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The Labor Market Effects of Reducing the Number of Illegal Immigrants

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Abstract

A controversial issue in the US is how to reduce the number of illegal immigrants and what effect this would have on the US economy. To answer this question we set up a two-country model with search in labor markets and featuring legal and illegal immigrants among the low skilled. We calibrate it to the US and Mexican economies during the 2000-2010 period. As immigrants – especially illegal ones – have a worse outside option than natives, their wages are lower. Hence, their presence reduces the labor cost of employers who, as a consequence, create more jobs per unemployed when there are more immigrants. Because of such effects our model shows increasing deportation rates and tightening border control weakens low-skilled labor markets, increasing unemployment of native low-skilled workers. Legalization, instead, decreases the unemployment rate of low-skilled natives and increases income per native.

JEL codes: F22, J61, J64.

Key Words: job creation, search costs, illegal immigrants, border controls, deportations, legalization, unemployment, wages.

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1 Introduction

Most of the existing papers on the labor market effects of immigration consider the number and skill composition of immigrants as an exogenous variable and analyze the consequences of changing those on native labor market outcomes. The number and type of immigrants entering a country, however, are not policy variables of choice, but the outcomes of economic, social and policy forces in the sending and receiving countries. In the economic literature on the effect of immigration, very little attention has been paid to the specific policies used and to the difference between the labor market effects of legal and illegal immigrants.[1]

A large part of the policy debate in the US, however, has been about different ways to reduce the number of illegal immigrants. The presence of a large number of illegal immigrants is an anomaly, but there is disagreement on how to address it. Economists are often asked whether reducing illegal immigrants would be costly or beneficial for the US economy. In particular, what policy, among border enforcement, deportation, self-deportation or legalization, would be most harmful to US firms and workers? The existing economic literature uses naive frameworks to answer this question. Based on an oversimplified canonical model of labor demand and supply, economists rarely focus explicitly on illegal immigrants, and they overlook the different implications across policies. The goal of this paper is to fill this gap by using a more insightful model to analyze the effects of different policies aimed at reducing the number of illegal immigrants. Do fewer illegal immigrants free jobs for Americans or do they reduce firm's profit and job creation? Will legalization increase migration pressures? Will deportation and border control decrease legal immigration?

To address these important questions, we propose a new model representing two connected labor markets parameterized to match the US and Mexico, and two groups of workers, high-skilled and low-skilled, that are complementary in production. Firms create jobs that are skill-specific and search frictions exist in the market. Legal and illegal migration opportunities from Mexico to the US arise and people take them if they increase their expected labor income net of costs. To focus on the issue of illegal immigrants, we consider migration of low-skilled workers only from Mexico, while US workers can be

[1] Throughout the paper we will use the adjectives "legal" and "illegal" immigrants to characterize immigrants who are endowed or not of proper documentation to reside and work in the US. Some scholars refer to those groups as "regular" and "irregular" or as "documented" and "undocumented" immigrants.

low-skilled (competing with immigrants) or high-skilled (complementing them in production). This model incorporates aspects of labor markets and migration that would not be captured by a classical demand-supply framework. These additional aspects turn out to be crucial. First, we characterize legal and illegal immigrants and native workers in the receiving country (US) as potentially different in their outside options and in their probability of breaking up a job-match. These differences affect the wage each type of worker can bargain with firms, given the productivity of the worker-firm match. In particular, illegal immigrants usually have the worse outside option, followed by legal immigrants and then natives. Hence, the first group will accept lower wages relative to legal immigrants and natives, implying US firms can cut labor costs by hiring them. Second, as a consequence of these labor cost savings, firms are willing to post more job openings and, if those are specific to skills, but not to immigrant workers, a positive job-creation effect will benefit native employment opportunities too.

Given the large productivity difference between Mexico and the US, illegal immigration opportunities – albeit associated with worse conditions than legal ones – can be attractive to unskilled Mexican workers. At the same time, US firms benefit from illegal immigrants by paying lower labor cost. These features capture the economic incentives leading to illegal immigration to the US. However, there is another crucial implication of this framework: rich country skilled and unskilled workers can benefit from illegal immigrants. More illegal workers push firms to create more jobs per unemployed worker in unskilled labor markets because their presence reduces the average firm's cost. As long as labor markets are not fully segmented between immigrants and natives, natives will increase their employment too. Hence, policies reducing the number of illegal immigrants may cost native workers employment and income. With our model we can quantify these costs and analyze how policies differ from each other.

We analyze the following four policies: (i) increasing border enforcement to reduce illegal immigration opportunities, (ii) increasing the costs that illegal immigrants face when looking for a job (no access to benefits), (iii) increasing the frequency of deportations, and (iv) increasing the probability of legalization. In analyzing these policies, we take a status-quo driven approach. Rather than asking whether there is a theoretically optimal number of illegal immigrants from the perspective of native income per person, we consider the status quo and determine the cost – in terms of native income per person, wages, and employment – of reducing the number of illegal immigrants by a certain percentage.

The policies described can be separated into two categories. Three of them (increased deportation, increased border control, and increased cost of looking for a job) not only decrease the number of illegal immigrants, but they also reduce the total number of immigrants (legal plus illegal). We will call these three "restrictive policies". In contrast, the fourth policy, legalization, decreases the number of illegal immigrants, but increases the total number of immigrants. By legalizing illegal immigrants this policy leaves the total immigrant stock unchanged and also provides stronger incentives for potential immigrants, as more of them can become legal in the US.

The three restrictive policies, by reducing unskilled immigrants (legal and illegal) have a depressing effect on the wages and employment of skilled workers (who are complementary to the unskilled) and on firms' profits (benefiting from the cost-reducing effect of illegal immigrants). In the canonical model, however, they would increase employment and wages of native unskilled by reducing competition from unskilled immigrants. To the contrary, because of the unskilled job creation effect of immigrants described above, the restrictive policies worsen labor market conditions for unskilled natives when analyzed within our model. Legalization, instead, as it increases the total number of unskilled immigrants enhancing their job-creation effect, produces a positive effect on the wages and employment of skilled natives and on unskilled native employment. While the wage effect of legalization on unskilled natives is negative, the overall effect on income per native in the receiving country is positive, contrary to the restrictive policies that reduce income per native in the receiving economy.

Quantitatively, our simulations show the following effects: increasing the deportation rate of illegal immigrants, or reducing illegal immigration opportunities at the border, to achieve a 50% reduction in the number of illegal immigrants (a very aggressive program) would produce an *increase* in the unemployment rate of unskilled natives by about 1.13% of its initial value. The unemployment rate of native skilled workers also *increases* by 0.57%. The first effect is due to a decrease in unskilled job creation by firms and the second to the negative productivity effect on skilled workers due to complementarity. A similar result can be obtained by increasing the cost of unemployment for illegal immigrants, which would increase native unemployment by 0.95%. This is because this alternate policy would also reduce the wage of illegal immigrants, partly offsetting the negative incentives to create unskilled jobs. The same reduction in illegal immigrants achieved with a legalization program would produce very different effects. The unemployment rate

of unskilled natives would *decrease* by about 1.31% of its initial value and that of skilled natives would *decrease* by 1.20% of its initial value. The increase in legal immigrants generated by the legalization program turns the negative labor market effect into a positive one. At the same time, legalization is the only policy that increases income per native in the scenario presented above (+0.45%), while employment losses of high- and low-skilled native workers and firm profits result in a net decrease in income per native when adopting the other three policies ($-0.25/-0.28\%$).

Several checks on parameter values and on different scenarios about immigrants' productivity confirm the above results are quite stable and apply, qualitatively, to most plausible scenarios. In summary, while the effects on income and unemployment are quite small, the difference between the restrictive policies (that deliver similar effects within each other) and the legalization is very clear: legalization is the only policy that produces an increase in income per native and a decrease in native skilled and unskilled unemployment. As the administrative costs to implement legalization are also likely much smaller than those of increasing border security and certainly of those of deporting immigrants, our analysis suggests that, in terms of consequences on income of natives, legalization seems the best option.

This paper is related to a large empirical literature on the effect of immigration on US labor market outcomes (see the meta-analysis by Longhi, Nyikamp and Poot (2005), (2008) and Lewis and Peri (forthcoming) for reviews of several important recent findings). Most of that literature adopts a canonical neoclassical labor demand-supply approach to derive a reduced form equation (e.g. Borjas 2003) or a slightly more structural approach to estimate the elasticity of relative demand (Ottaviano and Peri 2012, Manacorda et al 2012). Very few studies analyze immigration within the context of search-matching models of the labor market. Even fewer differentiate between legal and illegal immigration when looking at labor market implications.

