b_n u_n - f,$$

Also the government debt D is fixed and is not affected by a change in immigration policy. For the government debt to be sustainable the government must raise revenues to finance any additional fiscal burden due to immigration by increasing taxes. As already mentioned we assume that any expenditure in excess of tax revenues from payroll, income and consumption taxes is financed by an increase in the lump sum tax f imposed on natives and legal immigrants. If, however, immigration generates a fiscal gain, then f is reduced to maintain government debt at its steady-state level. The expression of the lump sum tax f is:

$$f = \frac{Dr(1-\tau) + \tilde{G} - T}{n+l}$$

where, as defined above, $\tilde{G} \equiv G^c + G^p + \sum_i i b_i u_i$ and $G^c = n g_n^c + l g_l^c + m g_m^c$. An increase in immigration will raise government expenditure on impure public goods G^c, but will also increase total tax revenues T, and may or may not increase government expenditure on unemployment insurance $\sum_i i b_i u_i$. Immigration affects the expenditure on unemployment insurance in two opposing ways. One the one hand, all else equal, more immigrants implies also more unemployed in the labor force, which may increase demand for unemployment benefits. On the other hand, if immigration increases firm profits leading to higher job creation, then the unemployment rate might fall, leading to lower unemployment insurance payments. It is therefore no clear cut that an increase in immigration creates additional fiscal burden to be paid by natives. Overall, an additional fiscal burden is less likely when, first, immigrants consume less of the public good than they pay in taxes, and second, when immigrants have a positive job creation effect in the host economy, which lowers the unem-

ployment rate, thereby reducing expenditure on unemployment insurance, and generating more tax revenues by increasing income from capital, wages and dividends.

Differentiating Φ with respect to m yields

$$\frac{d\Phi}{dm} = \frac{1}{1-\beta}\frac{1}{c_n} \underbrace{\frac{dc_n}{dm}}_{\text{positive/negative}},$$

where

$$\frac{dc_n}{dm} = \frac{[(1-\tau)w_n - b_n]}{1+\tau_c} \underbrace{\frac{de_n}{dm}}_{\text{positive}} + \frac{(1-\tau)e_n}{1+\tau_c} \underbrace{\frac{dw_n}{dm}}_{\text{positive}} + \frac{(1-\tau)r}{1+\tau_c} \underbrace{\frac{dk_n}{dm}}_{\text{positive}} + \frac{1-\tau}{1+\tau_c} \underbrace{\frac{d\pi_n}{dm}}_{\text{positive}} - \frac{1}{1+\tau_c} \underbrace{\frac{df}{dm}}_{\text{positive/negative}}$$

As summarized in Proposition 2, illegal immigrants induce job creation leading to higher employment and income for natives. Hence, putting aside fiscal considerations, the presence of illegal immigrants increases the consumption and welfare of natives. However, as discussed above, the effect of illegal immigration on lump sum tax f is ambiguous. On the one hand, illegal immigration induces a job creation effect to raise native's employment, wage rate, physical capital holdings and dividends, resulting in more tax revenues that can be used to reduce the lump sum tax. On the other hand, an increase in illegal immigration also means more uses of impure public goods, that require the government to impose a higher lump sum tax. In fact, as discussed above, the job creating effect of illegal immigrants stems partially from the limitations they face in accessing unemployment insurance, which forces them to accept lower wages, but also from the fact that they do not pay income taxes and firms can save on payroll taxes by hiring them. Once fiscal considerations are included, the overall impact of immigration on native's welfare may be positive or negative. Notice, however, that even if the impact of illegal immigrants on f is positive, meaning that they create a net fiscal burden for natives, their effect on native welfare may still be positive if the job creation effect is strong enough to raise natives' income by more than it raises taxes.

Legal immigrants, on the other hand, can potentially contribute more to the welfare state, by paying taxes, but their impact on job creation and thus natives' income may be positive or negative, as summarized in Proposition 3. Since legal immigrants pay more in taxes than illegal ones, it seems reasonable at first, to assume that the fiscal impact they impose on natives is smaller than that of illegal immigrants. However, this view ignores two aspects. First, legal immigrants may raise expenditure on public goods more than illegal immigrants, since the latter have limited access to welfare benefits. What matters for the overall fiscal impact is not tax revenues per se but tax revenues relative to welfare receipts. Second, and more importantly, this view overlooks the labor market effects of the two types

of immigration. If legal immigration reduces job creation or has a smaller positive effect on job creation, even if it pays more in taxes than collects in benefits, its overall fiscal effect may be more negative than that of illegal immigration.

In our quantitative exercise that follows we simulate the full effects of changes in immigration on fiscal burden and natives' welfare, taking into account the labor market impact of immigration, under different scenarios regarding immigrants' use of public services, capital holdings and firm ownership.

4 Quantitative Analysis

4.1 Parameterization

We parameterize the model to represent the average performance and conditions of the US economy between 2000 and 2010 a period in which the presence of illegal immigrants in the US has peaked to about 11.5 million individuals. To do so we combine three types of parameters. Some are taken from the literature. Others are taken directly from the US data. Finally a third group is chosen to match some moments of the data. The parameter choice is summarized in Table 1. We describe here in detail the sources and the methods used to calculate these parameters. For some key parameters we perform robustness checks in Appendix B so as to test the sensitivity of our main results to a range of plausible values.

We use a Cobb-Douglas matching function, $M_t = U_t^{\epsilon} v_t^{1-\epsilon}$, with constant returns to scale to U_t and v_t. Following common practice in these models, we set the unemployment elasticity of the matching function to $\epsilon = 0.5$ which is within the range of estimates reported in Petrongolo and Pissarides (2001). We postulate the workers' bargaining power to be $\eta = 0.5$, so that the Hosios condition ($\eta = \epsilon$) is met (see Hosios, 1990). We use the monthly interest rate $r = 0.4\%$ which implies a yearly real rate of about 5%.[5] We set the share of capital in GDP to $\alpha = 0.39$, which is the value we obtain using data from the Bureau of Economic Analysis (BEA) over the period 2000-2010.[6] Data from the BEA also give a value of 0.0061 for the monthly depreciation rate of the capital stock. Data from June 2007 to June 2010 from the Job Openings and Labor Turnover Survey (JOLTS) give an estimate for the monthly job-separation rate of $s = 3.3\%$, which is close to Hall's (2005) estimate of 3.4%. We standardized the native labor force to $n = 1$ and set $m = 0.06$ and $l = 0.11$. These numbers equal the average values obtained by dividing the number of illegal and legal immigrants, respectively, in the US in working age (16 to 65) by the total US native population in working age.[7]

[5] We match all the flow rates in the model to monthly rates.

[6] The definition of capital stock includes nonresidential equipment and structures.

[7] Tabulations of data from the U.S. Census Bureau prepared by the Migration Policy In-

We jointly calibrate the remaining 14 parameters of the model κ, D, b_n, b_l, b_m, x_l, x_m, G^p, g_n^c, g_l^c, g_m^c, τ, τ_p, τ_c to match the following targets. To pin down κ, the vacancy posting cost, we set the US employment rate to 94.4% as calculated from the Current Population Survey (CPS) for ages 16 and over. The government debt as a % of GDP is equal to 91% according to data from the OECD (Organisation for Economic Co-operation and Development), which gives a value for D. We use the US unemployment replacement ratio of 0.4 for the ratio of unemployment to employment income to get values for the unemployment incomes; we set $b_n = 0.4w_n$, $b_l = 0.4w_l$ and $b_m = 0$. The latter reflects the fact that illegal immigrants cannot access any unemployment insurance benefits. The values of the unemployment incomes, together with the tax rates τ, τ_p and τ_c and the search cost parameters x_l and x_m, determine the wage gaps between natives, legal and illegal immigrants. As explained below, we get the tax rates by targeting government revenues, thus we choose the values for x_l and x_m that match the wage gaps. In particular, we set the wage gap between legal immigrants and natives at 20% of the native wage which is consistent with the immigrant native wage gap estimated in Borjas and Friedberg (2009) for year 2000, after controlling for observed abilities such as education and age. Based on studies of the wage increase produced by legalization following Rivera-Batiz (1999) and Kossoudji and Cobb-Clark (2002) we set the wage gap between illegal and legal immigrants to a baseline value of 7.5% (as estimated from the NLSY data at page 621 of Kossoudji and Cobb-Clark, 2002). More recent studies of the legal-illegal immigrant wage gap (Barcellos, 2010) have identified somewhat smaller values estimated to be in the order of 5%. We use that value in a robustness check shown in Appendix B.

The remaining 7 parameters (G^p, g_n^c, g_l^c, g_m^c, τ, τ_p, τ_c) determine the government's tax revenues from natives, legal immigrants and illegal immigrants, and the expenditure on public goods created by each of these three groups of workers. Following a standard approach in the literature (e.g. Storesletten 2000, 2003, and Battisti et al. 2018) we assume, as a benchmark calibration, that immigrants incur impure public-goods consumption at the same rate as natives and set $g_m^c = g_l^c = g_n^c = g^c$. One could think of this as representing the worst case scenario regarding immigrants' contribution to the fiscal balance. Given the limitations that

stitute (https://www.migrationpolicy.org/programs/data-hub/charts/immigrant-share-us-population-and-civilian-labor-force) show that 14.45% of US civilian labor force between 2000 and 2010 are foreign born giving an estimate of about 28.45 millions of foreign born workers in the US labor force. Based on estimates from the Pew Research Center (see https://www.pewhispanic.org/interactives/unauthorized-trends/) the average number of unauthorised immigrants in the US over the same period is about 11.1 millions. About 90% of them are in working age so that the total unauthorised population in working age averages to about 10.2 millions. The remaining 18.3 millions of foreign born are considered legal immigrants. Dividing these numbers by the US native labor force in working age (total US labor force in working age minus foreign born in working age) we get $l = 0.11$ and $m = 0.06$.

immigrants and especially illegal immigrants face in accessing welfare benefits and other public goods, one could argue that native's consumption of impure public goods (other than unemployment insurance benefits) exceeds that of immigrants.[8] We then target the government expenditure on impure public goods to get a value for g^c and total government expenditure to get a value for G^p. Based on data from the OECD, over the 2000-2010 period, government expenditure for "individual" consumption averaged to 6.32%, while total government expenditure averaged to 38% of GDP.[9] We therefore set $\frac{G^c+\sum_i ib_i u_i}{Y} = 6.32\%$ and $\frac{\tilde{G}}{Y} = 38\%$. From the same data set we find that the government's revenues from payroll taxes, income taxes, and taxes on goods and services (consumption taxes) are equal to 6.42%, 11.66% and 4.39% of GDP, respectively.[10] Income taxes include taxes on individual and corporate income, while payroll taxes include mainly social security contributions.

While in the benchmark parameterization we set $g_m^c = g_l^c = g_n^c$, we also derive results under an alternative parameterization that allows for natives and immigrants to generate different expenditure on impure public goods. We set $g_n^c \neq g_l^c = g_m^c$ and choose the values of g_n^c and g_l^c $(= g_m^c)$ that match the ratio of tax receipts to outlays for natives and immigrants,

[8] Although safety net programs are aimed at low-income families not all immigrants have access due to restrictions imposed by law. Unauthorized immigrants and individuals on-nonimmigrant visas are not eligible for the Supplemental Nutrition Assistance Program, non-emergency Medicaid, Supplemental Security Income and Temporary Assistance for Needy Families. Additional restrictions were introduced by The Personal Responsibility and Work Opportunity Reconciliation Act of 1996 and the Illegal Immigration Reform and Immigrant Responsibility Act of 1996. Federal means-tested public benefit programs (such as Medicaid) became no longer available to lawful permanent residents for the first 5 years after receiving the legal-permanent status. Subsequent amendments to the 1996 legislation restored some benefits to legal immigrants, but not all. However, despite these restrictions we can still not rule out the possibility that some programs are used more intensively by immigrants. A general finding for the United States has been that immigrants are less likely to use some programs such as Social Security and Medicare, but more likely to use some other programs such as bilingual education. See Blau and Mackie (2017) for more details.

[9] In the OECD data set, the general government final consumption (not including government investment) is broken into two distinct groups: one that reflects expenditure on collective consumption, such as defence, justice etc., and one that reflects expenditure on individual consumption such as health care, housing, education etc. The second category, labeled as "individual", relates to the expenditure incurred by the government for the benefit of individual households. We consider these to be the expenditure on impure public goods. Over the 2000-2010 period, collective government expenditure averaged to 9.03%, while as mentioned above, individual government expenditure are equal to 6.32% of GDP. We consider the rest of the government expenditure ($38\% - 9.03\% - 6.32\% = 22.7\%$) to be expenditure on public investment and include it in our measure of G^p.

[10] In the OECD data set, total government revenue as a % of GDP averaged over years 2000-2010 equals 32.22%, whereas total tax revenue equals $6.42 + 11.66 + 4.39 = 22.47\%$. This is because, besides tax revenues, total government revenues, as compiled by OECD countries according to the 2008 System of National Accounts (SNA 2008), include also social contributions, transfers from other government units and international organizations, property income, sales of goods and services and miscellaneous transfers other than grants. Ignoring this additional revenues would overestimate our measure of lump sum tax f. For this reason, we take into account this additional revenue when calculating f. Note that, while this improves our estimate of fiscal deficit it comes without loss of generality, since this additional revenue is independent of the labor force size and is not affected by immigration.

which based on Blau and Mackie (2017) (see Box 8-1 and Table 8-2) are equal to 0.768 and 0.917, respectively, when all government consumption expenditure on pure public goods is attributed to natives. That is, these estimates assume that outlays to immigrants include only government expenditure on impure public goods, while outlays to natives include also consumption expenditure on pure public goods.[11] The values that match these targets are $g_n^c = 2.36$ and $g_l^c = g_m^c = 1.18$. Notice that this parameterization places a much larger weight in total government expenditure on impure public goods. Total expenditure on impure public goods (including unemployment insurance payments) as a percentage of GDP are about 24% in this case as opposed to 6.32% in the baseline parameterization.

Finally, let us point out that in the baseline parameterization we assume that only natives save, hold bonds and own firms meaning that $d_l = k_l = \pi_l = 0$ and $k_n = \frac{K}{n}$, $\pi_n = \frac{\Pi}{n}$ and $d_n = \frac{D}{n}$. In a second specification, we keep targeting the ratio of tax receipts to outlays for natives and immigrants, as above, but assume, instead that legal immigrants and natives are identical in terms of firm and capital ownership. We set, in particular, $k = k_n = k_l = \frac{K}{(n+l)}$, $\pi = \pi_n = \pi_l = \frac{\Pi}{(n+l)}$ and $d = d_n = d_l = \frac{D}{(n+l)}$. The calibration of parameters remains as described above. The only difference is that we change our targets for the ratio of tax receipts to outlays for natives and immigrants, to 0.766 and 0.933, respectively, which based on Blau and Mackie (2017) are the receipts to outlays ratio for natives and immigrants under the assumption that immigrants own US firms and make corporate and capital tax payments.[12] In this case we get $g_n^c = 2.27$ and $g_l^c = g_m^c = 1.65$.