The paper most closely related to ours is Chassamboulli and Palivos (2014). In that paper, however, immigration is exogenous – only the receiving country is analyzed, only legal immigrants exists, and no policy is explicitly considered. Chassamboulli and Palivos (2014) is the first paper, to our knowledge, that introduces the important job-creation effect of immigrants stemming from the fact that the profit for the firm generated by immigrants is larger than that generated by natives. This is an important building block of our model, too. We add to that framework the very important difference between

legal and illegal immigrants, the modeling of the migration decision from Mexico, and the representation and analysis of specific policies. With those tools we are the first to analyze the income and employment impact of different policies reducing the number of illegal immigrants.

Palivos (2009) is one of the very few papers analyzing the welfare effects of illegal immigrants on natives. Liu (2010) is the only other model we are aware of analyzing the effects of illegal immigration on the receiving country using a search-and-matching model. In his model, Liu (2010) only includes illegal immigrants and assumes they are identical to natives in their search and labor supply behavior, but may be complementary to native workers in production. We consider, instead, that immigrants – particularly illegal ones – are disadvantaged relative to natives in terms of job search conditions and search costs (they receive lower or no benefits when unemployed). We also include the possibility that illegal immigrants are subject to the risk of deportation. In our model what is commonly referred to as "exploitation" of illegal immigrants – being paid lower salaries – is due to their worse bargaining position, vis-a-vis their employer, relative to natives.

Finally, somewhat related to this paper, although mainly empirical, is the literature on immigration and labor market institutions. It has been recognized for some time that the specific labor market institutions (level of unemployment benefits, costs of hiring, centralization of wage bargaining) can significantly affect the impact of immigration on employment and wages of natives. For instance, Angrist and Kugler (2003) show that more protective labor markets result in larger impacts of immigration on unemployment. D'Amuri and Peri (2014) also show labor reallocation and the complementarity effects of immigrants can be larger in markets with lower rigidities.

The rest of the paper is organized as follows. Section 2 presents the model and provides intuition for its main results and the working of different mechanisms. We then describe in Section 3 the policy experiments we consider, as well as two special cases allowing us to illustrate how two important mechanisms function in the model. Section 4 describes the parameterization of the model calibrated to match the main labor market statistics of the US and Mexico for the period between 2000 and 2010. Section 5 shows the main effects obtained by simulating four different policies that would achieve a reduction in the number of illegal immigrants in the rich country. In Section 6 we present some checks that the results are robust to reasonable variations of the parameter values. Section 7 concludes the paper.

2 The Model

We describe here the main features of the model. Details of the equilibrium conditions and derivation of intermediate results are described in Appendix A. We consider two countries indexed by $i = [1, 2]$. Each country is endowed with a continuum of workers. All agents are risk neutral and discount the future at a common rate $r > 0$, equal to the real interest rate. Time is continuous. Country 1 has higher wages and higher employment rate than country 2. Hence, workers have economic incentives to migrate from country 2 to country 1. No worker has incentives to migrate from country 1 to country 2. Migration can be legal or illegal. We denote with I and L, respectively, the number of illegal and legal migrant workers in country 1. The difference between the two is that opportunities to migrate illegally are more frequent than those to migrate legally. However, illegal immigrants have higher search costs in the labor market and they face risk of deportation. The size of the labor force native of country 1 (indicated as N) is normalized to 1 and it is divided into two types of workers: skilled in measure of S and unskilled in measure of $1 - S$. Individuals born in country 2 are, instead, of measure F (foreign) and we assume they are all unskilled. The reason for this simplification is that we are focusing on the Mexico-US migration which mainly involves unskilled workers (without tertiary education). The total labor force of country 1 consists of natives, legal and illegal immigrants and its size is $1 + I + L$. The size of total labor force in country 2 is $F - I - L$. Individuals from either country enter the labor force at rate τ and exit at rate τ, so that the overall size of the labor force (native of country 1 and 2) remains constant. The new individuals enter the labor force as unemployed.

At any point in time, opportunities to migrate arise as "random events" occurring at rate μ_x if the worker is unemployed in country 2, and at rate μ_x^e if the worker is employed. The subscript $x = [I, L]$ indicates the type of immigration opportunity. Specifically, the worker may find an opportunity to migrate to country 1 legally (L) or illegally (I). Once in country 1, illegal immigrants face some risk of deportation, but may obtain legal status with probability n. This reflects the possibility that through some special circumstances (e.g. marriage) some illegal immigrants may become legal. This probability is, however, very small in absence of a legalization program. We assume that $\mu_x > \mu_x^e$ and, without loss of generality, we choose $\mu_x^e = 0$, $x = [L, I]$. Thus, migration opportunities arise only for the unemployed who are actively looking for them. This captures the idea that, in order to migrate, workers often need to move closer to the border and actively look for

migration opportunities. A worker will act upon an opportunity to migrate to country 1 if the benefit exceeds the cost. The migration cost, z is heterogeneous across individuals and is distributed according to the CDF $\Phi(z)$ with support $[\underline{z}, \bar{z}]$. Only the fraction of workers with costs lower than expected benefits will migrate. Once in country 1, migrants search for a job. Hence, the benefit from immigrating to country 1 is the difference between the value of searching for a job as an immigrant in country 1 and the value of searching for a job as a native in country 2.

2.1 Workers and Firms

Firms in country 1 operate in one of two intermediate sectors, or in the final sector.[2] The two intermediate sectors produce intermediate goods Y_1^u and Y_1^s using "unskilled" and "skilled" labor, respectively. Each of these two sectors operates a linear technology, which, through normalization of units, yields output equal to the number of respective workers employed. These intermediate inputs are non-storable. Once produced, they are sold in competitive markets and are assembled for the production of country 1's final good (Y_1), the numeraire. The production technology for the final good of country 1 is as follows:

$$Y_1 = [\alpha(Y_1^s)^\rho + (1-\alpha)(Y_1^u)^\rho]^{1/\rho}, \qquad \rho \leq 1, \tag{1}$$

where α is a positive parameter that governs income shares and ρ determines the elasticity of substitution between the unskilled and skilled inputs. Since the two intermediate inputs are sold in competitive markets, their prices, p_1^s and p_1^u will be equal to their marginal products, that is:

$$p_1^s = \alpha \left(\frac{Y_1}{Y_1^s}\right)^{1-\rho}, \tag{2}$$

$$p_1^u = (1-\alpha) \left(\frac{Y_1}{Y_1^u}\right)^{1-\rho}, \tag{3}$$

The production technology in (1) implies diminishing marginal products and Edgeworth complementarity between the two inputs Y_1^s and Y_1^u.[3] The migrants from country 2 in country 1 supply labor to the unskilled intermediate sector. The natives, on the other hand, can be either skilled (s) or unskilled (u). Hence the skilled labor market in Country 1 hires only skilled native workers whose marginal productivity is p_1^s and the unskilled labor market hires unskilled native workers and immigrants with marginal productivity p_1^u. The

[2] Our production side borrows from Acemoglu (2001).

[3] That is: $\frac{\partial p_1^t}{\partial Y_1^t} < 0$ and $\frac{\partial p_1^x}{\partial Y_1^t} > 0$ for $x \neq t$.

production technology in (1) implies immigrants are complements to skilled native workers and perfect substitutes for unskilled native workers. Without loss of generality, we keep the economy of country 2 simple by assuming all its workers are identically unskilled. Therefore, there is only one labor market in country 2 in which all matches produce constant output p_2 and total output in the country is equal to $Y_2 = (F - I - L - U_2)p_2$, where U_2 denotes the unemployed labor force of country 2, defined below.

2.2 Search and Matching

In each labor market of country i, unemployed workers and unfilled vacancies are brought together via a stochastic matching technology $M_i(U_i^t, V_i^t)$, where $t = [u, s]$ denotes the skill-type. U_i^t and V_i^t denote, respectively, the number of unemployed workers and vacancies of skill t in country i.[4] We assume the function $M_i(U_i^t, V_i^t)$, $i = [1, 2]$ exhibits standard properties: it is at least twice continuously differentiable, is increasing in its arguments, exhibits constant returns to scale, and satisfies the Inada conditions. Using the property of constant returns to scale, we can write the flow rate of match per unemployed worker of skill type t in country 1 as $M_i(U_i^t, V_i^t)/U_i^t = m_i(\theta_i^t)$. The flow rate of match per vacancy is $M_i(U_i^t, V_i^t)/V_i^t = q_i(\theta_i^t)$, where $\theta_i^t = V_i^t/U_i^t = m_i(\theta_i^t)/q_i(\theta_i^t)$ represents the measure of tightness in market t of country i and $m_i(\theta_i^t)$ is increasing in θ_i^t, while $q_i(\theta_i^t)$ is decreasing in θ_i^t.