[11] Using CPS (Current Population Survey) data Blau and Mackie (2017) estimate receipts to outlays for immigrants and natives under alternative scenarios for attributing public expenditures on pure public goods to immigrants and natives and under alternative scenarios for immigrants' ownership of U.S. companies and contribution to capital and corporate tax payments. In one of their scenarios they assume that immigrants' do not own shares of U.S. companies, thus pay not taxes on capital income or dividends, and in addition, do not assign to immigrants the average cost of pure public goods, implying that the cost of providing them to an additional immigrant should be zero, in line with our assumptions. To be consistent with these estimates, we measure total outlays to natives as $g_n^c n + b_n u_n n + rD + G_1^p$ and total outlays to immigrants as $g_l^c l + g_m^c m + b_l u_l l$, where G_1^p is the collective government expenditure (which averages to 9.03% of GDP – see footnote 9). Outlays to natives include expenditure for individual consumption, unemployment insurance receipts, interest payments for servicing government debt and government expenditure for collective consumption. Outlays to immigrants include only expenditure for individual consumption and unemployment insurance receipts. We should also point out that because the CPS does not identify the legal status of the responders all foreign-born in the survey are consider "immigrants" even though such a categorization also includes foreign students, workers on temporary employment visas and unauthorized immigrants. Since the Blau and Mackie estimate for immigrants' receipts to outlays ratio is for all immigrants, irrespective of legal status, we set $g_l^c = g_m^c$. Storesletten (2000) also assumes that illegal immigrants incur public consumption at the same rate as their legal counterparts.

[12] In another scenario Blau and Mackie (2017) keep the assumption that immigrants do not generate expenditure on pure public goods, but relax the assumption that they do not own firms. We use these estimates in this second specification. In this case, we measure total outlays to natives as $g_n^c n + b_n u_n n + rdn + G_1^p$ and total outlays to immigrants as $g_l^c l + g_m^c m + b_l u_l l + rdl$. We add interest payments to the outlays of not only natives but also legal immigrants since both hold government debt.

4.2 Quantitative Results

We describe here the effects of increasing the numbers of legal and illegal immigrants on labor market variables (unemployment rates, wages, and output) and consumption. We also characterize their fiscal impact, by reporting changes in government expenditure and revenues, and the change in the lump sum tax, f. Tables 2-4 show the effects of increasing legal immigration l. Columns 1-4 of each table show the effects of increasing l by 25%, 50%, 75% and 100%, respectively. Table 2 shows the results using the baseline parameterization, described in Section 4.1. In Tables 3 and 4 we use the two alternative parameterizations in which we match the receipts to outlays ratios based on Blau and Mackie (2017). In Table 3, only natives hold capital, debt and own firms, while in Table 4 natives and legal immigrants are identical in terms of ownership of firms, capital and debt. Tables 5-7 that follow the structure of Tables 2-4 show results for the effects of increasing illegal immigration m. In Table 8 we report results for the effects of a 5% increase in the labor force caused by an increase in legal and illegal immigration respectively. By considering changes in the labor force of equal size, we want to compare the effects of legal to those of illegal immigration. Finally, the consequences of a legalization program that replaces illegal immigrants with legal ones are summarized in Table 9.

4.2.1 Effects of increasing legal immigration

Increasing legal immigration increases natives' consumption. In our calibrated model a 50% increase in the number of legal immigrants increases each native's consumption by about $1.5\%-4\%$. This occurs for two reasons. First, with more legal immigrants in the labor market job creation increases. There are more vacancies per unemployed worker, the job finding rate increases and the unemployment rate falls. Worker's outside option improves which allows them to bargain for a higher wage. Job creation increases because legal immigrants' wages are sufficiently lower than those of natives, which means that their outside option is significantly lower. Their wages are lower enough so that their increased presence in the labor market increases the expected profits of firms from opening new vacancies. Firm profits and dividend income increases. Demand for capital also increases as the supply of labor increases leading to also higher capital income for native workers. Overall, this positive job creation effect leads to higher income to native workers from wages, dividends and capital earnings, and in turn, to higher consumption. Second, natives consumption increases because with a higher number of legal immigrants the fiscal burden on natives decreases. The lump sum tax f decreases meaning that legal immigrants help decrease government expenditure in excess of tax revenues (a 50% increase in l, decreases f by about $9.5\% - 19.2\%$). They increase the

tax base leading to more tax contributions relative to receipts, and at the same time, due to their positive job creation effect, they also lower expenditure on unemployment insurance.

Their positive impact on fiscal balance seems to be the main reason why legal immigrants increase natives' consumption. In Table B1 of Appendix B we show results for increasing l in the case where legal immigrants' outside option is not worse than that of natives. In particular, we set $x_l = 0$ so that $w_l = w_n$ and natives and legal immigrants generate equal profits to firms. The positive job creation effect completely vanishes in this case. In fact, it turns negative as the increased presence of legal immigrants lowers the expected profits of firms, by reducing their chances of matching with an illegal immigrant whose wage is lower and generates larger profits to firms. As can be seen unemployment increases in this case, while natives' wages fall, and expenditure on unemployment insurance increases. The percentage increase in dividends is smaller and is driven mainly by the fall in wages, while output per capita falls. Tax revenues increase by less, while government expenditures increase by more. Nevertheless, even in this case, we get a significant decrease in f when legal immigration increases. The main reason for the large decrease in f, despite the negative job creation effect, is the direct positive effect of legal immigrants on the fiscal balance: their tax contributions greatly exceed their consumption of the impure public good.

The effects of legal immigration on fiscal balance and natives' consumption carry through to the two alternative parameterizations, shown in Tables 3 and 4. Despite immigrants' consumption of impure public good (g_l^c) being significantly larger in these two cases (1.18 and 1.65 as opposed to 0.5 in the baseline calibration), we get a decrease in f and an increase in natives' consumption.[13]

4.2.2 Effects of increasing illegal immigration

Illegal immigrants also have a positive impact on native consumption, but unlike legal immigrants, their positive consumption effect stems mainly from their positive effect on job creation. They help natives increase consumption by reducing unemployment and increasing their income from wages, capital and dividends. They also help reduce expenditure on unemployment insurance considerably and, although they do not pay payroll and income taxes, they help increase tax revenues from not only consumption but also payroll and income taxes by increasing income to natives and legal immigrant workers.

As regards their net fiscal impact, it is positive but small relative to their strong positive

[13] We should perhaps clarify that for a more positive impact of immigrants on public finances what matters is not whether their consumption of impure public goods is lower than that of natives, but whether it is low relative to their tax payments. In the two alternative parameterizations, taxes remain the same, while immigrants' public consumption is larger than in the baseline parameterization, implying a more negative fiscal effect. Still, we get a decrease in f.

effect on firm profits, job creation and employment. In the baseline parameterezation (Table 5) their impact on f is negative. It becomes smaller, but remains negative, in the second parameterization (Table 6), where immigrants' public-good consumption is set higher, and in the third parameterization (Table 7), where immigrants' public-good consumption is at the highest, it turns positive, which means that in this case illegal immigrants increase government expenditure in excess of tax revenues. However, even in this case, their impact on native consumption is positive, which implies that their indirect positive effect on natives' income (from dividends, capital and wages) dominates over the additional fiscal burden they directly impose on them.

In Appendix B, we examine whether this positive job creation and consumption effect carries through when we reduce the gap in wages between legal and illegal immigrants to 5% and 0%, by reducing illegal immigrants search cost x_m. Results are in Tables B2 and B3. We see that even in these cases natives' consumption and labor market outcomes improve with the increase in illegal immigration. There are significant gains from the presence of illegal immigrants in the labor market stemming from the fact that firms that employ them do not have to pay payroll taxes or bear some of the weight of income taxes. Even when we set $x_m = 0$, which sets the wage of illegal immigrants about 10% and 30% higher than that of natives and legal immigrants, respectively, we get that the value of a job filled by an illegal immigrant to the firm is almost twice the value of a job filled by native (specifically, $J_m = 1.9J_n$)). As shown in Table B4, even in this case, increasing the presence of illegal immigrants in the labor force leads to a lower unemployment rate, lower expenditure on unemployment insurance, more income to natives (from dividends and capital), reduced fiscal burden on natives, and higher consumption.

4.2.3 Comparing effects: legal vs illegal immigration

The differences in the effects of legal and illegal immigration discussed above, could be partly driven by the different sizes of these populations. Since the legal immigrant population is almost twice as large as the illegal immigrant population, a certain percentage increase in the number of legal immigrants results in a much larger increase in labor force than an equal percentage increase in illegal immigrants. The larger positive impact of legal immigration on native consumption and fiscal balance, for instance, could be due to this difference in size. We therefore compare here the effects of changes in legal and illegal immigration that cause changes in total labor force of equal size.

Notice that under our assumption that legal and illegal immigrants' consumption of impure public goods is equal ($g_m^c = g_l^c$), then a certain percentage increase in the labor force due to immigration will produce the same percentage increase in government expenditure on

impure goods (excluding expenditure on unemployment insurance) irrespective of whether immigrants are legal or illegal. Thus, any differences in the welfare effects on natives between these two cases would be driven by their differential impact on first, fiscal balance through tax receipts, and second, job creation.

As shown in Table 8, illegal immigrants' impact on unemployment rate and unemployment insurance payments, wages and output per capita is almost double that of legal immigrants, while their positive impact on dividend and capital income is also larger than that of legal immigrants. This is because of the significantly more positive effect that illegal immigrants have on firm profits and job creation incentives. Nevertheless, even when considering changes in the labor force of equal size, the impact of legal immigrants on natives' consumption is in general larger than that of illegal immigrants. In our baseline calibration, for instance, a 5% increase in the labor force due to legal immigration increases each natives' consumption by 4.3%. The same increase in the size of the labor force due to illegal immigration increases native consumption by 3.1%. Despite the much stronger positive income effect of the latter, legal immigrants have a stronger positive impact on natives' welfare, because they help reduce significantly the fiscal burden on natives by paying more taxes. In the baseline case, increasing the number of legal immigrants to produce a 5% increase in the labor force decreases f by about 20%, while an increase in the labor force of the same size due to illegal immigration decreases f by only about 8%.

4.2.4 The effects of a legalization program

We next consider the effects of a legalization program by decreasing illegal immigrants and increasing legal immigrants at the same time, so that total number of immigrants remains the same. Since legal and illegal immigrants' consumption of public good is assumed to be equal ($g_m^c = g_l^c$), such a shift in the composition of immigrants should leave expenditure on impure goods, other than unemployment insurance, intact. The legalization program thus influences the fiscal balance only through its impact on job creation and income, tax receipts and unemployment insurance payments.

As regards tax receipts, the legalization program has two opposite effects. On the one hand, it ultimately generates more receipts from income and payroll taxes, since legalized immigrants must now pay income and are subject to payroll taxes. On the other hand, as discussed above, legal immigrants are more costly to firms than illegal immigrants and replacing illegal with legal immigrants may have a negative impact on firm profits, job creation and in turn income from wages, dividend and capital. The resulting decrease in tax base implies lower tax receipts. Moreover, any negative effect on job creation from a legalization program will translate into more unemployment insurance payments. We see in

Table 9 that in our calibrated model a legalization program indeed discourages job entry and leads to lower wages, a higher unemployment rate and more unemployment insurance payments. It also reduces dividends and capital earnings. All these deteriorate the fiscal balance. Nevertheless, the increased tax receipts from legalized immigrants dominate over these negative effects. The legalization program increases tax revenues more than it increases government expenditure, leading to a decrease in f and an improvement in the fiscal balance.

As regards its impact on native welfare, again, there are two opposing channels. On the one hand, it reduces the fiscal burden on natives, which results in higher consumption for natives. On the other hand, it reduces income to natives with a negative impact on their consumption. This negative income effect is stronger when legal immigrants are allowed to hold capital and earn dividends. In this case, the legalization program reduces per capita dividends and capital not only because it lowers firm profits and output, but also because dividends and capital must now be shared among a larger group of individuals. Under the assumption that legal immigrants are identical to natives in terms of firm ownership and capital, the legalization program, despite improving public finances, it has a small, but negative impact on native consumption. In our calibrated model with legal immigrants and natives being identical in terms of ownership, a legalization program that eliminates all illegal immigrants lowers native consumption by only 0.4%. But the positive effect on fiscal balance dominates over the negative income effect, and as a result, the legalization program increases natives' consumption, in the baseline parameterization, where following the tradition in this literature, we assume that only natives own firms and capital.

It is important to point out here that, since both types of immigrant increase native welfare, a legalization program is more beneficial to natives, in terms of welfare, and has a more positive impact on public finances than a purely restrictive program that removes illegal immigrants from the labor force (e.g., through deportations). In our calibrated model, a purely restrictive policy that eliminates all illegal immigrants from the labor market would increase f by about 11% (without taking into account the cost of implementing such a program), increase the unemployment rate by about 15% (as opposed to 6.5% by a legalization program) and decrease native consumption by about 4%.

4.2.5 Additional robustness checks

In Appendix B we conduct some further robustness checks for the effects of increasing legal and illegal immigration, in Tables B5-B7 and B8-B10, respectively, under the three alternative parameterizations we considered above. First, we consider a smaller wage gap between legal and illegal immigrants (5% and 0%), second, we set $x_l = 0$, which implies $w_l = w_n$, and finally, we consider higher separation rates for immigrants. In the analysis above, the

separation rates of natives, legal and illegal immigrants are set equal for analytical tractability and to illustrate more clearly how immigration can increase job creation and welfare if immigrants generate larger profits to firms. But, if immigrants are also more likely to break a match due to repatriation then the profits they generate to firms may be lower. We investigate this possibility by allowing for different repatriation rates for legal and illegal immigrants. Since we are not aware of comparable estimates, we use the monthly return rates of Mexican illegal and legal immigrants, which are 0.0039 and 0.0023, respectively. In this case, the respective job separation rates for illegal and legal immigrants now change to 0.0369 and 0.0353. We find that the results are essentially unchanged when we calibrate the model using these values for the separation rates. Results are also unchanged when we lower the wage gap between legal and illegal immigrants or set the wage of legal immigrants equal to that of natives. As discussed above, only in the case of increasing legal immigration, a higher wage for legal immigrants (or equivalently, a lower search costs for legal immigrants) implies a smaller positive impact on job creation, which can also turn negative. But the effects of legal immigration on the fiscal balance and native welfare are robust to lower wage gaps between natives and legal immigrants. Even when we set the wage gap to zero, legal immigrants' impact on welfare and fiscal balance remains positive.