Each firm posts at most one vacancy. The number of vacancies in each market is determined endogenously by free entry. While vacancies in country 1 are skill-specific, they cannot be specifically "targeted" to natives or to immigrants. They are open to both native and immigrant workers with those skills. A vacant firm bears a recruitment cost c_i^t specific to the country and skill type, related to the expenses of keeping a vacancy open and looking for a worker. An unemployed worker of type t in country i receives a flow of income b_i^t, which can be considered as the opportunity cost of employment. In addition, individuals have an additional cost of being unemployed π_{ij}^t per unit of time where the subscript $j = [N, I, L]$ denotes the worker's origin and status: native (N), illegal immigrant (I) and legal immigrant (L). Such subscript applies only to the unskilled market of country 1. This cost is larger for the legal immigrant than for native workers. Illegal immigrants face an even higher level of this cost. The reason is legal immigrants,

[4] Since there is only one labor market in country 2 the superscript t is not relevant in the case $i = 2$. In what follows we drop the superscript t whenever $i = 2$.

whether they are permanent residents or on temporary visas, have access to significantly fewer benefits than US citizens. The Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) of 1996 restricted many federal government benefits (Food stamps, TANF, AFDC and others) to require US citizenship. Hence, non-naturalized legal immigrants (the majority of unskilled foreign-born) faced a significantly larger cost of being without a job. In the 2000's some states reinstated some of these benefits for non-citizens. Moreover, all legal immigrants on temporary visas (such as H2B and other working visas) are not eligible for any welfare assistance, including unemployment insurance. Hence, their access to income when not employed is significantly smaller than for natives. Undocumented immigrants cannot access any welfare programs/unemployment insurance and hence their cost of unemployment is even larger. We standardize the unemployment cost of a native worker to 0 and set $\pi^s_{1N} = \pi^u_{1N} = \pi_{2N} = 0$, $\pi^u_{1I} = \pi_I$, $\pi^u_{1L} = \pi_L$ and we presume $\pi_I > \pi_L > 0$, which will be confirmed by the calibration.[5]

Legal immigrants face zero deportation risk. They have a positive probability of returning home, however, reflecting the possibility of return for personal or other reasons. Illegal immigrants face the additional risk of being repatriated by deportation. Hence the return probability of illegal immigrants is higher than for legal immigrants. Let d_L and d_I denote the instant return rate of legal and illegal immigrants, respectively. We set $d_I \geq d_L > 0$ where their difference is the deportation rate. Upon return to country 2 the worker joins the pool of unemployed and starts searching for a job.

When a vacancy and a worker are matched they bargain over the division of the produced surplus. The status of the worker as well as the output that results from a match are known to both parties. Wages, denoted as w^t_{ij}, differ by country (i), skill type (t) and migration status (j). They are determined by Nash bargaining of the produced surplus between the firm and the worker. After an agreement has been reached, production commences immediately. Matches in country i dissolve at the rate σ^t_i, specific to skill type t and country i. Following a job destruction, the worker and the vacancy enter the corresponding market and search for a new match.

[5] The most natural way to think of unemployment costs is a reduction of the unemployment benefits. That is, natives earn b^t_1 while unemployed, whereas legal and illegal immigrants earn $b^t_1 - \pi_L$ and $b^t_1 - \pi_I$, respectively. Alternatively, we could think that immigrants have higher costs of searching because they do not have access to the same networks or assistance as natives.

2.3 Optimality Conditions and Free entry

At each point in time a worker is either employed (E) or unemployed (U), while a vacancy may be either filled (F) or empty (V). We use the notation $J_{ij}^{\kappa,t}$ to denote the present discounted value associated with each state $\kappa = [V, F, U, E]$, where $i = [1, 2]$ denotes the country, $j = [N, I, L]$ the worker's immigration status and $t = [u, s]$ indicates the worker's skill type.

Eighteen Bellman equations describe the optimal behavior of workers and firms. Since all workers and firms in country 2 are identical, four Bellman equations (one for each state $\kappa = [V, F, U, E]$) describe the values of workers and firms in country 2. The remaining fourteen Bellman equations describe the values of workers and firms in country 1, where workers differ in terms of skills and immigration status. Specifically, for each of the three states, $[F, U, E]$, there are four Bellman equations: one for legal immigrants, one for illegal immigrants, one for unskilled natives and one for skilled natives. The value of an unskilled vacancy searching for a worker (V), instead, is the same for legal immigrants, illegal immigrants and unskilled natives because the vacancy is open to any of them and is described by the same Bellman equation. Another Bellman equation describes the value of a skilled vacancy.[6] The full set of Bellman equations is in Appendix A.

A second set of equilibrium conditions is that of free-entry (vacancy posting) on the firm side in each of the two labor markets in country 1 (skilled and unskilled) and in country 2. Firms open vacancies up to the point that an additional one has zero expected value. In equilibrium this implies the following three conditions:

$$J_i^{V,t} = 0, \quad i = [1, 2] \text{ and } t = [s, u] \text{ if } i = 1, \tag{4}$$

Wages are then determined by Nash bargaining between the matched firm and the worker. The outside options of the firm and the worker are the value of a vacancy and the value of being unemployed, respectively. Let $S_{ij}^t \equiv J_{ij}^{F,t} + J_{ij}^{E,t} - (J_{ij}^{U,t} + J_i^{V,t})$ denote the surplus of a match between a vacancy of skill type t in country i and a worker of immigration status j. With Nash-bargaining the wage w_{ij}^t is set to a level such that the worker gets a share β of the surplus, where β represents the relative bargaining power of workers, and the share $(1-\beta)$ goes to the firm. This implies five equilibrium conditions (for

[6] The superscript t and the subscript j are not relevant for country 2, we therefore drop them whenever $i = 2$. We also drop the superscript t in the cases $j = [L, I]$, since all immigrants provide only unskilled labor and can only be employed in unskilled jobs, and the subscript j in the case $\kappa = V$ and $i = 1$, since unskilled vacancies in country 1 are common to immigrants and natives.

matches with legal immigrants, illegal immigrants, unskilled natives and skilled natives in country 1 and for matches with native workers in country 2) of the following form:

$$\begin{aligned} \beta S_{ij}^t &= J_{ij}^{E,t} - J_{ij}^{U,t} \qquad (1-\beta) S_{ij}^t = J_{ij}^{F,t} - J_i^{V,t} \\ \text{for } i &= [1,2];\ j = [N, I, L] \text{ if } i = 1; \text{ and } t = [s, u] \text{ if } j = N \end{aligned} \tag{5}$$

2.4 The Immigration Decision

An (unemployed) worker located in country 2 will choose to immigrate to country 1 when an immigration opportunity arises if its benefit exceeds its cost. The benefit from migration is the difference between the value of searching for an unskilled job in country 1 and the value of searching in country 2. Workers are heterogeneous in their migration costs. A worker whose migration cost is z, will chose to take advantage of an opportunity to enter country 1 legally only if $J_{1L}^U - J_2^U \geq z$; while he/she will enter illegally if $J_{1I}^U - J_2^U \geq z$. The threshold costs, denoted as z_I^* and z_L^*, representing the highest cost a worker is willing to pay in order to obtain illegal or legal entry into country 1, are defined by the following conditions:

$$z_I^* = J_{1I}^U - J_2^U \tag{6}$$

$$z_L^* = J_{1L}^U - J_2^U \tag{7}$$

Notice $z_L^* > z_I^*$ in equilibrium because the value of searching for a job in country 1 is higher when the immigrant is legal than when he/she is illegal (i.e. $J_{1L}^U > J_{1I}^U$). This proceeds from the assumption that illegal immigrants have higher search costs ($\pi_I > \pi_L > 0$) and face the risk of deportation ($d_I > d_L > 0$), both of which reduce the value they can generate while searching for a job and the value of a job to them. This implies, for a given distribution of the migration cost z, there will always be a larger share of country 2'S population willing to take a legal immigration opportunity than an illegal one.

2.5 The Steady-State conditions

The last set of equilibrium conditions are the steady-state conditions. Five of them determine the constant number of unemployed workers of each type in each country by equating the flows into and out of unemployment status for each type of worker: U_2 are in country 2, U_{1N}^s are skilled natives in country 1, U_{1N}^u are unskilled natives in country 1, U_{1L} are legal immigrants in country 1 and U_{1I} are illegal immigrants in country 1. Two

more conditions guarantee the stationarity of the number of legal and illegal immigrants, L and I by equating the flows into and out of the group. The seven formal conditions defining these steady state variables are given by (38-44) in Appendix A.2. Let us also define the variables $\phi \equiv U_{1N}^u/(U_{1N}^u + U_{1I} + U_{1L})$ to be the share of native workers in the pool of unemployed unskilled workers of country 1 and $\lambda \equiv U_{1L}/(U_{1L} + U_{1I})$ to be the share of legal immigrants among unemployed immigrants in country 1. In equilibrium ϕ and λ are also constant. Writing the steady state conditions for unemployed and migrants as a function of parameters, labor market tightness in the respective markets $(\theta_1^s, \theta_1^u, \theta_2)$ and threshold costs z_I^* and z_L^* we obtain the following expressions:

$$u_{1N}^s = \frac{U_{1N}^s}{S} = \frac{\sigma_1^s + \tau}{\sigma_1^s + \tau + m(\theta_1^s)} \tag{8}$$

$$u_{1N}^u = \frac{U_{1N}^u}{1-S} = \frac{\sigma_1^u + \tau}{\sigma_1^u + \tau + m(\theta_1^u)} \tag{9}$$

$$u_{1I} = \frac{U_{1I}}{I} = \frac{\sigma_1^u + \tau + d_I + n}{\sigma_1^u + \tau + d_I + n + m(\theta_1^u)} \tag{10}$$

$$u_{1L} = \frac{U_{1L}}{L} = \frac{\sigma_1^u + \tau + d_L - n\frac{I}{L}(1-u_{1I})}{\sigma_1^u + \tau + d_L + m(\theta_1^u)} \tag{11}$$

$$u_2 = \frac{U_2}{F-I-L} = \frac{\sigma_2 + \tau}{\sigma_2 + \tau + m(\theta_2)} \tag{12}$$

$$L = \frac{\mu_L \Phi(z_L^*) u_2 (F-I) + nI}{d_L + \tau + \mu_L \Phi(z_L^*) u_2} \tag{13}$$

$$I = \frac{\mu_I \Phi(z_I^*) u_2 (F-L)}{d_I + n + \tau + \mu_I \Phi(z_I^*) u_2} \tag{14}$$

Expressions (8)-(14) reveal some important mechanisms at work in our model. First, (13) and (14) show the equilibrium number of migrants I and L depend negatively on the return probabilities (d_I and d_L), positively on the rates of migration opportunities (μ_I, μ_L), and positively on the threshold migration costs z_I^* and z_L^*. The latter implies any economic and policy factor that increases the value of searching for a job in country 1 relative to country 2 encourages immigration and translates to larger stocks of legal L and illegal I immigrants in country 1. Second, the legalization rate (n) increases the steady-state number of legal immigrants L and decreases the steady-state number of illegal immigrants I. Third, as customary in these models, unemployment rates increase with the relative separation probability σ_i^t and decrease with the matching probability $m(\theta_i^t)$

in the corresponding market.[7] The impact of immigration policies on θ_i^t, and in turn, on the matching probability $m(\theta_i^t)$, is the main channel through which they can influence the unemployment rate of the native workers that participate in that market.

Let us notice that once the constant equilibrium values of L, I, U_{1N}^s, U_{1N}^u, U_{1L}, U_{1I} are determined, a linear technology determines production of intermediates for country 1 so that: $Y_1^u = 1 - S + L + I - U_{1N}^u - U_{1L} - U_{1I}$ and $Y_1^s = S - U_{1N}^s$.

2.6 Equilibrium

The eighteen Bellman equations (20-37), five Nash-Bargaining conditions (5), three free entry conditions (4), seven steady-state conditions (8-14) and two immigration-threshold conditions (6-7) plus 2 marginal productivity conditions (2, 3), the two linear production functions of intermediates and the aggregate production function of country 1 (1) and country 2 constitute the fourty-one equilibrium conditions determining the fourty-one endogenous variables of the model. These endogenous variables are the eighteen values of $J_{ij}^{\kappa,t}$ across countries, skills and immigration status, five wages $(w_{1N}^s, w_{1N}^u, w_{1L}, w_{1I}, w_2)$, three labor market tightness values (θ_1^u, θ_1^s , θ_2) the number of unemployed and migrants of each type (I, L, U_{1N}^s, U_{1N}^u, U_{1L}, U_{1I}, U_2) the immigration cost thresholds (z_I^*, z_L^*) the marginal productivity of skilled and unskilled workers (p_1^u, p_1^s), the output of skilled and unskilled firms (Y_1^u, Y_1^s) and the final output of country 1 and 2 (Y_1, Y_2). In Appendix A.3 we show how to derive some intermediate results and provide a description for how to solve the model in blocks. However, given that some of the expressions are cumbersome and unintuitive, we omit those from the text. Instead, we will explain, before calibrating and simulating the full model, the intuition behind two key mechanisms with the help of two special cases described in Section 3 below.

2.7 Three key conditions

Before moving to the special cases, it is useful, to show three equilibrium relations that provide some intuition for the role of legal and illegal immigrants on unskilled job creation (vacancy posting) by firms in country 1.

Manipulating the Bellman equations of the value (to the firm) of a filled unskilled vacancy, $J_{1N}^{F,u}$, J_{1L}^F and J_{1I}^F, we can write the difference in value between a native-filled

[7] The unemployment rates of illegal and legal immigrants, u_{1I} and u_{1L}, increase also with the probability of return d_I and d_L (respectively) and with the exit/entry rate τ. All those parameters, in the steady state, act as separation rates.

vacancy and a legal immigrant-filled one, and between one filled by a legal and an illegal immigrant as follows:

$$J_{1N}^{F,u} - J_{1L}^{F} = \frac{[w_{1L} - w_{1N}^{u}] + d_L J_{1N}^{F,u}}{r + \tau + \sigma_1^u + d_L} \tag{15}$$

$$J_{1L}^{F} - J_{1I}^{F} = \frac{[w_{1I} - w_{1L}] + [d_I - d_L] J_{1L}^{F}}{r + \tau + \sigma_1^u + d_I + n} \tag{16}$$

Expression (15) reveals if $w_{1L} < w_{1N}$, which would be the case when legal immigrants have higher search cost than natives (worse outside option), then $J_{1N}^{F,u} < J_{1L}^{F}$ as long as d_L is small. So the value of a legal immigrant is higher than that of a native to the firm, given their equal productivity, as long as the wage paid to the immigrant is low enough, relative to the native wage, to compensate for the larger probability the immigrants ends the match by returning to their country of origin. Likewise, condition (16) reveals that if $w_{1I} < w_{1L}$, because illegal immigrants have worse outside options than legal ones, then $J_{1L}^{F} < J_{1I}^{F}$ as long as the difference between the return probabilities, $d_I - d_L$ – representing the deportation rate – is sufficiently small. Hence, low deportation rates and high search cost for illegal immigrants make them particularly valuable to the firm. Further, low return rates and high search cost for legal immigrants make them valuable to the firm. A negative value of expressions (15) and (16) implies legal and illegal immigrants may stimulate job creation. This vacancy creation effect can be seen by manipulating the free entry condition for unskilled vacancies in country one to get:

$$\frac{c_1^u}{q(\theta_1^u)} = \phi J_{1N}^{F,u} + (1 - \phi)\left[\lambda J_{1L}^{F} + (1 - \lambda) J_{1I}^{F}\right] \tag{17}$$

In this expression a larger share of immigrants among the unemployed (smaller value of ϕ), and a larger share of illegal ones among them (smaller value of λ), increase the value of the right-hand side as long as (15) and (16) are negative, by shifting weight on J_{1I}^{F} relative to $J_{1N}^{F,u}$. This would imply more vacancy posting (free entry) and an increase in market tightness θ_1^u to increase the left-hand side and reduce the right-hand side to maintain the equality (recall that $q(\theta_1^u)$ is decreasing in θ_1^u). This implies a policy that decreases the share of both illegal and total immigrants in the labor force certainly depresses the labor market tightness through this channel. However, a policy that decreases the share of illegal immigrants, but increases the share of total immigrants, may offset the first negative impact with a positive impact on θ_1^u.