5 Extensions

In this section, we extend the basic model in two different directions. First, we let illegal immigrants be imperfect substitutes for native and legal immigrant workers. This adds an additional channel through which legal and illegal immigrants can influence labor market outcomes, and in turn the fiscal balance and welfare. Changes in the composition of immigrants influence the marginal product of natives and immigrants, therefore their wages and firm profits from employing them. We also consider here the case where illegal immigrants not only produce a differentiated labor input, but also participate in a segmented labor market, which is isolated from natives and legal immigrants. Second, we consider a version of the model in which immigrants are allowed to "congest" the public good. That is, we allow for the provision of the public good to change depending on tax revenues, as the government attempts to keep its debt sustainable. In this version of the model changes in the number of immigrants influence the amount of public good that is allocated to each worker.

5.1 Imperfect Substitution

We explore here the possibility that illegal immigrants produce a differentiated labor input, meaning that their labor is not perfect substitute to that of legal immigrants or natives. We consider a generalized production function in which natives and legal immigrant workers are perfect substitutes, but they are imperfect substitutes to illegal immigrant workers. More specifically, the production function of the final good is still given by (5), but the intermediate labor input, X_t, is now a CES sub-aggregate, namely,

$$X_t = \left[\varrho(E_{n,t} + E_{l,t})^{\sigma} + (1-\varrho)E_{m,t}^{\sigma}\right]^{\frac{1}{\sigma}}, \quad 1 > \varrho > 0, \ \sigma \leq 1, \tag{37}$$

where ϱ is a parameter that governs income shares and σ is associated with the elasticity of substitution between illegal and legal or native workers: $1/(1-\sigma)$.[14]

Clearly, native and immigrant labor have now different marginal products and hence different prices, $p_{i,t}$:

$$p_{n/l,t} = (1-\alpha)\varrho\frac{Y_t}{X_t}\left(\frac{X_t}{E_{n,t}+E_{l,t}}\right)^{1-\sigma} \tag{38}$$

$$p_{m,t} = (1-\alpha)(1-\varrho)\frac{Y_t}{X_t}\left(\frac{X_t}{E_{m,t}}\right)^{1-\sigma}. \tag{39}$$

where the subscript $i = [n/l, m]$ is used to denote the native/legal-immigrant labor input and the labor input of illegal immigrants, respectively. The rate of return on capital on the other hand is still given by (6). In steady state, the marginal products p_i are no longer fixed and now depend on immigrant stock and market tightness, θ. Since the two labor inputs (produced by illegal and legal/native workers, respectively) are imperfect substitutes, an increase in one type of labor will lower the price of its labor input and raise the price of the other labor input. For instance, an increase in illegal immigration will lower p_m and increase $p_{n/l}$. Moreover, higher productivity leads to higher profits and induces the entry of jobs, whereas lower productivity leads to lower profits and discourages the entry of jobs. Therefore, the impact of immigration on the market tightness θ is ambiguous.

[14] Battisti et al. (2018) assume that natives and immigrants are heterogeneous in terms of skills. They adopt a CES production structure that implies imperfect substitution across skills, and use education as a proxy for skills. In their framework, production complementarities between immigrants and natives are stronger the more dissimilar their skill/education compositions are. Hence, given that legal immigrants and natives have similar skill compositions, whereas illegal immigrants are predominately unskilled, introducing skill heterogeneity into our set up is an alternative way to introduce complimentarity between natives/legal immigrants and illegal immigrants. However, we prefer this CES structure that puts more emphasis on the complementarities that arise due to differences in legal status. The idea is that immigrants that are not authorised to work are restricted to perform certain productive roles, which are often different from those of their legal counterparts, even if they have similar education and skills.

We calibrate the model as described in Section 4.1. As an empirical basis for our choices of σ, we use the estimates reported in Ottaviano and Peri (2012). Based on their estimates, the elasticity between immigrant and native workers of the same skill type $1/(1-\sigma)$ should range from about 6.5 to about 20, meaning that σ should lie somewhere between 0.85 and 0.95. We set $\sigma = 0.9$, which is within this range. Also, in lack of good empirical estimate that can guide our choice of value for ϱ, for the results below we set $\varrho = 0.6$. This value ensures that a firm that meets a native worker will form an employment relation and will not decide to wait for an immigrant worker. It also ensures that all types of workers are employed, that is, an unemployed worker will not turn down an employment opportunity and continue searching.

Tables 10-12 show the effects of increasing legal immigration l, Tables 13-15 show the effects of increasing illegal immigration m, while Tables 16 and 17 show the effects of 5% increase in the labor force due to legal and illegal immigration and of a legalization program, respectively. As can be seen, our previous results are robust to the generalized set-up. More specifically, legal immigrants increase native welfare and reduce the fiscal burden on natives. Illegal immigrants also have a positive impact on native consumption and welfare, mainly due to their positive labor market effect, which translates into higher income and more consumption to natives, as in the baseline model, while their net fiscal contribution can be negative. As in the baseline model, their fiscal contribution is positive in the first two specifications, where legal immigrants do not hold capital, debt, or own firms, and turns negative, but remains relatively small, in the last specification where legal immigrants and natives are identical in terms of ownership.

Overall, compared with the results in our baseline model, the differences are quantitatively small and they stem mainly from the different effects on the marginal productivity of illegal immigrants. More illegal (legal) immigrants lower (increase) the marginal product and wage of illegal immigrants, whereas this is not the case under perfect substitution. This, in turn, implies different responses in job creation and tax revenues from consumption, but the differences are quantitatively small.

Despite producing a differentiated labor input, we assumed so far that illegal immigrants search in the same market as legal immigrants and native workers. One could argue, however, that if illegal immigrants produce a differentiated labor input, then jobs created for illegal immigrants may be different than those targeted towards legal immigrants or natives. That is, the market for illegal immigrants may be segmented, meaning that illegal immigrants do not "compete" for the same jobs as natives and legal immigrants. If markets are segmented, then illegal immigrants affect incentives to create jobs for natives (or legal immigrants) only through their impact on marginal product $p_{n/l}$, implying a much smaller positive job

creation effect on natives. That is, an increase in the proportion of illegal immigrants in the group of job seekers no longer increases the expected profits of jobs suited for natives or legal immigrants, because illegal immigrants participate in a different labor market (see Appendix C for a short description of the model with segmented markets).[15] The question that follows is whether results carry through when we assume that illegal immigrants search in a separate market and firms create vacancies targeted, in particular, to illegal or legal/native workers.

We show results for this case in Appendix B, Tables B11 to B14. The main results carry through. In fact, under segmented markets the job creation effect of legal immigrants on natives is slightly more positive, since increasing their presence in this case, does not reduce the chances that firms match with an illegal immigrant worker who generates larger profits to firms. As regards the impact of increasing the number of illegal immigrants, the positive job creation effect is smaller, as expected, and works mainly through the positive effect of more illegal immigrants on $p_{n/l}$, but remains large enough to generate a positive welfare effect on natives.

5.2 Public Service Congestion and Welfare

A common argument against immigrants is that they congest public services thereby reducing native welfare by reducing the amount of services available to natives. In this section we explore this possibility. In our baseline model we assumed that households' consumption of the public good is constant (i.e., g_n^c, g_l^c and g_m^c are constant). Increased use of public services by immigrants implies an increase in a lump-sum tax imposed on natives, which indirectly reduces natives' welfare by reducing their net income and in turn consumption. In other words, in the baseline model, the presence of immigrants does not reduce the provision of the public good or the amount of public good that is allocated to each native; it can only generate more (or less) taxes to be contributed by native workers. In the alternative set up that we analyse here, there is no lump sum tax. Instead, we allow for the provision of the public good to change depending on tax revenues as the government attempts to keep its debt sustainable. Changes in the number of immigrants influence the amount of public good that is allocated to each worker.

The household derives utility from private consumption, as above, but also from consumption of public goods, which in this version of the model is endogenous and depends on

[15] As show in Appendix C in this case there are two different job creation conditions one that determines vacancies suited for legal immigrants and natives and one that determines vacancies suited for illegal immigrants. Thus expected profits from opening vacancies for natives do not depend on illegal immigrant population.

government revenues. In particular, the household's discounted lifetime utility is given by:

$$\sum_{t=0}^{\infty} \beta^t \left[\log(c_{i,t}) + \psi_i \log(g^c_{i,t})\right] \tag{40}$$

where $g^c_{i,t}$ is impure-public-good consumption of a household of type-i, and ψ_i is the relative preference parameter.[16] The household's problem is to choose the time paths $\{c_{i,t}, k_{i,t+1}\}_{t=0}^{\infty}$ subject to the following budget constraint:

$$(1+\tau_c)c_{i,t} + k_{i,t+1} - k_{i,t} + d_{i,t+1} - d_{i,t} = (1-\tau)(w_{i,t}e_{i,t} + r_t k_{i,t} + r_t d_{i,t} + \pi_{i,t}) + b_i u_{i,t} \tag{41}$$

Notice that there is no lump sum tax f_t, since the government now adjusts its provision of the public good in order to keep its debt sustainable, given its tax receipts. More specifically, the sequence of $G_{t=0}^{\infty}$ is such that the current government debt equals the net present value of future deficits and surpluses:

$$D_t = \frac{\sum\limits_z \left[T_{t+z} - G_{t+z} - \sum\limits_i i b_i u_{i,t+z}\right]}{\prod\limits_z \left[1 + r_{t+z}(1-\tau)\right]}, \tag{42}$$

where $T_{t+z} \equiv (\tau + \tau_p)\left(n w_{n,t+z} e_{n,t+z} + l w_{l,t+z} e_{l,t+z}\right) + \tau n (r_{t+z} k_{n,t+z} + \pi_{n,t+z}) + \tau l (r_{t+z} k_{l,t+z} + \pi_{l,t+z}) + \tau_c \sum\limits_i i c_{i,t+z}$. Moreover, as above, $G_{t+z} \equiv G^c_{t+z} + G^p_{t+z}$.

We assume that access of native, legal and illegal immigrants to impure public goods and services can differ by the proportions, $\rho_n = 1$, $\rho_l \leq 1$ and $\rho_m \leq 1$. Therefore, the household i's consumption of impure public good is given by

$$g^c_{i,t} = \frac{\rho_i G^c_t}{\rho_n n + \rho_l l + \rho_m m}$$

The rest of the model assumptions remain as above.

As above we examine the long run consequence of changes in immigrant population and focus on steady state. The equations describing the steady state equilibrium remain as above; the only change here is that $f = 0$. Moreover, given that in steady state the government

[16] Note that in our baseline model we assume for simplicity that households utility does not depend on public consumption. Since in the baseline model public consumption is constant, this assumption comes with no loss of generality; changes in the size of immigrant population do not affect public consumption and thus welfare. Likewise, without loss of generality, we assume here that households' utility depends only on their consumption of impure public goods, since, due to their property of non-rival use, the allocation of pure public goods across households is independent of the size of the labor force.

debt D is fixed, the provision of the public good is given by:

$$G = T - Dr(1-\tau) - \sum_i ib_i u_i, \tag{43}$$

where $T \equiv (\tau + \tau_p)(nw_n e_n + lw_l e_l) + \tau(rK + \Pi) + \tau_c \sum_i ic_i$, $G \equiv G^p + G^c$ and the amount of impure public good allocated to each native household is:

$$g_n^c = \frac{\rho_n G^c}{\rho_n n + \rho_l l + \rho_m m}$$

The lifetime discounted utility of a native household is given by

$$\Phi = \frac{1}{1-\beta}\left[\log c_n + \psi_n \log(g_n^c)\right].$$

A change in immigration will change G through its impact on T and $\sum_i ib_i u_i$. To be consistent with the notion that pure public goods are non-excludable and non-rivalrous we assume that use of pure public goods by immigrants does not reduce availability to natives. Hence, a change in the number of immigrants will only affect the total amount the government devotes to impure public goods, G^c. An increase in the number of immigrants may increase the tax base and total tax revenues T, with a positive impact on G^c. Even if immigrants pay less in taxes relative to natives, an increase in their number may affect positively tax receipts if their presence in the labor market benefits firms, leads to higher job creation, capital, dividends and wages. Their presence may also reduce unemployment insurance payments, if it helps increase job creation, with an additional positive impact on G^c. However, this does not mean that natives' welfare will increase, because, even if G^c increases, the amount allocated to each native g_n^c may decrease if immigrants congest the public services, which is more likely to occur when the restrictions they might face on accessing of public goods are sufficiently low (i.e., g_m^c or g_l^c is large relative to g_n^c).

We calibrate the model as described in Section 4.1. The only difference here is that we do not match targets on expenditures on public goods since in this version they are determined endogenously. In our calibrated model the steady state amount of total government expenditure that keeps government debt sustainable is about 32% of GDP (as opposed to 38% in our baseline model). To determine the steady state value of G^c we set $\frac{G^c + \sum_i ib_i u_i}{Y} = 6.32\%$ as in our baseline calibration, which gives a much smaller weight in total government expenditure on impure goods; in particular, it implies $\frac{G^c}{G^p} = 0.20$, but we also experiment with higher values of G^c. In our alternative calibration, in which we match the Blau and Mackie (2017) receipts to outlays ratio we get $\frac{G^c}{G^p} = 1.56$. In Table B15 of Appendix B we also

report results for this case. In lack of evidence that can accurately guide our choice of values for parameters ρ_l and ρ_m, once again, we set $\rho_l = \rho_m = 1$, implying maximum congestion on the use of public goods from immigrant workers. As above, this case can be viewed as representing the worst-case scenario regarding immigrants congestion of public services, if one accepts that, due to restrictions by law, immigrants use of public services is lower than that of natives. Finally we set the relative preference parameter to $\psi_n = \psi_l = \psi_m = 0.56$. Based on estimates found in Ni (1995) values for this parameter range between 0.33 and 0.56. In Appendix B we also present results with $\psi_n = \psi_l = \psi_m = 0.33$ (see Table B16).