Finally, let us notice the impact of immigrants on θ_1^u is also the channel through which they affect skilled native workers. As long as skilled and unskilled workers are complementary in production, a larger supply of the unskilled labor input Y_1^u implies a greater price for skilled labor input p_1^s, and thus, larger profits for skilled firms. Hence, immigration policies that stimulate the creation of unskilled jobs and raise θ_1^u will also stimulate the creation of skilled jobs (i.e. raise θ_1^s), with a positive impact on skilled native employment and wages.

3 Policy Effects in Special Cases

The rich structure of the model presented above allows us to analyze different policies. We consider four: (i) reduced opportunities of illegal entry (increased border control) captured by a decline in μ_I; (ii) increased search cost for illegal immigrants, captured by an increase in π_I; (iii) increased probability of deportation, captured by an increase of d_I for given d_L (iv) increased probability of legalization, captured by an increase in n. All these measures reduce the number of illegal immigrants. They have, however, different implications on native labor markets as well as different incentive effects on immigration.

There are the two main channels through which the presence of illegal (and legal) immigrants affects labor market outcomes of natives in our model. The first channel, that we call the "price channel", operates through the price of the intermediate input, p_1^u. As evidenced in equation (3), a decrease in I, which is translated by the linear production technology into a decrease in Y_1^u, increases the marginal productivity of the unskilled labor input, thereby causing its price to rise. This "price effect" is the standard one, also present in the canonical model: immigrants substitute for native unskilled, so reducing their supply increases the marginal productivity of those remaining, putting upward pressure on their wages and downward pressure on their unemployment rate. The second channel, that we call the "labor-cost channel" works instead through the expected labor cost to an unskilled-sector firm from a filled job and follows the logic described in 2.7. A decrease in I, which corresponds to an increase in the share of legal immigrants λ, would increase the expected labor cost and reduce the value of a vacancy to an unskilled-sector firm. Hence, firms post fewer vacancies and the tightness of the labor market decreases putting downward pressure on wages and upward pressure on unemployment of native unskilled.

For both effects it is important to know whether the policy reducing I also reduces

total immigrants (and their share in the labor force $1-\phi$). A policy that decreases total immigrants $(I+L)$ together with I may exacerbate both effects, while a policy that decreases I but increases $(I+L)$ may attenuate, and even reverse, each effect. Before considering the general case, it is useful to consider two special cases in which the price and the labor-cost effects work one at a time, while the other effect is muted.

3.1 Identical Options for Natives and Immigrants: the Price Channel only

The first case considered is one in which unskilled natives, legal and illegal immigrants are identical in their search cost and in their probability of breaking a match. The parameter restrictions generating this case are: $d_I = d_L = 0$ (no probability of random return for immigrants) and $\pi_I = \pi_L = 0$ (no search costs for immigrants). In this case a decrease in I can be achieved through either border control or legalization (as the other two channels have been muted) and it will essentially represent a decrease in the supply of unskilled workers who are identical to native ones. While framed in a search-model with two labor markets (skilled and unskilled), the working of this model is very similar to that of a canonical model in which changing the number of illegal immigrants is like changing the supply of unskilled workers. The effects on wages and employment are very similar to what a classical model of labor demand and supply for two complementary types of labor would deliver.

A consequence of the assumptions above is that legal immigrants, illegal immigrants and native unskilled will be paid the same wage: $w^u_{1N} = w^u_{1L} = w^u_{1I} = w^t_1$. Therefore, the expected value of filling an unskilled vacancy with natives, legal or illegal immigrants is the same ($J^{F,u}_{1N} = J^F_{1L} = J^F_{1I}$) and changing the share of legal, illegal immigrants and natives in the labor force has no effect on the incentive to post vacancies (the right-hand side of 17 does not depend on λ and ϕ in this case). This means that the labor-cost channel is not operating and the only effects work through the price channel.

3.1.1 Identical Natives and Immigrants: Effects of Border Controls

A decrease in the number of illegal immigrants I achieved through increased border control (lower μ_I) reduces the total number of unskilled workers, $(1-S+L+I)$ in country 1 and through the linear technology of the unskilled-sector it lowers $Y^u_1 = \frac{m(\theta^u_1)}{\sigma^u_1+\tau+m(\theta^u_1)}\left[1-S+I+L\right]$ in equilibrium. Since skilled and unskilled labor inputs are

complements in the production of the final good ($\rho < 1$), the decrease in Y_1^u raises the marginal productivity of unskilled labor p_1^u and lowers that of skilled labor p_1^s (from 2 and 3). Since higher prices lead to higher match surplus, this induces the posting of unskilled jobs and raises the tightness and matching probability in the unskilled sector $m(\theta_1^u)$. The increase in the matching probability of unskilled native workers, in turn, drives their unemployment rate down and drives their wages up by improving their outside option. The opposite holds for skilled workers. Their unemployment rate increases and their wage decreases.

3.1.2 Identical Natives and Immigrants: Effects of Legalization:

A decrease in the number of illegal immigrants I achieved through legalization (increase in the rate n) leaves the total number of immigrants unchanged by simply increasing the number of legal immigrants L by the same amount that it decreases illegal ones I. In this case "legal"and "illegal" are simply labels given to identical type of workers and they are also identical to unskilled natives. Hence legalization does not change any feature of the labor market nor the incentives of people in country 2 to immigrate since there is no benefit from obtaining legal status. Hence in this case the production and the price of the unskilled intermediate input (Y_1^u and p_1^u, respectively) remain unchanged. In this case, the legalization of illegal immigrants has no impact on job creation and labor market outcomes of native. Relative to the restrictive policy of increasing border controls, legalization fully eliminates the positive effects on wage and employment of unskilled natives and the negative effects on wage and employment of skilled native workers.

3.2 Perfect Substitution Skilled-Unskilled: the Labor-Cost channel only

The second special case represents, in some respects, the opposite scenario. In this case we consider perfect substitutability in production between skilled and unskilled workers (which corresponds to the assumption $\rho = 1$ in the production function 1), but we maintain differences between unskilled natives, legal immigrants and illegal immigrants so that $d_I > d_L > 0$ and $\pi_I > \pi_L > 0$. Illegal immigrants can be deported and they have the highest search costs. Legal immigrants have a certain probability of returning and also intermediate search costs.

In this case, the price effect is muted because the prices (marginal productivity) of

the intermediate goods are constant, as the aggregate production function is linear in the intermediates. In particular, $p_1^s = \alpha$ and $p_1^u = 1 - \alpha$, and they will be unaffected by the relative supply of skilled and unskilled. This implies the skilled sector is unaffected by the employment and labor market conditions in the unskilled sector, and as a consequence, the wage and unemployment rate of skilled native workers are independent of I. For unskilled workers, instead, the labor market effects of reducing illegal immigrants works only through their effects on the expected labor cost. We can see from expression (17) that an increase in the proportion of natives in total unemployment of country 1 (ϕ) and an increase in the proportion of legal immigrants in the total number of unemployed immigrants (λ) decreases the expected value of a vacancy and reduces job creation[8]. Moreover, policies that increase the search cost for illegal immigrants (π_I) or increase their deportation probability (d_I) also influence directly the value of filling a vacancy with an illegal immigrant J_{1I}^F and in turn affect the right-hand side of (17). Policies aimed at reducing illegal immigrants, therefore, can affect the expected labor cost to an unskilled firm in country 1 and in turn their job creation.

3.2.1 Perfect Skill Substitution: Border controls, Search Cost and Deportation Rates

Border controls, search cost and deportation rates reduce the total proportion of immigrants in the unemployment pool of country 1 hence increasing ϕ. This effect decreases the weight on term $[\lambda J_{1L}^F + (1-\lambda)J_{1I}^F]$ and increases the weight on the term J_{1N}^F in the right-hand side of (17). If $J_{1I}^F > J_{1L}^F > J_{1N}^F$ (which is the empirically relevant case) then the decline in the proportion of immigrants will increase the expected labor cost to an unskilled firm and decrease job creation and market tightness θ_1^u to maintain the equality in (17).

Also, immigration policies aimed at reducing illegal immigrants would, increase λ, the fraction of legal workers among unemployed immigrants. Such a change shifts weight from J_{1I}^F to J_{1L}^F in the expression $[\lambda J_{1L}^F + (1-\lambda)J_{1I}^F]$ of (17) and as long as $J_{1I}^F > J_{1L}^F$ it reduces market tightness θ_1^u to maintain equality. Both effects of the restrictive policies conjure to a decrease in θ_1^u and hence they have an unambiguously positive impact on unemployment and negative impact on wages of unskilled native workers.

Besides this effect, increasing the search cost for illegal immigrants (π_I), or increasing

[8] As long as expressions (15) and (16) are negative.

their deportation probability (d_I), directly affects the cost of employing an illegal immigrant and hence his value to the firm, J_{1I}^F. Those two policies have opposite effects on the cost of employing an illegal immigrant. An increase in π_I worsens the outside option of illegal immigrants and hence lowers their wage w_{1I}^u for given productivity, thereby lowering labor costs to the firm. The increased deportation policy, instead, by increasing the probability of breaking a match, increases the cost of employing an illegal immigrant and reduces incentives for job posting. Hence, the same reduction in the number of illegal immigrants achieved through an increase in π_I has a smaller negative impact on job creation in the unskilled sector than an increase in d_I, as it will increase J_{1I}^F, while an increase in d_I will reduce J_{1I}^F and have an additional negative impact on unskilled labor market tightness (via reducing the value of the right-hand side of 17).

3.2.2 Perfect Skill Substitution: Legalization

Following the three policies described above, both $1-\lambda$ (the share of illegal immigrants among unemployed immigrants) and $1-\phi$ (the immigrant share in unemployment) decrease and produces a depressing effect on job creation. Legalization, instead, is the only policy that may decrease the share of illegal immigrants without reducing the total share of immigrants in country 1. By granting illegal immigrants legal status and increasing the incentives to migrate, the overall number of immigrants is increased. The positive effect on job creation implied by an increase in total immigrants will mitigate the negative effect on job creation due to the reduction of illegal immigrants.

The impact of legalization on the share of immigrants in the labor force (and in the unemployment pool) is, in general, ambiguous. There are, however, reasonable parameter configurations such that an increase in n raises total immigrants as a share of the labor force. This situation is more likely when the opportunities for legal entry μ_L are small. To the limit, when $\mu_L = 0$ so that all new immigrants are illegal and can become legal with probability n, an increase in the legalization probability raises the total number of immigrants (legal and illegal together) for two reasons. First, because a higher legalization probability means the rate by which immigrants return home is on average lower (fewer deportations). Second, because higher chances of legalization raise the expected value of being illegal. This attracts a larger share of country 2 workers by increasing z_I^*. In the general case, where $\mu_L > 0$, a higher n will have the additional effect of deterring the

entry of legal immigrants through its negative impact on z_L^*.[9] In our simulations, for the relevant parameter range, an increase in n (legalization) lowers ϕ and raises λ. These compositional changes involve two opposite effects on the creation of unskilled jobs in country 1: the decrease in ϕ raises it, while the increase in λ lowers it. The relative size of these two opposite effects depends on how large μ_L is relative to n, among other factors. Hence, while we cannot be sure the effect of legalization through the labor-cost channel is positive on the labor market tightness of unskilled workers, the described mechanisms suggest it will be larger (either reducing a negative effect or turning it into a positive one) than the effect of the other policies considered.

3.3 Both Channels

In the basic model in which both channels are at work, their relative effect will determine the effect of reducing illegal immigrants on native unemployment and wages. The three "restrictive" policies – reducing border crossing, increasing search costs and increasing deportation – have a positive price effect on employment and wages of native unskilled workers. However, they may also have a negative labor-cost effect on those variables: if the second effect prevails, they may be harmful to employment and wage of native unskilled. They will certainly hurt the wage of skilled workers through the price channel. On the other hand, legalization – the only policy that may reduce the number of illegal immigrants while increasing total immigration – attenuates the positive price effect on employment and wages of unskilled, but may have a positive impact through reduction of labor costs. In the presence of a significant labor-cost effect, the effect of legalization on the employment of native unskilled may be beneficial, while it also benefits native skilled, if there is complementarity across skills. Relative to the canonical model, the search model introduces the important labor-cost effects that may reverse or attenuate the canonical predictions on native labor market outcomes. We now simulate the effects obtained in a model matched to the US-Mexican economy.

[9] A higher legalization probability improves the outside option of potential immigrants in country 2 and increases their wage w_2. The value of searching for a job in country 2 (J_2^U) therefore increases, with a negative impact on z_L^*.

4 Baseline parameterization of the Model

We parameterize the model to represent the average performance and conditions of the US and Mexican economies between 2000 and 2010, a period in which the presence of illegal immigrants in the US peaked to about 11.5 million individuals. To do so, we combine parameters obtained from three different sources: some parameters are taken from the literature, others are taken directly from the US and Mexican data, while a third group is chosen to match moments of the data. The parameter choice is summarized in Table 1. We describe here in detail the sources and methods used to calculate these parameters. For some key parameters we perform robustness checks in Section 6 so as to test the sensitivity of our main results to a range of plausible values.

We use a Cobb-Douglas matching function, $M_i^t = \xi_i (U_i^t)^{\varepsilon} (V_i^t)^{1-\varepsilon}$, $i = [1, 2]$, $t = [u, s]$ with constant return to scale to U_i^t and V_i^t. Following common practice in these models, we set the unemployment elasticity of the matching function to $\varepsilon = 0.5$, which is within the range of estimates reported in Petrongolo and Pissarides (2001). We postulate the worker's bargaining power to be $\beta = 0.5$, so that the Hosios condition ($\beta = \varepsilon$) is met (see Hosios, 1990). We use the monthly interest rate $r = 0.4\%$ which implies a yearly real rate of about 5%.[10] This is calculated as the 30-year treasury constant maturity bond rate minus the average GDP deflator over the period 1980-2010 for the US.[11] We define as skilled a worker who has at least some college education and unskilled workers are those with no college education. Based on estimates from Ottaviano and Peri (2012) the elasticity of substitution between workers with at least some college education and workers with no college education is around 2. We therefore set $\rho = 0.5$. We assume that the distribution of migration costs is uniform over the interval $[0, \bar{z}]$ where we have standardized the lower bound to 0.

We consider only immigrants from Mexico to the US whose vast majority is unskilled (no college degree). Our measure of $I + L$ therefore includes only unskilled Mexican immigrants.[12] The rest of the labor force of country 1 (which we normalize to 1) includes unskilled and skilled US natives. The share of skilled workers in the US is set to $S = 0.54$. This is the average (over years 2000 and 2010) share of US-born workers with some

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

[11] If one uses the short-term rate, namely the 3-months treasury rate during the 1980-2010 period, one gets a smaller value of $r = 0.2\%$. We use this in a robustness check. We consider the longer interval 1980-2010 as interest rates were unusually low in the 2000-2010 period.

[12] We omit the skilled Mexicans from our analysis with no consequences as they constitute a very small percentage of the total.

college or more in the native working age (25-65) population. Data for this measure come from IPUMS USA. Using the same data we find the monthly inflow of new individuals in the US native labor force is 0.061% and hence we set $\tau = 0.00061$. Using matched data from the Current Population Survey (CPS) we estimated the average skilled and unskilled monthly job-separation rates in the US (σ_1^s and σ_1^u, respectively) to be 0.024 and 0.032, respectively.[13] As we are not aware of comparable estimates for Mexico, we set the separation rate of Mexican jobs equal to that of unskilled US jobs, $\sigma_2 = \sigma_1^u = 0.032$. The Mexican population in working age (residing in Mexico and the US), F, is set to 0.33 of the US native population in working age which is standardized to 1. This number equals the average value obtained from census data 2000 and 2010 by dividing the Mexican unskilled population (in Mexico and US) and the total US native population in the US.