Results for the baseline calibration are shown in Tables 18-21. They are in line with the results in our baseline model. Both types of immigrants increase native welfare and private consumption, and increase also the amount public good allocated to each native g_n^c. Legal immigrants have a more positive impact on g_n^c than illegal immigrants, because they contribute more in taxes, while their impact on private consumption is weaker than that of illegal immigrants. This explains why a legalization program, although reduces the private consumption of natives, it increases their welfare by increasing the provision of the public good (see Table 21). Despite their stronger positive labor market effect, illegal immigrants congest natives' consumption of public goods by more, and this negative effect is stronger when the share of impure public goods in total expenditure on public goods is large. As shown in Table B15, for $\frac{G^c}{G^p} = 1.56$, increasing the number of illegal immigrants, decreases g_n^c. But this negative effect remains small relative to their positive impact on private consumption and, even in this case, illegal immigrants have a positive impact on native welfare. It is important to point out, however, that these results are based on the assumption that illegal immigrants face no restrictions in accessing public goods; impure public goods are allocated equally between natives, legal immigrants and illegal immigrants. In Table B17 (in Appendix B) we show that setting $\rho_m = 0.7$ or lower, meaning that public services allocated to illegal immigrants are no more than 70% of those allocated to natives, ensures that the impact of illegal immigration on g_n^c is positive, even at $\frac{G^c}{G^p} = 1.56$.

6 Conclusions

An important concern in the public debate over immigration is on its fiscal impact. Since legal and illegal immigrants differ in many aspects, thus affect the labor market and tax base differently, and also contribute to the fiscal balance in different ways, it's important to distinguish illegal from legal immigrants. However, most research on this subject overlooks this dimension. Our paper investigates the welfare and fiscal impact of legal and illegal immigration by developing a dynamic general equilibrium model that explicitly takes into

account the job creation effect of immigration. We allow legal and illegal immigrants to have different outside options and tax contributions. We also allow native, legal and illegal immigrants to face different restrictions in the use of public services. In our model the overall effect of each of the two types of immigration on native welfare depends on two interrelated dimensions. On the one hand, by paying taxes and consuming the public good, immigrants can have a direct fiscal effect. On the other hand, through the job creation channel, immigrants can influence the host country's wages and employment opportunities, output, firm profits and in turn the fiscal balance.

In our calibrated baseline economy, we have found that an increase in either type of immigrants increases the welfare of the host country's citizens, but the main reason for the increase in native welfare can differ. For legal immigrants, the first dimension is more important. Their positive effect on native welfare stems mainly from their positive direct fiscal impact as their tax contributions greatly exceed their consumption of public good. Besides their positive welfare effect, illegal immigrants can also contribute positively to the fiscal balance, but these positive effects stem mainly from their positive job creation effect. Illegal immigrants increase native consumption and overall tax contributions, through their positive effect on job creation, wages, output and firm profits. We have shown that these results are robust in a calibrated version of the model where illegal immigrants are imperfect substitutes to native and legal immigrants and participate in a segmented labor submarket. We have also shown that our main results carry through when we allow immigrants to reduce native welfare by reducing the amount of services available to natives. Our analysis also sheds light on the potential effects of immigration policies and specifically of how to deal with illegal immigration. We have shown that the effects of a program that legalizes illegal immigrants leads to a fiscal gain and an increase in native welfare and is more beneficial to natives than a purely restrictive program that removes illegal immigrants from the host-country labor force.

By considering heterogeneity in immigrant legal status and addressing relevant policy questions, such as the effects of legalizations, our approach compliments previous analyses centered on the implications of search frictions for the welfare and fiscal effects of immigration. But it can still be extended in various dimensions, such as to account for fiscal redistribution among different generations. With the intergenerational feature, we can examine how legal and illegal immigration affect the burden of aging population differently. In this case, legal immigrants can increase the number of contributors to the pension scheme, but they also are more likely to stay and retire in the host country. Illegal immigrants, on the other hand, make less pension contributions, but they are more likely to return home, while their children could help overcome the burden of population aging. Moreover, similar

to our paper, the impact of immigrants on social insurance programs hinges also on their labor market impact, which also depends on their legal status. Therefore, it's important to disentangle the strength of each possible dimension when examining the pension effect of legal and illegal immigration.

Table 1: Baseline Parameter Values

Value	*Interpretation*
$r = 0.004$	Monthly real interest rate
$\epsilon = 0.5$	Unemployment elasticity of the matching function
$\eta = 0.5$	Workers' bargaining power
$\alpha = 0.39$	Share of capital in GDP
$\delta = 0.0061$	Monthy depreciation rate
$s = 0.033$	Monthly separation rate
$n = 1.00, l = 0.11, m = 0.06$	Normalized number of natives, legal and illegal immigrants
$\kappa = 18.9398$	Vacancy cost
$D = 10.3891$	Government debt
$b_n = 2.1599, b_l = 1.7999, b_m = 0$	Unemployment flow incomes
$x_l = 12.2185, x_m = 29.8213$	Search costs
$G^p = 3.6176$	Expenditure on pure public good
$g_n^c = g_l^c = g_m^c = 0.5040$	Consumption of impure public good
$\tau = 0.1795, \tau_p = 0.1318, \tau_c = 0.0955$	Tax rates

Table 2: Effects of Increasing Legal Immigration

Increase in l by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
u	-2.35	-4.44	-6.33	-8.03
w_n	0.07	0.13	0.19	0.24
w_l	0.52	0.99	1.42	1.80
w_m	1.11	2.11	3.01	3.82
Dividends, Capital and Output:				
π_n	5.10	10.15	15.14	20.09
k_n	2.49	4.98	7.45	9.92
y	0.14	0.26	0.38	0.48
Government Expenditures and Revenues:				
Unempl. Ins.	-0.30	-0.43	-0.43	-0.31
Impure Exp.	2.35	4.70	7.05	9.40
Total Exp.	0.31	0.63	0.95	1.27
Cons. Tax Rev.	3.51	7.00	10.49	13.97
Income Tax Rev.	2.40	4.79	7.18	9.57
Payroll Tax Rev.	2.36	4.72	7.08	9.44
Total Rev.	1.82	3.63	5.44	7.25
f	-9.84	-19.16	-28.03	-36.46
Consumption:				
c_n	2.04	4.01	5.91	7.75
c_l	2.81	5.44	7.90	10.22
c_m	1.26	2.38	3.40	4.32

The entries in the Table are % change effects of increasing the number of legal immigrants l. The results reported are for our baseline parameterization described in Section 4.1.

Table 3: Effects of Increasing Legal Immigration
$(g_n^c \neq g_l^c = g_m^c)$

Increase in l by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 2)				
Dividends, Capital and Output:				
(as in Table 2)				
Government Expenditures and Revenues:				
Unempl. Ins	(as in Table 2)			
Impure Exp.	1.27	2.54	3.81	5.08
Total Exp.	0.74	1.49	2.23	2.99
Cons. Tax Rev.	3.15	6.29	9.43	12.55
Income Tax Rev.	2.40	4.79	7.18	9.57
Payroll Tax Rev.	2.36	4.72	7.08	9.44
Total Rev.	1.77	3.53	5.29	7.05
f	-7.00	-13.62	-19.90	-25.86
Consumption:				
c_n	1.70	3.34	4.92	6.46
c_l	2.20	4.25	6.16	7.95
c_m	1.26	2.38	3.40	4.32

The entries in the Table are % change effects of increasing the number of legal immigrants l. The results reported are for our alternative parameterization matching the Blau and Mackie (2017) receipts to outlays ratios.

Table 4: Effects of Increasing Legal Immigration
($g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$,
$d_n = d_l = d$)

Increase in l by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 2)				
Dividends, Capital and Output:				
π	2.56	4.95	7.18	9.26
k	0.02	0.02	0.02	0.01
y	0.14	0.26	0.38	0.48
Government Expenditures and Revenues:				
Unempl. Ins.	(as in Table 2)			
Impure Exp.	1.78	3.56	5.34	7.13
Total Exp.	1.04	2.08	3.12	4.17
Cons. Tax Rev.	2.91	5.80	8.69	11.57
Income Tax Rev.	2.41	4.82	7.22	9.62
Payroll Tax Rev.	2.36	4.72	7.08	9.44
Total Rev.	1.74	3.47	5.21	6.94
f	-4.92	-9.56	-13.95	-18.11
Consumption:				
c_n	0.76	1.46	2.12	2.74
c_l	1.22	2.35	3.40	4.38
c_m	1.26	2.38	3.40	4.32

The entries in the Table are % change effects of increasing the number of legal immigrants l. The results reported are for our alternative parameterization matching the Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table 5: Effects of Increasing Illegal Immigration

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
u	-2.70	-5.14	-7.35	-9.36
w_n	0.08	0.15	0.22	0.28
w_l	0.60	1.15	1.65	2.10
w_m	1.28	2.44	3.50	4.46
Dividends, Capital and Output:				
π_n	4.43	8.78	13.06	17.28
k_n	1.44	2.88	4.30	5.71
y	0.16	0.31	0.44	0.56
Government Expenditures and Revenues:				
Unempl. Ins.	-2.70	-5.14	-7.35	-9.36
Impure Exp.	1.28	2.56	3.85	5.13
Total Exp.	0.09	0.19	0.30	0.41
Cons. Tax Rev.	1.93	3.85	5.76	7.66
Income Tax Rev.	0.59	1.15	1.69	2.21
Payroll Tax Rev.	0.29	0.54	0.78	0.99
Total Rev.	0.53	1.05	1.55	2.04
f	-2.22	-4.31	-6.28	-8.16
Consumption:				
c_n	0.84	1.64	2.42	3.17
c_l	1.29	2.47	3.56	4.57
c_m	1.45	2.76	3.95	5.04

The entries in the Table are % change effects of increasing the number of illegal immigrants m. The results reported are for our baseline parameterization described in Section 4.1.

Table 6: Effects of Increasing Illegal Immigration
$(g_n^c \neq g_l^c = g_m^c)$

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 5)				
Dividends, Capital and Output:				
(as in Table 5)				
Government Expenditures and Revenues:				
Unempl. Ins.		(as in Table 5)		
Impure Exp.	0.69	1.38	2.08	2.77
Total Exp.	0.33	0.66	1.00	1.35
Cons. Tax Rev.	1.74	3.46	5.18	6.88
Income Tax Rev.		(as in Table 5)		
Payroll Tax Rev.		(as in Table 5)		
Total Rev.	0.51	1.00	1.47	1.94
f	-0.63	-1.13	-1.52	-1.80
Consumption:				
c_n	0.64	1.26	1.84	2.40
c_l	0.95	1.79	2.54	3.21
c_m	1.45	2.76	3.95	5.04

The entries in the Table are % change effects of increasing the number of illegal immigrants m. The results reported are for our alternative parameterization matching the Blau and Mackie (2017) receipts to outlays ratios.

Table 7: Effects of Increasing Illegal Immigration
($g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$,
$d_n = d_l = d$)

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 5)				
Dividends, Capital and Output:				
(as in Table 5)				
Government Expenditure and Revenues:				
Unempl. Ins.	(as in Table 5)			
Impure Exp.	0.97	1.94	2.92	3.89
Total Exp.	0.49	0.98	1.49	2.00
Cons. Tax Rev.	1.61	3.20	4.78	6.35
Income Tax Rev.	(as in Table 5)			
Payroll Tax Rev.	(as in Table 5)			
Total Rev.	0.49	0.96	1.42	1.86
f	0.46	1.06	1.77	2.58
Consumption:				
c_n	0.48	0.93	1.35	1.74
c_l	0.96	1.84	2.65	3.41
c_m	1.45	2.76	3.95	5.04

The entries in the Table are % change effects of increasing the number of illegal immigrants m. The results reported are for our alternative parameterization matching the Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table 8: Effects of a 5% Increase in Labor Force due to Legal and Illegal Immigration

	Baseline		$g_n^c \neq g_l^c = g_m^c$		$g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$	
	$\uparrow$ **in** l	$\uparrow$ **in** m	$\uparrow$ **in** l	$\uparrow$ **in** m	$\uparrow$ **in** l	$\uparrow$ **in** m
u	-4.70	-9.17	as in baseline		as in baseline	
w_n	0.14	0.28				
w_l	1.05	2.06	as in baseline		as in baseline	
w_m	2.23	4.37				
π	10.79	16.86			5.24	16.86
k	5.29	5.57	as in baseline		0.02	5.57
y	0.28	0.54			as in baseline	
Unempl. Ins.	-0.44	-9.17	as in baseline		as in baseline	
Impure Exp.	5.00	5.00	2.70	2.70	3.79	3.79
Total Exp.	0.67	0.40	1.58	1.31	2.21	1.95
Cons. Tax Rev.	7.45	7.47	6.69	6.71	6.17	6.19
Income Tax Rev.	5.09	2.16	as in baseline		5.12	2.16
Payroll Tax Rev.	5.02	0.97	as in baseline		as in baseline	
Total Rev.	3.86	1.99	3.76	1.89	3.70	1.82
f	-20.32	-7.97	-14.43	-1.78	-10.13	2.50
c_n	4.26	3.10	3.54	2.34	1.55	1.70
c_l	5.76	4.47	4.50	3.15	2.49	3.34
c_m	2.52	4.94	2.52	4.94	2.52	4.94

The entries in the Table are % change effects of a 5% increase in the labor force due to legal (l) and illegal (m) immigration. The first two columns show results for our baseline parameterization, the next two columns results for our alternative parameterization matching Blau and Mackie (2017) receipts to outlays ratios, and the last two columns results for our third parameterization matching Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table 9: Effects of a Legalization Program

	Baseline				$k_n = k_l = k$, $d_n = d_l = d$, $\pi_n = \pi_l = \pi$			
$\downarrow m$ **by:**	25%	50%	75%	100%	25%	50%	75%	100%
				Unemployment and Wage Rates:				
u	1.53	3.13	4.81	6.58		as in baseline		
w_n	-0.05	-0.09	-0.14	-0.20				
w_l	-0.34	-0.70	-1.07	-1.46		as in baseline		
w_m	-0.72	-1.48	-2.27	-3.10				
				Dividends, Capital and Output:				
π	-1.69	-3.40	-5.14	-6.90	-3.00	-5.94	-8.83	-11.68
k	-0.09	-0.19	-0.29	-0.39	-1.42	-2.81	-4.17	-5.50
y	-0.09	-0.19	-0.29	-0.39		as in baseline		
				Government Expenditures and Revenues:				
Unempl. Ins.	2.69	5.49	8.41	11.46				
Impure Exp.	0.00	0.00	0.00	0.00		as in baseline		
Total Exp.	0.08	0.17	0.26	0.35				
Cons. Tax Rev.	-0.03	-0.06	-0.10	-0.14		as in baseline		
Income Tax Rev.	0.70	1.39	2.06	2.72	0.71	1.41	2.09	2.75
Payroll Tax Rev.	0.98	1.94	2.88	3.80		as in baseline		
Total Rev.	0.45	0.88	1.31	1.72	0.45	0.89	1.32	1.73
f	-3.14	-6.13	-8.96	-11.65	-3.07	-6.00	-8.78	-11.40
				Consumption:				
c_n	0.27	0.52	0.74	0.94	-0.08	-0.17	-0.28	-0.40
c_l	0.22	0.38	0.49	0.54	-0.32	-0.66	-1.02	-1.42
c_m	-0.81	-1.66	-2.55	-3.48	-0.81	-1.66	-2.55	–

The entries in the Table are the % change effects of a legalization program that replaces illegal immigrants by legal immigrants. Under the assumption that $g^c_m = g^c_l$ a legalization program has no impact on expenditure on impure public goods (other than unemployment insurance payments). Thus, results for the alternative parameterization that matches receipts to outlays ratios based on Blau and Mackie (2017) are identical to results for the baseline parameterization, shown in the first four columns of the Table. Results change only in the third parameterization in which legal immigrants are allowed to also own firms, capital and debt, shown in the last four columns of the Table.