From Masferrer and Roberts (2009), the total number of returnees to Mexico each year (excluding deportation and averaged over the available period 2001-2005) was about 245,000 per year. These are the most precisely estimated returns to Mexico measured during the 2000-2010 decade. As of 2001, the total Mexican-born unskilled population in the US was about 9.1 millions.[14] The basic yearly return migration rate for Mexican migrants can be obtained as the ratio of returnees to US residents which equals 0.027 per year. We consider this to be the "basic" rate of return for Mexican immigrants and we apply it to legal Mexican immigrants for the decade 2000-2010. In order to compute the yearly return rate of illegal Mexican immigrants we add to the basic rate the deportation rate of non-criminal Mexicans. More specifically, applying the same basic return rate of 0.027 to the illegal Mexican population in the US, which was estimated at about 5.2 million in 2001 (Passel and Capps, 2004), gives an estimate of 0.14 million of illegal Mexicans returning to Mexico each year. We then add the deportation of non-criminal Mexicans to that number by using Masferrer and Roberts (2009). They report, on average (for the period 2001-2005), about 100,000 non-criminal Mexicans deported per year[15] so that the total number of previously illegal Mexicans going home (either returning or deported) was about 0.24 million per year. The ratio of total returnees (0.24 million) to the total number of illegal Mexicans (5.2 million) gives the return+deportation rate of the illegal Mexicans equal to 0.0453 yearly. Based on these values and recalling that our model uses monthly

[13] These measures include employment to unemployment and employment to inactivity transitions.

[14] This number comes from the US Census, 1990.

[15] As in our model people are deported while working or looking for a job we assume that they are not criminal.

rates we set the monthly return rates by converting the yearly ones: $(1-d_L)^{12} = (1-0.027)$ and $(1-d_I)^{12} = (1-0.0453)$. This gives $d_L = 0.0023$ and $d_I = 0.0039$ corresponding to a return probability of 0.23% and 0.39% per month respectively. Given the limited evidence on these parameters we also conduct robustness checks allowing values for the return rate twice as large (see section 6.1). Both rates are low relative to the average separation rate of less-skilled jobs which was about 3% per month.

The legalization rate of illegal immigrants is available for the period 2009-2010 and it is calculated as follows. During this period there were about 100,000 naturalizations of Mexicans per year (see Lee, 2012) and of those naturalizations according to table A.1 of Hill et al. (2010) about half were of individuals who had been at some point illegal immigrants. Hence about 50,000 illegal Mexican immigrants per year were naturalized (via marriage, family unification and other specific circumstances). The estimate of illegal Mexicans in 2010 was around 6.8 millions (out of a total of 12 million Mexicans immigrants in the US in that year [16]) so that the "naturalization rate" per year for illegal Mexicans immigrants was (50,000/6,800,000)=0.007.(0.7% per year). We consider this form of naturalization as the way of becoming legal from illegal in absence of an amnesty. Hence converting this yearly rate into monthly rate (approximately dividing by 12) gives a value of $n = 0.0006$. This is the monthly probability of legalization equal to 0.06% per month.

We jointly calibrate the remaining 14 parameters of the model (c_1^s, c_1^u c_2, b_1^s, b_1^u, b_2, $\frac{\mu_L}{\bar{z}}$, $\frac{\mu_I}{\bar{z}}$, ξ_1, ξ_2, π_L, π_I, p_2 and α) to match the targets described here.[17] We target the ratio of employment/population in working age for workers with some college education or more (skilled workers) and for high-school graduates or less (unskilled workers) in the US using IPUMS USA data averaging 2000 and 2010 and we obtain values equal to 87% and 73%, respectively.[18] We also target the employment/population ratio in Mexico, which using IPUMS International data, 2000 and 2010 equals 59%.[19] Our next target is the

[16] see Hoefer, Rythina and Baker (2012)

[17] Under the assumption that the distribution of migration costs is uniform over the interval $[0, \bar{z}]$, the individual values of μ_L, μ_I and $\bar{z}$ do not matter. What matters, instead, is our choice of values for $\frac{\mu_L}{\bar{z}}$ and $\frac{\mu_I}{\bar{z}}$ and we therefore match those.

[18] As there are very large flows between employment and non-employment for individuals in working age we match the value of U in both countries to non-employment rather than to unemployment. In addition, while the non-employment rate in Mexico is much larger than in the US, the unemployment rate in Mexico is strangely lower than in the US, suggesting that the Mexican measure of unemployment does not reflect the true number of workers searching for jobs. We therefore find it more appropriate to match non-employment instead of unemployment in both countries.

[19] To measure the employment to population ratios in the US and Mexico we use ages 25-65 and average

wage premium for workers in the US who have at least some college education. Using IPUMS USA data 2000-2010 we find it to be on average equal to 68%.[20] We use the Conference Board's Help-Wanted Index (HWI) to calculate the vacancy to unemployment ratio which is equal to 0.62 in the US and we assume that the vacancy to unemployment ratio in Mexico takes the same value. As baseline value we then set the wage gap between legal immigrants and natives in the US in 2000-2010 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.[21] We target the wage ratio between US and Mexico to be equal to 4 which is close to the average ratio of income per person between the two countries in the years 2000-2010, according to Penn World Table, version 7.1[22]. We use Hall and Milgrom's (2008) estimate for the ratio of unemployment to employment income of 0.71 to pin down values for the unemployment incomes; we set $b_1^s = 0.71 w_{1N}^s$, $b_2 = 0.71 w_2$ and $b_1^u = 0.71 w_1^u$, where w_1^u is the average wage of unskilled workers in the US. We set the ratio of Mexican immigrants to the US native labor force to $(L + I) = 0.038$ (averaging 2000 and 2010) and the proportion of legal immigrants in the total number of Mexican immigrants to 56% (from Hoefer et al. 2012) so that $I = 0.017$ and $L = 0.021$. Finally, 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 will use that value in a robustness check in section 6.1.

The values of the parameters matching the above targets are as follows: $\alpha = 0.643$, $c_1^s = 0.068$, $c_1^u = 0.146$, $c_2 = 0.028$, $b_1^s = 0.419$, $b_1^u = 0.249$, $b_2 = 0.086$, $\pi_I = 0.381$, $\pi_L = 0.301$, $\xi_1 = 0.113$, $\xi_2 = 0.060$, $p_2 = 0.135$, $\frac{\mu_I}{\bar{z}} = 0.0166\%$ and $\frac{\mu_L}{\bar{z}} = 0.0039\%$

over years 2000 and 2010. Since our focus is on unskilled Mexican immigrants and their consequences for US native workers, our measure of total population in country 1 $(1 + I + L)$ includes only US- and Mexican-born workers; all other (immigrant) workers are excluded. Moreover, our measure of total population in country 2 includes only unskilled Mexican workers, i.e. workers with no college education.

[20] To measure the wage premium we use hourly wages of workers of ages 25-65 and average over 2000-2010.

[21] Several other papers (e.g. LaLonde and Topel 1991, Kerr and Kerr 2011) show that immigrants are paid less than natives even after controlling for other observable productivity determinants such as education and language. A negative immigrant premium of 20% as the one used here is within the range found in the survey by Kerr and Kerr (2011).

[22] Available at: http://pwt.sas.upenn.edu/php_site/pwt_index.php.

and they are shown in Table 1. The last two coefficients, determining the flow-rate of migration opportunities seem very low. However, they imply an illegal immigration rate equal to $\Phi(z_I^*)\mu_I = 0.000706$, which is equal to a 0.07% per month and a legal immigration rate of $\Phi(z_L^*)\mu_L = 0.000429$ equal to 0.04% per month. In yearly rate, combining the two types of migration, this gives an immigration rate of about 1% per year from Mexico to the US. This is exactly the average rate observed in the 2000's.

As discussed above, the conditions $J_{1N}^F - J_{1L}^F < 0$ and $J_{1L}^F - J_{1I}^F < 0$ are crucial in determining whether the reduction in the number of illegal (and total) immigrants has a positive impact on the creation of unskilled jobs in country 1. With the targeted legal immigrant-native wage gap equal to 20% and with the illegal-legal immigrant wage gap equal to 7.5%, and using the choice of the remaining parameters as described above, the calibration discussed above yields $J_{1I}^F = 3.56 J_{1N}^F$ and $J_{1L}^F = 3.08 J_{1N}^F$. This implies that the value of jobs that are filled by immigrants (legal and illegal) is significantly higher than that of jobs filled by natives, while the value of jobs filled by illegal immigrants is only somewhat larger than that of jobs filled by legal ones. This also implies that a higher share of immigrants may generate a significant increase in the expected surplus to the firm and, in turn, a job-creating effect on the economy of country 1.