Table 10: Effects of Increasing Legal Immigration under Imperfect Substitution

Increase in l by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
u	-2.67	-5.04	-7.15	-9.04
w_n	0.07	0.13	0.18	0.23
w_l	0.58	1.10	1.56	1.98
w_m	1.16	2.21	3.18	4.08
Dividends, Capital and Output:				
π_n	5.10	10.92	16.27	21.56
k_n	2.53	5.04	7.54	10.94
y	0.17	0.32	0.46	0.58
Government Expenditures and Revenues:				
Unempl. Ins.	-0.63	-1.05	-1.30	-1.40
Impure Exp.	2.35	4.70	7.05	9.40
Total Exp.	0.30	0.61	0.92	1.23
Cons. Tax Rev.	3.54	7.07	10.59	14.10
Income Tax Rev.	2.42	4.84	7.25	9.66
Payroll Tax Rev.	2.39	4.77	7.15	9.52
Total Rev.	1.84	3.67	5.49	7.32
f	-10.00	-19.47	-28.45	-36.99
Consumption:				
c_n	2.07	4.06	5.97	7.82
c_l	2.91	5.61	8.14	10.51
c_m	1.32	2.52	3.62	4.63

The entries in the Table are the % change effects of increasing the number of legal immigrants l in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants (see Section 5.1). The results reported are for our baseline parameterization described in Section 4.1.

Table 11: Effects of Increasing Legal Immigration under Imperfect Substitution ($g_n^c \neq g_l^c = g_m^c$)

Increase in l by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 10)				
Dividends, Capital and Output:				
(as in Table 10)				
Government Expenditures and Revenues:				
Unempl. Ins.	(as in Table 10)			
Impure Exp.	1.27	2.54	3.81	5.09
Total Exp.	0.73	1.47	2.21	2.96
Cons. Tax Rev.	3.19	6.37	9.53	12.68
Income Tax Rev.	2.42	4.84	7.25	9.66
Payroll Tax Rev.	2.39	4.77	7.15	9.52
Total Rev.	1.79	3.57	5.35	7.12
f	-7.16	-13.91	-20.30	-26.36
Consumption:				
c_n	1.73	3.38	4.98	6.53
c_l	2.30	4.43	6.41	8.26
c_m	1.32	2.52	3.62	4.63

The entries in the Table are the % change effects of increasing the number of legal immigrants l in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants (see Section 5.1). The results reported are for our alternative parameterization matching the Blau and Mackie (2017) receipts to outlays ratios.

Table 12: Effects of Increasing Legal Immigration under Imperfect Substitution ($g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$)

Increase in l by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 10)				
Dividends, Capital and Output:				
π	2.95	5.68	8.22	10.60
k	0.05	0.08	0.10	0.12
y	0.17	0.32	0.46	0.58
Government Expenditures and Revenues:				
Unempl. Ins.	(as in Table 10)			
Impure Exp.	1.78	3.56	5.34	7.13
Total Exp.	1.03	2.06	3.10	4.14
Cons. Tax Rev.	2.95	5.88	8.80	11.71
Income Tax Rev.	2.44	4.87	7.30	9.72
Payroll Tax Rev.	2.39	4.77	7.15	9.52
Total Rev.	1.76	3.51	5.26	7.01
f	-5.08	-9.87	-14.38	-18.64
Consumption:				
c_n	0.79	1.52	2.20	2.84
c_l	1.31	2.52	3.62	4.65
c_m	1.32	2.52	3.62	4.63

The entries in the Table are the % change effects of increasing the number of legal immigrants l in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants (see Section 5.1). The results reported are for our alternative parameterization matching the Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table 13: Effects of Increasing Illegal Immigration under Imperfect Substitution

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
u	-1.88	-3.60	-5.19	-6.66
w_n	0.17	0.33	0.48	0.62
w_l	0.55	1.07	1.55	2.00
w_m	-2.05	-3.60	-4.83	-5.84
Dividends, Capital and Output:				
π_n	3.45	6.85	10.21	13.53
k_n	1.25	2.47	3.67	4.85
y	-0.03	-0.09	-0.17	-0.26
Government Expenditures and Revenues:				
Unempl. Ins.	-1.88	-3.60	-5.19	-6.66
Impure Exp.	1.28	2.56	3.85	5.13
Total Exp.	0.12	0.24	0.36	0.49
Cons. Tax Rev.	1.69	3.34	4.96	6.54
Income Tax Rev.	0.55	1.08	1.59	2.08
Payroll Tax Rev.	0.31	0.60	0.88	1.14
Total Rev.	0.49	0.97	1.43	1.87
f	-1.86	-3.59	-5.23	-6.78
Consumption:				
c_n	0.78	1.52	2.24	2.93
c_l	1.11	2.15	3.12	4.04
c_m	-1.94	-3.40	-4.54	-5.46

The entries in the Table are the % change effects of increasing the number of illegal immigrants m in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants (see Section 5.1). The results reported are for our baseline parameterization described in Section 4.1.

Table 14: Effects of Increasing Illegal Immigration under Imperfect Substitution ($g_n^c \neq g_l^c = g_m^c$)

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 13)				
Dividends, Capital and Output:				
(as in Table 13)				
Government Expenditures and Revenues:				
Unempl. Ins.	(as in Table 13)			
Impure Exp.	0.69	1.39	2.08	2.77
Total Exp.	0.35	0.71	1.07	1.43
Cons. Tax Rev.	1.50	2.96	4.38	5.77
Income Tax Rev.	0.55	1.08	1.59	2.08
Payroll Tax Rev.	0.31	0.60	0.88	1.14
Total Rev.	0.47	0.91	1.35	1.77
f	-0.27	-0.41	-0.45	-0.41
Consumption:				
c_n	0.58	1.13	1.66	2.16
c_l	0.77	1.47	2.11	2.69
c_m	-1.94	-3.40	-4.54	-5.46

The entries in the Table are the % change effects of increasing the number of illegal immigrants m in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants (see Section 5.1). The results reported are for our alternative parameterization matching the Blau and Mackie (2017) receipts to outlays ratios.

Table 15: Effects of Increasing Illegal Immigration under Imperfect Substitution ($g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$)

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 13)				
Dividends, Capital and Output:				
(as in Table 13)				
Government Expenditures and Revenues:				
Unempl. Ins.	(as in Table 13)			
Impure Exp.	0.97	1.94	2.92	3.89
Total Exp.	0.51	1.03	1.55	2.08
Cons. Tax Rev.	1.37	2.69	3.98	5.24
Income Tax Rev.	0.55	1.08	1.59	2.08
Payroll Tax Rev.	0.31	0.60	0.88	1.14
Total Rev.	0.45	0.88	1.29	1.69
f	0.83	1.77	2.82	3.96
Consumption:				
c_n	0.43	0.82	1.19	1.53
c_l	0.77	1.49	2.15	2.77
c_m	-1.94	-3.40	-4.54	-5.46

The entries in the Table are the % change effects of increasing the number of illegal immigrants m in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants (see Section 5.1). The results reported are for our alternative parameterization matching the Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table 16: Effects of a 5% Increase in Labor Force due to Legal and Illegal Immigration under Imperfect Substitution

	Baseline		$g_n^c \neq g_l^c = g_m^c$		$g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$	
	↑ **in** l	↑ **in** m	↑ **in** l	↑ **in** m	↑ **in** l	↑ **in** m
u	-5.32	-6.52	as in baseline		as in baseline	
w_n	0.14	0.61				
w_l	1.16	1.96	as in baseline		as in baseline	
w_m	2.34	-5.74				
π	11.60	13.20			6.01	13.20
k	5.36	4.73	as in baseline		0.08	4.73
y	0.34	-0.25			as in baseline	
Unempl. Ins.	-1.09	-6.52	as in baseline		as in baseline	
Impure Exp.	5.00	5.00	2.70	2.70	3.79	3.79
Total Exp.	0.65	0.48	1.56	1.40	2.19	2.02
Cons. Tax Rev.	7.52	6.39	6.77	5.63	6.25	5.12
Income Tax Rev.	5.15	2.03	as in baseline		5.18	2.03
Payroll Tax Rev.	5.07	1.11	as in baseline		as in baseline	
Total Rev.	3.90	1.83	3.80	1.73	3.74	1.65
f	-20.64	-6.62	-14.74	-0.42	-10.45	3.84
c_n	4.31	2.86	3.59	2.11	1.61	1.50
c_l	5.94	3.95	4.69	2.64	2.66	2.71
c_m	2.66	-5.38	2.66	-5.38	2.66	-5.38

The entries in the Table are % change effects of a 5% increase in the labor force due to legal (l) and illegal (m) immigration in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants (see Section 5.1). The first two columns show results for our baseline parameterization, the next two columns results for our alternative parameterization matching Blau and Mackie (2017) receipts to outlays ratios, and the last two columns results for our third parameterization matching Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table 17: Effects of a Legalization Program under Imperfect Substitution

	Baseline				$k_n = k_l = k$, $d_n = d_l = d$, $\pi_n = \pi_l = \pi$			
$\downarrow m$ **by:**	25%	50%	75%	95%	25%	50%	75%	95%
				Unemployment and Wage Rates:				
u	0.42	0.87	1.36	1.82		as in baseline		
w_n	-0.13	-0.27	-0.40	-0.53				
w_l	-0.24	-0.48	-0.74	-0.97		as in baseline		
w_m	3.57	8.82	18.39	43.57				
				Dividends, Capital and Output:				
π	-0.47	-0.96	-1.50	-2.00	-1.80	-3.57	-5.34	-6.78
k	0.10	0.15	0.13	0.01	-1.24	-2.49	-3.77	-4.88
y	0.10	0.15	0.13	0.01		as in baseline		
				Government Expenditures and Revenues:				
Unempl. Ins.	1.57	3.18	4.84	6.25				
Impure Exp.	0.00	0.00	0.00	0.00		as in baseline		
Total Exp.	0.05	0.10	0.15	0.19				
Cons. Tax Rev.	0.19	0.31	0.32	0.15		as in baseline		
Income Tax Rev.	0.76	1.49	2.20	2.72	0.76	1.51	2.22	2.75
Payroll Tax Rev.	0.98	1.94	2.89	3.63		as in baseline		
Total Rev.	0.49	0.97	1.42	1.73	0.50	0.97	1.42	1.74
f	-3.60	-7.00	-10.15	-12.38	-3.53	-6.87	-9.96	-12.15
				Consumption:				
c_n	0.34	0.65	0.90	1.02	-0.01	-0.05	-0.13	-0.27
c_l	0.47	0.89	1.23	1.42	-0.07	-0.18	-0.35	-0.58
c_m	3.55	8.77	18.29	43.42	3.55	8.77	18.29	43.42

The entries in the Table are the % change effects of a legalization program that replaces illegal immigrants by legal immigrants, in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants (see Section 5.1). Under the assumption that $g^c_m = g^c_l$ a legalization program has no impact on expenditure on impure public goods (other than unemployment insurance payments). Thus, results for the alternative parameterization that matches receipts to outlays ratios based on Blau and Mackie (2017) are identical to results for the baseline parameterization, shown in the first four columns of the Table. Results change only in the third parameterization in which legal immigrants are allowed to also own firms, capital and debt, shown in the last four columns of the Table.

Table 18: Congestion Effects of Increasing Legal Immigration

Increase in l by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 2)				
Dividends, Capital and Output:				
(as in Table 2)				
Government Expenditures and Revenues:				
Unempl. Ins.	(as in Table 2)			
Impure Exp.	10.42	20.78	31.11	41.40
Total Exp.	1.67	3.34	5.01	6.67
Cons. Tax Rev.	2.31	4.62	6.92	9.22
Income Tax Rev.	(as in Table 2)			
Payroll Tax Rev.	(as in Table 2)			
Total Rev.	1.65	3.30	4.95	6.60
Consumption and Welfare:				
c_n	0.76	1.51	2.24	2.96
c_l	0.58	1.10	1.57	1.99
c_m	1.26	2.38	3.40	4.32
g_n^c	7.88	15.36	22.47	29.25
Φ_n	3.88	7.37	10.53	13.41
Φ_l	5.96	11.23	15.94	20.18
Φ_m	6.06	11.42	16.20	20.50

The entries in the Table are the % change effects of increasing the number of legal immigrants l in the model extension in which households' consumption of impure public good is endogenous (see Section 5.2), for our baseline parameterization (total expenditure on impure public goods are equal to 6.32% of GDP and $\frac{G^c}{G^p} = 0.2$). Note that the % changes in g_m^c and g_l^c are both equal to the % change in g_n^c shown in the Table.

Table 19: Congestion Effects of Increasing Illegal Immigration

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 5)				
Dividends, Capital and Output:				
(as in Table 5)				
Government Expenditures and Revenues:				
Unempl. Ins.	(as in Table 5)			
Impure Exp.	3.56	6.97	10.25	13.43
Total Exp.	0.48	0.94	1.39	1.83
Cons. Tax Rev.	1.49	2.98	4.47	5.97
Income Tax Rev.	(as in Table 5)			
Payroll Tax Rev.	(as in Table 5)			
Total Rev.	0.47	0.93	1.37	1.81
Consumption and Welfare:				
c_n	0.51	1.00	1.48	1.95
c_l	0.67	1.27	1.82	2.33
c_m	1.45	2.76	3.95	5.04
g_n^c	2.25	4.30	6.17	7.90
Φ_n	1.36	2.60	3.74	4.80
Φ_l	2.36	4.47	6.37	8.10
Φ_m	2.96	5.59	7.97	10.12

The entries in the Table are the % change effects of increasing the number of illegal immigrants m in the model extension in which households' consumption of impure public good is endogenous (see Section 5.2), for our baseline parameterization (total expenditure on impure public goods are equal to 6.32% of GDP and $\frac{G^c}{G^p} = 0.2$). Note that the % changes in g_m^c and g_l^c are both equal to the % change in g_n^c shown in the Table.

Table 20: Congestion Effects of a 5% Increase in Labor Force due to Legal and Illegal Immigration

	↑ **in** l	↑ **in** m
Unemployment and Wage Rates:		
(as in Table 8)		
Dividends, Capital and Output:		
(as in Table 8)		
Government Expenditures and Revenues:		
Unempl. Ins.	(as in Table 8)	
Impure Exp.	22.10	13.12
Total Exp.	3.55	1.79
Cons. Tax Rev.	4.91	5.82
Income Tax Rev.	(as in Table 8)	
Payroll Tax Rev.	(as in Table 8)	
Total Rev.	3.51	1.77
Consumption and Welfare:		
c_n	1.60	1.91
c_l	1.16	2.28
c_m	2.52	4.94
g_n^c	16.28	7.73
Φ_n	7.79	4.70
Φ_l	11.86	7.93
Φ_m	12.05	9.91

The entries in the Table are the % change effects of a 5% increase in the labor force due to legal (l) and illegal (m) immigration in the model extension in which households' consumption of impure public good is endogenous (see Section 5.2), for our baseline parameterization (total expenditure on impure public goods are equal to 6.32% of GDP and $\frac{G^c}{G^p} = 0.2$). Note that the % changes in g_m^c and g_l^c are both equal to the % change in g_n^c shown in the Table.

Table 21: Congestion Effects of a Legalization Program

↓ **in** m **by:**	25%	50%	75%	100%
Unemployment and Wage Rates:				
(as in Table 9)				
Dividends, Capital and Output:				
(as in Table 9)				
Government Expenditures and Revenues:				
Unempl. Ins.		(as in Table 9)		
Impure Exp.	3.56	6.97	10.25	13.43
Total Exp.	0.48	0.94	1.39	1.83
Cons. Tax Rev.	-0.22	-0.45	-0.67	-0.88
Income Tax Rev.		(as in Table 9)		
Payroll Tax Rev.		(as in Table 9)		
Total Rev.	0.42	0.83	1.23	1.62
Consumption and Welfare:				
c_n	-0.10	-0.21	-0.31	-0.43
c_l	-0.38	-0.77	-1.18	-1.61
c_m	-0.81	-1.66	-2.55	–
g_n^c	2.02	3.96	5.82	7.59
Φ_n	0.79	1.53	2.22	2.85
Φ_l	0.92	1.73	2.45	3.06
Φ_m	0.33	0.55	0.64	–

The entries in the Table are the % change effects of a legalization program that replaces illegal with legal immigrants, in the model extension in which households' consumption of impure public good is endogenous (see Section 5.2), for our baseline parameterization (total expenditure on impure public goods are equal to 6.32% of GDP and $\frac{G^c}{G^p} = 0.2$*). Note that the % changes in* g_m^c *and* g_l^c *are both equal to the % change in* g_n^c *shown in the Table.*

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COMPANION APPENDIX

Immigration, Legal Status and Fiscal Impact

Andri Chassamboulli and Xiangbo Liu

Appendix A: Proofs

- A.1 Restrictions on Parameter Values
- A.2 Proof of Proposition 1
- A.3 Proof of Proposition 2

Appendix B: Additional Robustness Checks and Extensions

Appendix C: Segmented Markets and Imperfect Substitution

A Proofs

A.1 Restrictions on Parameter Values

To ensure that all types of workers are employed, all surpluses must be positive. Given the Nash sharing rule this requires that all J_i are positive. For $J_n > 0$, it is necessary and sufficient to assume that $p > \frac{(1+\tau_p)b_n}{1-\tau}$. Given that $J_m > J_l \geq J_n$, $p > \frac{(1+\tau_p)b_n}{1-\tau}$ implies also that $J_l > 0$ and $J_m > 0$.

The assumption that $p > \frac{(1+\tau_p)b_n}{1-\tau}$ guarantees also that $J_n > V = 0$. Thus, a firm that meets a native worker will form an employment relation and will not decide to wait for an immigrant worker, despite the fact that the latter generate more surplus to firms.

A.2 Proof of Proposition 1

Differentiating the left-hand side (LHS) of equation (36) with respect to θ yields

$$\frac{\partial LHS}{\partial \theta} = -\frac{\kappa}{q^2} q'(\theta) > 0.$$

Differentiating the right-hand side (RHS) of equation (36) with respect to θ yields

$$\frac{\partial RHS}{\partial \theta} = -\frac{\eta(1-\eta)\mu'(\theta)}{(r+s+\eta\mu)^2(n+l+m)} \left[n\left(p - \frac{(1+\tau_p)b_n}{1-\tau}\right) + l\left(p - \frac{(1+\tau_p)(b_l - x_l)}{1-\tau}\right) + m\left(p - b_m + x_m\right)\right] < 0.$$

The LHS of equation (36) is increasing with respect to θ, whereas the RHS is decreasing in θ. It follows that the curves of the LHS and the RHS intersect only once. Therefore, the steady-state equilibrium exists and is unique.

A.3 Proof of Proposition 2

Consider an increase in illegal immigration m. Differentiating the RHS of equation (36) with respect to m yields

$$\frac{\partial RHS}{\partial m} = \frac{1-\eta}{r+s+\eta\mu} \frac{1}{(n+l+m)^2} \left[n\left(\frac{1+\tau_p}{1-\tau} b_n - (b_m - x_m)\right) + l\left(\frac{1+\tau_p}{1-\tau}(b_n - x_l) - (b_m - x_m)\right)\right] > 0.$$

Differentiating the LHS of equation (36) with respect to m yields

$$\frac{\partial LHS}{\partial m} = 0.$$

An increase in m shifts the curve of the RHS to the right, while it does not change the position of the LHS curve. As a result, an increase in m leads to a higher θ. Moreover, given equations

(32)-(34) and (27), we show that $\frac{dw_i}{dm} > 0$, $\frac{du_i}{dm} < 0$ and $\frac{de_i}{dm} > 0$. Combining $\frac{de_i}{dm} > 0$ with equations (21) and (25), we show $\frac{dk_i}{dm} > 0$.

Using the free-entry condition in (36), together with (27) we can write total dividends (in 26) as:

$$\Pi = \frac{\kappa}{q} r(n + l + m) \left(\frac{\mu}{\mu + s} \right)$$

Given $\frac{dq}{d\theta} < 0$, $\frac{d\mu}{d\theta} > 0$ and $\frac{d\theta}{dm} > 0$, it follows that $\frac{d\Pi}{dm} > 0$, which also implies $\frac{d\pi_i}{dm} > 0$.

B Additional Robustness Checks and Extensions

Table B1: Effects of Increasing l, robustness check: $x_l = 0$, $w_l = w_n$

Increase in l by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
u	0.25	0.50	0.73	0.96
w_n	-0.01	-0.01	-0.02	-0.03
w_l	-0.01	-0.01	-0.02	-0.03
w_m	-0.06	-0.12	-0.17	-0.23
Dividends, Capital and Output:				
π_n	2.06	4.12	6.18	8.24
k_n	2.33	4.67	7.00	9.34
y	-0.02	-0.03	-0.04	-0.06
Government Expenditures and Revenues:				
Unempl. Ins.	2.74	5.48	8.22	10.97
Impure Exp.	2.35	4.70	7.05	9.40
Total Exp.	0.40	0.81	1.21	1.61
Cons. Tax Rev.	3.43	6.86	10.29	13.72
Income Tax Rev.	2.41	4.82	7.23	9.64
Payroll Tax Rev.	2.45	4.91	7.36	9.82
Total Rev.	1.83	3.66	5.49	7.32
f	-9.35	-18.25	-26.74	-34.85
Consumption:				
c_n	1.78	3.52	5.20	6.83
c_l	1.58	3.09	4.53	5.90
c_m	-0.08	-0.15	-0.22	-0.28

The entries in the Table are % change effects of increasing the number of legal immigrants l, when $x_l = 0$ (the rest of the parameters are chosen as in the baseline parameterization described in Section 4.1).

Table B2: Effects of Increasing m – robustness check: 5% legal/illegal wage gap

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
u	-2.60	-4.94	-7.07	-9.02
w_n	0.08	0.15	0.21	0.27
w_l	0.58	1.10	1.58	2.02
w_m	1.15	2.19	3.13	4.00
Dividends, Capital and Output:				
π_n	4.30	8.53	12.69	16.79
k_n	1.44	2.86	4.28	5.69
y	0.15	0.29	0.42	0.54
Government Expenditures and Revenues:				
Unempl. Ins.	-2.60	-4.94	-7.07	-9.02
Impure Exp.	1.28	2.56	3.85	5.13
Total Exp.	0.10	0.20	0.31	0.42
Cons. Tax Rev.	1.93	3.86	5.76	7.66
Income Tax Rev.	0.57	1.13	1.66	2.17
Payroll Tax Rev.	0.27	0.52	0.75	0.96
Total Rev.	0.53	1.04	1.53	2.02
f	-2.17	-4.21	-6.15	-7.99
Consumption:				
c_n	0.82	1.61	2.38	3.12
c_l	1.24	2.39	3.45	4.43
c_m	1.30	2.49	3.57	4.56

The entries in the Table are % change effects of increasing the number of illegal immigrants m, when the targeted legal/illegal wage gap is set to 5% (the rest of the parameters chosen as in baseline parameterization described in Section 4.1).

Table B3: Effects of Increasing m – robustness check: 0% legal/illegal wage gap

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
u	-2.35	-4.49	-6.44	-8.24
w_n	0.07	0.13	0.19	0.25
w_l	0.52	1.00	1.44	1.85
w_m	0.88	1.69	2.43	3.11
Dividends, Capital and Output:				
π_n	4.01	7.95	11.85	15.69
k_n	1.42	2.84	4.24	5.64
y	0.14	0.27	0.38	0.49
Government Expenditures and Revenues:				
Unempl. Ins.	-2.35	-4.49	-6.44	-8.24
Impure Exp.	1.28	2.56	3.85	5.13
Total Exp.	0.10	0.21	0.33	0.45
Cons. Tax Rev.	1.94	3.86	5.77	7.68
Income Tax Rev.	0.55	1.08	1.59	2.09
Payroll Tax Rev.	0.25	0.47	0.68	0.87
Total Rev.	0.51	1.01	1.50	1.98
f	-2.05	-3.99	-5.84	-7.61
Consumption:				
c_n	0.79	1.55	2.29	3.01
c_l	1.14	2.20	3.19	4.11
c_m	1.02	1.96	2.82	3.61

The entries in the Table are % change effects of increasing the number of illegal immigrants m, when the targeted legal/illegal wage gap is set to 0% (the rest of the parameters are chosen as in the baseline parameterization described in Section 4.1).

Table B4: Effects of Increasing m – robustness check: $x_m = 0$

Increase in m by:	25%	50%	75%	100%
Unemployment and Wage Rates:				
u	-0.15	-0.29	-0.43	-0.57
w_n	0.00	0.01	0.01	0.02
w_l	0.03	0.07	0.10	0.13
w_m	0.01	0.02	0.03	0.03
Dividends, Capital and Output:				
π_n	1.45	2.90	4.35	5.80
k_n	1.29	2.58	3.87	5.16
y	0.01	0.02	0.03	0.03
Government Expenditures and Revenues:				
Unempl. Ins.	-0.15	-0.29	-0.43	-0.57
Impure Exp.	1.28	2.56	3.85	5.13
Total Exp.	0.17	0.34	0.51	0.68
Cons. Tax Rev.	1.89	3.78	5.67	7.55
Income Tax Rev.	0.33	0.65	0.98	1.30
Payroll Tax Rev.	0.02	0.03	0.05	0.06
Total Rev.	0.38	0.76	1.13	1.51
f	-0.94	-1.87	-2.80	-3.73
Consumption:				
c_n	0.49	0.98	1.47	1.96
c_l	0.24	0.49	0.73	0.97
c_m	0.02	0.03	0.05	0.07

The entries in the Table are % change effects of increasing the number of illegal immigrants m, when $x_m = 0$ (the rest of the parameters are chosen as in the baseline parameterization described in Section 4.1).

Table B5: Effects of Increasing l by 50% - Robustness checks

	Baseline	$\frac{w_l}{w_m} = 1.05$	$\frac{w_l}{w_m} = 1$	$x_l = 0,\ w_l = w_n$	$\uparrow s_l, s_m$
Unemployment and Wage Rates:					
u	-4.44	-4.53	-4.71	0.50	-4.39
w_n	0.13	0.14	0.14	-0.01	0.13
w_n	0.99	1.01	1.05	-0.01	0.97
w_n	2.11	2.00	1.77	-0.12	2.06
Dividends, Capital and Output:					
π_n	10.15	10.25	10.49	4.12	9.96
k_n	4.98	4.98	4.99	4.67	4.96
y	0.26	0.27	0.28	-0.03	0.25
Government Expenditures and Revenues:					
Unempl. Ins.	-0.43	-0.52	-0.71	5.48	-0.13
Impure Exp.	4.70	4.70	4.70	4.70	4.70
Total Exp.	0.63	0.62	0.62	0.81	0.64
Cons. Tax Rev.	7.00	7.01	7.02	6.86	6.97
Income Tax Rev.	4.79	4.80	4.82	4.82	4.77
Payroll Tax Rev.	4.72	4.73	4.75	4.91	4.70
Total Rev.	3.63	3.63	3.65	3.66	3.61
f	-19.16	-19.21	-19.30	-18.25	-19.02
Consumption:					
c_n	4.01	4.02	4.05	3.52	3.99
c_l	5.44	5.47	5.54	3.09	5.39
c_m	2.38	2.28	2.06	-0.15	2.35

The entries in the Table are % change effects of increasing the number of legal immigrants l by 50%, for our baseline paramterization described in Section 4.1. The first column shows results for the baseline case and the next four columns results for four robustness checks: setting the legal/illegal wage gap to 5% (column 2), setting the legal/illegal wage gap to 0% (column 3), setting $x_l = 0$ which implies natives and legal immigrants' wages are equal (column 4) and higher separation rates for legal and illegal immigrants reflecting repatriations and deportations (column 5).

Table B6: Effects of Increasing l by 50% - Robustness checks - $g_n^c \neq g_l^c = g_m^c$

	Baseline	$\frac{w_l}{w_m} = 1.05$	$\frac{w_l}{w_m} = 1$	$x_l = 0,\ w_l = w_n$	$\uparrow s_l, s_m$
Unemployment and Wage Rates:					
u	-4.44	-4.53	-4.71	0.50	-4.39
w_n	0.13	0.14	0.14	-0.01	0.13
w_l	0.99	1.01	1.05	-0.01	0.97
w_m	2.11	2.00	1.77	-0.12	2.06
Dividends, Capital and Output:					
π_n	10.15	10.25	10.49	10.49	9.96
k_n	4.98	4.98	4.99	4.99	4.96
y	0.26	0.27	0.28	0.28	0.25
Government Expenditures and Revenues:					
Unempl. Ins.	-0.43	-0.52	-0.71	5.48	-0.13
Impure Exp.	2.54	2.55	2.56	3.03	2.52
Total Exp.	1.49	1.49	1.49	1.95	1.48
Cons. Tax Rev.	6.29	6.29	6.30	5.94	6.27
Income Tax Rev.	4.79	4.80	4.82	4.82	4.77
Payroll Tax Rev.	4.72	4.73	4.75	4.91	4.70
Total Rev.	3.53	3.54	3.55	3.53	3.52
f	-13.62	-13.64	-13.68	-10.88	-13.55
Consumption:					
c_n	3.34	3.34	3.36	2.62	3.32
c_l	4.25	4.28	4.34	1.83	4.22
c_m	2.38	2.28	2.06	-0.15	2.35

The entries in the Table are % change effects of increasing the number of legal immigrants l by 50%, for our alternative parametization matching the Blau and Mackie (2017) receipts to outlays ratios. The first column shows results for the baseline case and the next four columns results for four robustness checks: setting the legal/illegal wage gap to 5% (column 2), setting the legal/illegal wage gap to 0% (column 3), setting $x_l = 0$ which implies natives and legal immigrants' wages are equal (column 4) and higher separation rates for legal and illegal immigrants reflecting repatriations and deportations (column 5).

Table B7: Effects of Increasing l by 50% - Robustness checks - $g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$

	Baseline	$\frac{w_l}{w_m} = 1.05$	$\frac{w_l}{w_m} = 1$	$x_l = 0$, $w_l = w_n$	$\uparrow s_l, s_m$
Unemployment and Wage Rates:					
u	-4.44	-4.53	-4.71	0.50	-4.39
w_n	0.13	0.14	0.14	-0.01	0.13
w_l	0.99	1.01	1.05	-0.01	0.97
w_m	2.11	2.00	1.77	-0.12	2.06
Dividends, Capital and Output:					
π_n	4.95	5.05	5.27	-0.80	4.77
k_n	0.02	0.03	0.04	-0.27	0.00
y	0.26	0.27	0.28	-0.03	0.25
Government Expenditures and Revenues:					
Unempl. Ins.	-0.43	-0.52	-0.71	5.48	-0.13
Impure Exp.	3.56	3.57	3.58	4.04	3.54
Total Exp.	2.08	2.08	2.08	2.53	2.08
Cons. Tax Rev.	5.80	5.80	5.81	5.47	5.78
Income Tax Rev.	4.82	4.83	4.85	4.85	4.80
Payroll Tax Rev.	4.72	4.73	4.75	4.91	4.70
Total Rev.	3.47	3.48	3.49	3.48	3.46
f	-9.56	-9.58	-9.63	-6.92	-9.48
Consumption:					
c_n	1.46	1.47	1.49	0.77	1.44
c_l	2.35	2.38	2.43	0.77	2.33
c_m	2.38	2.28	2.06	-0.15	2.35

The entries in the Table are % change effects of increasing the number of legal immigrants l by 50%, for our alternative parametization matching the Blau and Mackie (2017) receipts to outlays ratios and assuming legal immigrants and natives are identical in terms of firm, capital and debt ownership. The first column shows results for the baseline case and the next four columns results for four robustness checks: setting the legal/illegal wage gap to 5% (column 2), setting the legal/illegal wage gap to 0% (column 3), setting $x_l = 0$ which implies natives and legal immigrants' wages are equal (column 4) and higher separation rates for legal and illegal immigrants reflecting repatriations and deportations (column 5).

Table B8: Effects of Increasing m by 50% - Robustness checks

	Baseline	$\frac{w_l}{w_m} = 1.05$	$\frac{w_l}{w_m} = 1$	$x_l = 0,\ w_l = w_n$	$\uparrow s_l, s_m$
Unemployment and Wage Rates:					
u	-5.14	-4.94	-4.49	-4.74	-4.89
w_n	0.15	0.15	0.13	0.14	0.15
w_l	1.15	1.10	1.00	0.14	1.08
w_m	2.44	2.19	1.69	1.13	2.30
Dividends, Capital and Output:					
π_n	8.78	8.53	7.95	8.28	11.54
k_n	2.88	2.86	2.84	2.85	2.85
y	0.31	0.29	0.27	0.28	0.28
Government Expenditures and Revenues:					
Unempl. Ins.	-5.14	-4.94	-4.49	-4.74	-4.89
Impure Exp.	2.56	2.56	2.56	2.56	2.56
Total Exp.	0.19	0.20	0.21	0.20	0.20
Cons. Tax Rev.	3.85	3.86	3.86	3.96	3.82
Income Tax Rev.	1.15	1.13	1.08	1.02	1.15
Payroll Tax Rev.	0.54	0.52	0.47	0.42	0.51
Total Rev.	1.05	1.04	1.01	0.99	1.04
f	-4.31	-4.21	-3.99	-3.98	-4.20
Consumption:					
c_n	1.64	1.61	1.55	1.55	1.64
c_l	2.47	2.39	2.20	1.01	2.36
c_m	2.76	2.49	1.96	1.41	2.62

The entries in the Table are % change effects of increasing the number of illegal immigrants m by 50%, for our baseline paramterization described in Section 4.1. The first column shows results for the baseline case and the next four columns results for four robustness checks: setting the legal/illegal wage gap to 5% (column 2), setting the legal/illegal wage gap to 0% (column 3), setting $x_l = 0$ which implies natives and legal immigrants' wages are equal (column 4) and higher separation rates for legal and illegal immigrants reflecting repatriations and deportations (column 5).

Table B9: Effects of Increasing m by 50% - Robustness checks - $g_n^c \neq g_l^c = g_m^c$

	Baseline	$\frac{w_l}{w_m} = 1.05$	$\frac{w_l}{w_m} = 1$	$x_l = 0,\ w_l = w_n$	$\uparrow s_l, s_m$
Unemployment and Wage Rates:					
u	-5.14	-4.94	-4.49	-4.74	-4.89
w_n	0.15	0.15	0.13	0.14	0.15
w_l	1.15	1.10	1.00	0.14	1.08
w_m	2.44	2.19	1.69	1.13	2.30
Dividends, Capital and Output:					
π_n	8.78	8.53	8.53	8.53	8.53
k_n	2.88	2.86	2.86	2.86	2.86
y	0.31	0.29	0.29	0.29	0.29
Government Expenditures and Revenues:					
Unempl. Ins.	-5.14	-4.94	-4.49	-4.74	-4.89
Impure Exp.	1.38	1.39	1.40	1.65	1.37
Total Exp.	0.66	0.67	0.69	0.82	0.66
Cons. Tax Rev.	3.46	3.47	3.47	3.46	3.44
Income Tax Rev.	1.15	1.13	1.08	1.02	1.15
Payroll Tax Rev.	0.54	0.52	0.47	0.42	0.51
Total Rev.	1.00	0.98	0.96	0.93	0.99
f	-1.13	-1.02	-0.77	0.24	-1.06
Consumption:					
c_n	1.26	1.23	1.16	1.04	1.26
c_l	1.79	1.70	1.51	0.29	1.69
c_m	2.76	2.49	1.96	1.41	2.62

The entries in the Table are % change effects of increasing the number of illegal immigrants m by 50%, for our alternative parametization matching the Blau and Mackie (2017) receipts to outlays ratios. The first column shows results for the baseline case and the next four columns results for four robustness checks: setting the legal/illegal wage gap to 5% (column 2), setting the legal/illegal wage gap to 0% (column 3), setting $x_l = 0$ which implies natives and legal immigrants' wages are equal (column 4) and higher separation rates for legal and illegal immigrants reflecting repatriations and deportations (column 5).

Table B10: Effects of Increasing m by 50% - Robustness checks - $g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$

	Baseline	$\frac{w_l}{w_m} = 1.05$	$\frac{w_l}{w_m} = 1$	$x_l = 0$, $w_l = w_n$	$\uparrow s_l, s_m$
Unemployment and Wage Rates:					
u	-5.14	-4.94	-4.49	-4.74	-4.89
w_n	0.15	0.15	0.13	0.14	0.15
w_l	1.15	1.10	1.00	0.14	1.08
w_m	2.44	2.19	1.69	1.13	2.30
Dividends, Capital and Output:					
π_n	8.78	8.53	7.95	8.28	11.54
k_n	2.88	2.86	2.84	2.85	2.85
y	0.31	0.29	0.27	0.28	0.28
Government Expenditures and Revenues:					
Unempl. Ins.	-5.14	-4.94	-4.49	-4.74	-4.89
Impure Exp.	1.94	1.95	1.95	2.20	1.93
Total Exp.	0.98	0.99	1.01	1.14	0.99
Cons. Tax Rev.	3.20	3.20	3.20	3.20	3.17
Income Tax Rev.	1.15	1.13	1.08	1.02	1.15
Payroll Tax Rev.	0.54	0.52	0.47	0.42	0.51
Total Rev.	0.96	0.95	0.92	0.89	0.95
f	1.06	1.17	1.42	2.37	1.13
Consumption:					
c_n	0.93	0.90	0.83	0.72	0.93
c_l	1.84	1.77	1.63	0.72	1.80
c_m	2.76	2.49	1.96	1.41	2.62

The entries in the Table are % change effects of increasing the number of illegal immigrants m by 50%, for our alternative parametization matching the Blau and Mackie (2017) receipts to outlays ratios and assuming legal immigrants and natives are identical in terms of firm, capital and debt ownership. The first column shows results for the baseline case and the next four columns results for four robustness checks: setting the legal/illegal wage gap to 5% (column 2), setting the legal/illegal wage gap to 0% (column 3), setting $x_l = 0$ which implies natives and legal immigrants' wages are equal (column 4) and higher separation rates for legal and illegal immigrants reflecting repatriations and deportations (column 5).

Table B11: Effects of Increasing l under Imperfect Substitution and Segmented Markets

	Baseline		$g_n^c \neq g_l^c = g_m^c$		$g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$	
↑ in l by:	50%	100%	50%	100%	50%	100%
u	-6.44	-11.34	as in baseline		as in baseline	
u_m	-0.01	-0.03	as in baseline		as in baseline	
w_n	0.18	0.31				
w_l	1.42	2.50	as in baseline		as in baseline	
w_m	0.67	1.29				
π	10.34	20.34			5.13	9.49
k	5.12	10.17	as in baseline		0.15	0.23
y	0.40	0.70			0.40	0.70
Unempl. Ins.	-2.51	-3.89	as in baseline		as in baseline	
Impure Exp.	4.70	9.40	2.55	5.11	3.58	7.15
Total Exp.	0.55	1.14	1.42	2.88	2.01	4.06
Cons. Tax Rev.	7.23	14.38	6.52	12.95	6.03	11.98
Income Tax Rev.	5.00	9.94	as in baseline		5.12	2.16
Payroll Tax Rev.	4.96	9.87	as in baseline		as in baseline	
Total Rev.	3.78	7.52	3.68	7.33	3.63	7.22
f	-20.36	-38.50	-14.75	-27.77	-10.70	-20.04
c_n	4.27	8.18	3.59	6.88	1.73	3.18
c_l	6.25	11.59	5.06	9.30	2.96	5.38
c_m	0.67	1.29	0.67	1.29	0.67	1.29

The entries in the Table are % change effects of a 50% and 100% increase in legal immigration (l) in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants and illegal immigrants search in a separate market (see Appendix C). The first two columns show results for our baseline parameterization, the next two columns results for our alternative parameterization matching Blau and Mackie (2017) receipts to outlays ratios, and the last two columns results for our third parameterization matching Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table B12: Effects of Increasing m under Imperfect Substitution and Segmented Markets

	Baseline		$g_n^c \neq g_l^c = g_m^c$		$g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$	
↑ in l by:	50%	100%	50%	100%	50%	100%
u	-0.15	-0.29	as in baseline		as in baseline	
u_m	0.11	0.18	as in baseline		as in baseline	
w_n	0.23	0.45				
w_l	0.30	0.59	as in baseline		as in baseline	
w_m	-4.99	-8.34				
π	10.56	21.11				
k	2.36	4.64	as in baseline		as in baseline	
y	-0.20	-0.47				
Unempl. Ins.	-0.15	-0.29	as in baseline		as in baseline	
Impure Exp.	2.56	5.13	1.39	2.78	1.95	3.90
Total Exp.	0.34	0.68	0.81	1.63	1.14	2.28
Cons. Tax Rev.	2.89	5.66	2.50	4.88	2.23	4.35
Income Tax Rev.	0.81	1.58	as in baseline		5.12	2.16
Payroll Tax Rev.	0.25	0.48	as in baseline		as in baseline	
Total Rev.	0.73	1.44	0.68	1.33	0.64	1.26
f	-1.75	-3.34	1.47	3.09	3.66	7.46
c_n	1.13	2.21	0.74	1.43	0.41	0.78
$c_.$	0.73	1.42	0.05	0.05	0.50	0.95
c_m	-4.99	-8.34	-4.99	-8.34	-4.99	-8.34

The entries in the Table are % change effects of a 50% and 100% increase in illegal immigration (m) in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants and illegal immigrants search in a separate market (see Appendix C). The first two columns show results for our baseline parameterization, the next two columns results for our alternative parameterization matching Blau and Mackie (2017) receipts to outlays ratios, and the last two columns results for our third parameterization matching Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table B13: Effects of a 5% Increase in Labor Force due to Legal and Illegal Immigration under Imperfect Substitution and Segmented Markets

	Baseline		$g_n^c \neq g_l^c = g_m^c$		$g_n^c \neq g_l^c = g_m^c$, $k_n = k_l = k$, $\pi_n = \pi_l = \pi$, $d_n = d_l = d$	
	↑ **in** l	↑ **in** m	↑ **in** l	↑ **in** m	↑ **in** l	↑ **in** m
u	-6.79	-0.28	as in baseline		as in baseline	
u_m	-0.02	0.18	as in baseline		as in baseline	
w_n	0.19	0.44				
w_l	1.50	0.58	as in baseline		as in baseline	
w_m	0.71	-8.20				
π	10.99	20.59			5.43	20.59
k	5.44	4.53	as in baseline		0.16	4.53
y	0.42	-0.45	as in baseline		as in baseline	
Unempl. Ins.	-2.63	-0.28	as in baseline		as in baseline	
Impure Exp.	5.00	5.00	2.72	2.72	3.80	3.80
Total Exp.	0.59	0.66	1.51	1.59	2.14	2.22
Cons. Tax Rev.	7.69	5.52	6.93	4.76	6.41	4.24
Income Tax Rev.	5.31	1.55	as in baseline		5.34	1.55
Payroll Tax Rev.	5.27	0.47	as in baseline		as in baseline	
Total Rev.	4.02	1.40	3.92	1.30	3.86	1.23
f	-21.58	-3.26	-15.62	3.01	-11.33	7.27
c_n	4.53	2.16	3.81	1.39	1.83	0.76
c_l	6.62	1.38	5.35	0.05	3.13	0.93
c_m	0.71	-8.20	0.71	-8.20	0.71	-8.20

The entries in the Table are % change effects of a 5% increase in the labor force due to legal (l) and illegal (m) immigration in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants and illegal immigrants search in a separate market (see Appendix C). The first two columns show results for our baseline parameterization, the next two columns results for our alternative parameterization matching Blau and Mackie (2017) receipts to outlays ratios, and the last two columns results for our third parameterization matching Blau and Mackie (2017) receipts to outlays ratios and assuming that natives and legal immigrants are identical in terms of firm, capital and debt ownership.

Table B14: Effects of a Legalization Program under Imperfect Substitution and Segmented Markets

	Baseline				$k_n = k_l = k$, $d_n = d_l = d$, $\pi_n = \pi_l = \pi$			
$\downarrow m$ **by:**	25%	50%	75%	95%	25%	50%	75%	95%
				Unemployment and Wage Rates:				
u	-1.88	-3.61	-5.21	-6.39		as in baseline		
u_m	-0.08	-0.20	-0.42	-0.98		as in baseline		
w_n	-0.07	-0.14	-0.22	-0.30				
w_l	0.27	0.51	0.71	0.84		as in baseline		
w_m	3.91	9.59	19.83	46.51				
				Dividends, Capital and Output:				
π	-2.43	-4.89	-7.40	-9.44	-3.73	-7.39	-11.00	-13.86
k	0.18	0.32	0.38	0.31	-1.15	-2.32	-3.54	-4.59
y	0.18	0.32	0.38	0.31		as in baseline		
				Government Expenditures and Revenues:				
Unempl. Ins.	-0.76	-1.40	-1.95	-2.32				
Impure Exp.	0.00	0.00	0.00	0.00		as in baseline		
Total Exp.	-0.02	-0.04	-0.06	-0.07				
Cons. Tax Rev.	0.47	0.86	1.13	1.15		as in baseline		
Income Tax Rev.	0.95	1.88	2.79	3.47	0.96	1.90	2.81	3.50
Payroll Tax Rev.	1.23	2.45	3.65	4.60		as in baseline		
Total Rev.	0.65	1.29	1.89	2.33	0.66	1.29	1.90	2.34
f	-4.86	-9.47	-13.79	-16.94	-4.80	-9.34	-13.60	-16.70
				Consumption:				
c_n	0.62	1.19	1.68	2.00	0.27	0.50	0.67	0.74
c_l	1.43	2.75	3.97	4.84	0.59	1.11	1.55	1.80
c_m	3.91	9.59	19.84	46.53	3.91	9.59	19.84	46.53

The entries in the Table are the % change effects of a legalization program, in the model extension where illegal immigrants are imperfect substitutes to natives and legal immigrants and illegal immigrants search in a separate market (see Appendix C). "Baseline" refers to the baseline and alternative (that matches Blau and Mackie (2017) receips/outlays ratios) parameterizations in which only natives own firms, capital and debt. Results shown in the last four columns of the Table are for the third paramterization in which legal immigrants are identical to natives in terms of ownership.

Table B15: Congestion Effects - Robustness check $\frac{G^c}{G^p} = 1.56$

(1) Increase in l by:					**(2) Increase in m by:**				
	25%	50%	75%	100%		25%	50%	75%	100%
g_n^c	0.50	0.97	1.41	1.82	g_n^c	-0.30	-0.63	-0.99	-1.36
Φ_n	0.49	0.97	1.43	1.88	Φ_n	0.22	0.42	0.61	0.79
Φ_l	0.53	1.01	1.45	1.84	Φ_l	0.41	0.76	1.06	1.33
Φ_m	0.95	1.79	2.55	3.23	Φ_m	0.90	1.68	2.38	3.00

(3) A legalization program					**(4) A 5% increase in LF**		
↓ in m by:	25%	50%	75%	100%		**Due to legal**	**Due to illegal**
g_n^c	0.56	1.09	1.60	2.09	g_n^c	1.03	-1.32
Φ_n	0.04	0.08	0.11	0.14	Φ_n	1.03	0.77
Φ_l	-0.14	-0.30	-0.47	-0.67	Φ_l	1.07	1.30
Φ_m	-0.43	-0.88	-1.38	–	Φ_m	1.89	2.94

The entries in the Table are the % change effects of increasing legal (l) and illegal (m) immigration (1st and 2nd panel), a legalization program (3rd panel) and a 5% increase in the labor force due to legal and illegal immigration (4th panel) in the model extension in which households' consumption of impure public good is endogenous (see Section 5.2), for our alternative parameterization where we set $\frac{G^c}{G^p} = 1.56$. Note that changing the ratio of impure to pure public goods alters only the impact of immigration on $g_n^c (= g_l^c = g_m^c)$ and welfare (Φ_n, Φ_l, Φ_m). Effects on all other variables are as in Tables 18, 19, 21 and 20, respectively.

Table B16: Welfare effects when $\psi = 0.33$

Increase in l by:	25%	50%	75%	100%
Φ_n	2.25	4.29	6.15	7.87
Φ_l	3.18	6.00	8.51	10.78
Φ_m	3.52	6.63	9.41	11.91
Increase in m by:	25%	50%	75%	100%
Φ_n	0.86	1.65	2.38	3.07
Φ_l	1.44	2.74	3.91	4.97
Φ_m	2.04	3.85	5.49	6.97
A legalization program				
Decrease in m by:	25%	50%	75%	100%
Φ_n	0.39	0.74	1.07	1.37
Φ_l	0.29	0.53	0.70	0.82
Φ_m	-0.15	-0.37	-0.67	–
A 5% increase in LF				
	Due to legal		**Due to illegal**	
Φ_n	4.54		3.00	
Φ_l	6.33		4.86	
Φ_m	7.00		6.83	

The entries in the Table are the % change effects of increasing legal (l) and illegal (m) immigration (1st and 2nd panel), a legalization program (3rd panel) and a 5% increase in the labor force due to legal and illegal immigration (4th panel) in the model extension in which households' consumption of impure public good is endogenous (see Section 5.2), when $\psi = 0.33$. Note that the change in ψ affects only our measure of welfare (Φ_n, Φ_l, Φ_m). Effects on all other variables are as in Tables 18, 19, 21 and 20, respectively.

Table B17: Congestion Effects of Increasing Illegal Immigration – lower values of ρ_m

Increase in m by:	25%	50%	75%	100%
		$\rho_m = 0.7$		
g_n^c	0.07	0.09	0.08	0.05
Φ_n	0.27	0.52	0.75	0.97
Φ_l	0.46	0.85	1.20	1.51
Φ_m	1.02	1.93	2.73	3.44
		$\rho_m = 0.65$		
g_n^c	0.13	0.22	0.27	0.29
Φ_n	0.29	0.55	0.80	1.04
Φ_l	0.48	0.90	1.27	1.60
Φ_m	1.08	2.03	2.88	3.63
		$\rho_m = 0.6$		
g_n^c	0.19	0.34	0.45	0.54
Φ_n	0.30	0.59	0.85	1.10
Φ_l	0.50	0.94	1.33	1.68
Φ_m	1.14	2.15	3.05	3.85

The entries in the Table are the % change effects of increasing illegal immigration m, in the model extension in which households' consumption of impure public good is endogenous (see Section 5.2), at different values of ρ_m. Note that changes in the value of ρ_m affect only households consumption of impure public goods $g_n^c (= g_l^c)$ and g_m^c and welfare (Φ_n, Φ_l, Φ_m). Effects on all other variables are as in Table 19.

C Segmented Markets and Imperfect Substitution

The set up of the government, the final good sector and households' problem, remains as in the baseline model (see Section 2). Only the intermediate production sector changes to take into account 1. that illegal immigrants are imperfect substitutes to natives and legal immigrants, and thus prices of labor inputs are now $p_{n/l,t}$ (given by 38) and $p_{m,t}$ (given by 39), and 2. that there are two separate sub-markets one for legal immigrants and natives and one for illegal immigrants.

The values of jobs filled with workers of type $i = [n, l]$, remain as in the baseline model, the only difference is that now the price of the labor input is $p_{n/l,t}$. The same holds for the value of a job filled by an immigrant worker. It only changes to take into account that the price of the labor input is $p_{m,t}$.

$$\begin{aligned} J_{i,t} &= p_{n/l,t} - (1+\tau_p)w_{i,t} + \frac{1}{1+r_{t+1}}\left[(1-s)J_{i,t+1} + sV_{t+1}\right] \text{ for } i = [n,l] \\ J_{m,t} &= p_{m,t} - w_{m,t} + \frac{1}{1+r_{t+1}}\left[(1-s)J_{m,t+1} + sV_{t+1}\right] \end{aligned}$$

There are now two types of vacancies, those suited for natives/legal immigrants, $v_{n/l,t}$, and those suited for illegal immigrants, $v_{m,t}$. There are two Bellman equations, one for each type:

$$\begin{aligned} V_{n/l,t} &= -\kappa + \frac{1}{1+r_{t+1}}\left\{q_{n/l,t}\left[\phi_t J_{n,t+1} + (1-\phi_t)J_{l,t+1}\right] + (1-q_{n/l,t})V_{n/l,t+1}\right\} \\ V_{m,t} &= -\kappa + \frac{1}{1+r_{t+1}}\left\{q_{m,t}J_{m,t+1} + (1-q_{m,t})V_{m,t+1}\right\} \end{aligned}$$

where $q_{n/l,t}$ is the probability that a vacant firm with a vacancy suited for a native or legal immigrant will find a match and $q_{m,t}$ is the probability that a vacant firm with a vacancy suited for an illegal immigrant will find a match. Note that the former matches with either a native worker, with probability ϕ_t, or a legal immigrant worker, with probability $(1-\phi_t)$ where $\phi_t \equiv \frac{nu_{n,t}}{nu_{n,t}+lu_{l,t}}$ is the share of natives in total searching population of natives and legal immigrants.

There are two free-entry conditions, $V_{n/l,t} = 0$ and $V_{m,t} = 0$ determining tightness, $\theta_{n/l} \equiv \frac{v_{n/l,t}}{U_{n,t}+U_{l,t}}$ and $\theta_m \equiv \frac{v_{m,t}}{U_{m,t}}$, respectively, in each sub-market:

$$\frac{\kappa}{q_{n/t,t}} = \frac{1}{1+r_{t+1}}\left[\phi_t J_{n,t+1} + (1-\phi_t)J_{l,t+1}\right] \tag{44}$$

$$\frac{\kappa}{q_{m,t}} = \frac{1}{1+r_{t+1}}J_{m,t+1} \tag{45}$$

The value to a worker of being unemployed satisfies:

$$\begin{aligned} Z_{i,t} &= b_i - x_i + \frac{1}{1+r_{t+1}}\left[\mu_{n/l,t}W_{i,t+1} + (1-\mu_{n/l,t})Z_{i,t+1}\right] \text{ for } i = [n,l] \\ Z_{m,t} &= b_m - x_m + \frac{1}{1+r_{t+1}}\left[\mu_{m,t}W_{m,t+1} + (1-\mu_{m,t})Z_{m,t+1}\right] \end{aligned}$$

where $\mu_{n/l,t}$ is the probability that a native or legal immigrant will find a job and $\mu_{m,t}$ is the probability that an illegal immigrant will find a job. As in the baseline model, the value to a worker of being employed satisfies:

$$\begin{aligned} W_{i,t} &= (1-\tau)w_{i,t} + \frac{1}{1+r_{t+1}}\left[(1-s)W_{i,t+1} + sZ_{i,t+1}\right] \text{ for } i = [n,l] \\ W_{m,t} &= w_{m,t} + \frac{1}{1+r_{t+1}}\left[(1-s)W_{m,t+1} + sZ_{m,t+1}\right] \end{aligned}$$

and wages satisfy the Nash bargaining conditions.

Since there are two types of vacancies and two separate sub-markets there are also two different matching functions. $M_{n/l,t} = M(v_{n/l,t}, U_{n,t} + U_{l,t})$ gives the number of matches between natives or legal immigrants and the vacancies that are suited for them. Likewise, $M_{m,t} = M(v_{m,t}, U_{m,t})$ gives the number of matches between illegal immigrants and vacancies. Hence, $q_{n/l,t} = \frac{M_{n/l,t}}{v_{n/l,t}} = M(1, \frac{1}{\theta_{n/l,t}})$, $\mu_{n/l,t} = \frac{M_{n/l,t}}{U_{n,t}+U_{l,t}} = M(\theta_{n/l,t}, 1)$, $q_{m,t} = \frac{M_{m,t}}{v_{m,t}} = M(1, \frac{1}{\theta_{m,t}})$ and $\mu_{m,t} = \frac{M_{m,t}}{U_{m,t}} = M(\theta_{m,t}, 1)$.

The evolution of the number of household members that are unemployed is given by:

$$\begin{aligned} u_{i,t+1} &= (1-\mu_{n/l,t})u_{i,t} + se_{i,t} \text{ for } i = [n,l] \\ u_{m,t+1} &= (1-\mu_{m,t})u_{m,t} + se_{m,t} \end{aligned}$$

where $e_{i,t} = 1 - u_{i,t}$ and $e_{m,t} = 1 - u_{m,t}$.

Finally, total dividends change to take into account that prices are now given by $p_{n/l,t}$ and $p_{m,t}$.

$$\Pi_t = \left[p_{n/l,t} - (1+\tau_p)w_{n,t}\right]E_{n,t} + \left[p_{n/l,t} - (1+\tau_p)w_{l,t}\right]E_{l,t} + (p_{m,t} - w_{m,t})E_{m,t} - \kappa(v_{n/l,t} + v_{m,t})$$