5 Simulated Effects of Policies on Native Labor Market Outcomes

We simulate the effects of the four different policies aimed at reducing the number of illegal immigrants, described above, one at a time. We focus on the effects of those policies on the labor market outcomes of natives, skilled and unskilled, and on the total income of natives, $\tilde{Y}_1$, which is given by the following expression:

$$\tilde{Y}_1 = Y_1 + b_1^u U_{1N}^u + b_1^s U_{1N}^s - c_1^u v_1^u - c_1^s v_1^s - w_{1I}(I - U_{1I}) - w_{1L}(L - U_{1L}) \qquad (18)$$

Expression (18) assumes that employers are natives and it shows that total income to natives includes total wage income to natives plus firm profits plus unemployment income to native workers minus the cost of keeping vacancies open. An alternative definition can be obtained omitting the natives' unemployment income (which is reasonable if one thinks that such income is generated by transfers rather than by additional home-production) obtaining what we can call "income from market activities" as follows:

$$\tilde{Y}_{1a} = \widetilde{Y}_1 - b_1^u U_{1N}^u - b_1^s U_{1N}^s \tag{19}$$

Notice that as the policies do not change the number of natives, the percentage impact on total native income captures also the percentage impact on income per native. The simulations that we perform consist in using each of the four policy instruments to reduce illegal immigrants by a certain percentage (we simulate reductions between 10% and 100%, where 100% implies that no illegal immigrants is left in the US). In Table 2 we report the effects on the relevant outcomes for natives for each of the four policies implemented so as to reduce illegal immigrants by 10 or 50% of their initial value (the first being a rather limited policy while the second being a drastic one). In Figures 1-3, we consider the impact of the policies on one endogenous variable at a time plotted against the percentage reduction in illegal immigrants obtained with each policy.

Figure 1 is made of six panels. Those on the left show the impact of the four policies on unskilled natives' labor market outcomes while those on the right show the effects on skilled natives. The variables shown are labor market tightness (top row), unemployment rate (median row) and wages (bottom row). The solid trajectory captures in each panel the effect of increasing the job search costs for illegal immigrants (π_I), the dashed trajectory shows the effect of increasing the deportation rate (d_I) the dash and dots trajectory shows the effects of increasing border security (reducing μ_I) and the dotted line represents the effect of increasing the legalization rate (n). The horizontal axis shows the decrease in illegal immigrants (I) as percentage of their initial number. The vertical axis shows the effect on the outcome variable as a percentage of its initial value. The percentage changes in the policy parameters needed to obtain the same change in illegal immigrants may be different from policy to policy. The figures allow us to easily compare the effects on the labor market outcomes of natives, skilled and unskilled due to policies that deliver a varying percentage reduction of illegal immigrants.[23] The entries in Table 2 represent the percentage effect on native unskilled outcomes (top three rows), native skilled outcomes (next 3 rows) and native income (last 2 rows) from reducing illegal immigrants by 10 and 50% with each type of policy. Columns 1 and 2 show the impact of reducing illegal immigrants by 10 and 50% using increased border controls (lower μ_I). Columns 3 and

[23]The percent changes shown in the figures span from 10% to 100% and hence add information to the Tables. The figures allow us to see the full relationship between the percentage change in illegal immigrants and the percent changes in the labor market outcomes of natives. As it turns out, the relation is close to linear in most cases. It is still useful to visualize it for the basic results.

4 show the impact of the same reduction obtained by making it more costly for illegal immigrants to search for a job (higher π_I). Columns 5 and 6 show the effects of increasing deportation probabilities (higher d_I). Columns 7 and 8 show the effects of increasing the legalization probability n. Finally, Columns 9 and 10 show the effects of a policy combination we discuss in Section 5.1 below.

The effects on labor market tightness, shown in the top panels of Figure 1 (and in the top row and fourth row of Table 2), are key to understanding the other effects. In those figures we see that increases in search costs, deportation probability, and border controls all decrease the labor market tightness for skilled and unskilled native workers. This is because these restrictive measures decrease the share of immigrants overall, implying an increase in expected labor costs for firms that more than offset the positive price effects on unskilled workers. Hence, unskilled job creation will decrease, as will unskilled labor market tightness. For skilled workers, instead, the only effect would be through relative prices (marginal productivity) which declines, implying their labor market tightness will decrease (see panels on the right). Notice that, although marginally, an increase in search cost is the policy with the least negative effect on market tightness, among the restrictive ones. This is because, while it decreases the total number of immigrants, it also increases firm surplus per illegal immigrant (by worsening their outside option). The second effect reduces the first. The top row of Figure 1 shows this positive effect reduces the negative impact on market tightness only minimally.

The only policy with a significantly different effect on labor market tightness is the increase in the legalization rate. This policy *increases* the market tightness of unskilled because it increases legal (and total) immigration. Hence, through this channel and because immigrants reduce the labor costs of the firm, legalization generates higher job creation and higher market tightness among unskilled.

The two panels in the intermediate row of Figure 1, then, show how labor market tightness translates into effects on the unemployment rates.[24] These effects mimic (with the opposite sign) those on market tightness: fewer vacancies per unemployed result in higher unemployment rates in equilibrium. To gauge the size of the effects, we see in Table 2 that for a 50% reduction in illegal immigrants, achieved through tighter border control or increased deportation rates, the native unemployment rate of unskilled is $1.13 - 1.14\%$ higher than before and $0.57 - 0.58\%$ higher for high skilled natives.[25] The same reduc-

[24] The variable "unemployment" in our model captures all non-employed in working age.

[25] Using the base-value of 27 percentage points as non-employment rate of unskilled and 12 as non-

tion achieved via increased search costs for illegal immigrants increases native low-skilled unemployment only by 0.95%. Skilled unemployment rate increases by 0.55%. However, if the same reduction is achieved via increased legalization rate, the unemployment rate of natives unskilled would actually be *reduced* by 1.31% (or 0.35 percentage points, using the base-value of 27 percentage points as non-employment rate of unskilled) and the unemployment rate of skilled would also be *reduced* by 1.20% (0.14 percentage points, using the base-value of 12 percentage points for skilled). While these effects are small the benchmark simulation suggests that the US labor market for unskilled and skilled workers is made tighter by a policy that legalizes immigrants. In layman language, legalization encourages firms to create jobs in the perspective of hiring legal immigrants and this expansion benefits native workers as well. To the contrary when using the restrictive policies the benchmark simulations of our model show negative effects on tightness and positive on unemployment rates. Firms reduce job creation as they have lower chances of hiring immigrants.

The bottom panels of Figure 1 (and the third and sixth row of Table 2) show the effects on native skilled and unskilled wages. In this case the price effect prevails and the policies restricting the total supply of immigrants increase the wage of native unskilled workers and reduce the wage of skilled ones, vice-versa legalization has the opposite effect and reduces unskilled wage while raising skilled one. While a tighter labor market, as generated by legalization, increases the bargaining power of workers and allows them to bargain for higher wages, for given productivity, the reduction of their marginal productivity, due to the price effect, prevails on wages. Specifically achieving a 50% reduction in illegal immigrants with either of the "restrictive" policies increases native unskilled wages by $0.55 - 0.56\%$ and reduces native skilled wages by $0.34 - 0.35\%$. Achieving the same goal with legalization, instead, reduces the wage of unskilled natives by 1.23% and increases the wage of skilled natives by 0.75%. The interesting finding of this first set of simulations is that, in this model, it is not possible to predict the impact of reducing illegal immigrants on wages and unemployment rates of native unskilled (and skilled) workers unless we know what policy is used. Moreover the impact of a policy on wages and employment is not necessarily consistent with the simple canonical model in which a change in the supply of immigrants affects wages and employment of natives in the same direction.

Inspection of Figure 1A (and Table A1) in the appendix shows that effects similar to

employment rate of high skilled in the US (see Section 4) this implies an increase of non-employment rate by 0.3 percentage points for unskilled and 0.06 percentage points for skilled.

those for unskilled natives emerge for the unemployment and wages of legal immigrants (lower panels in Figure 1A). Hence the increased job creation by firms, from a legalization program, benefits employment of unskilled natives and legal immigrants, however reduces their wages. To the contrary increased job search costs, border enforcement and deportation hurts job creation and employment of legal immigrants, but increases their wages.

The policies have very different effects on the wage of illegal immigrants (top panels of Figure 1A). In particular, all policies, but border control, reduce the wage of illegal immigrants. A policy that reduces illegal immigrants by 50% by increasing their job-search costs, thus worsening their outside option, would also reduce their wages by 3.31%. The same drastic reduction in illegal immigrants achieved through deportation also reduces the wage of illegal immigrants (by 0.73%). Notice also that despite its positive job creation effect, a legalization program produces a large increase in the unemployment rate of illegal immigrants (+19.28%) and a relatively large decrease in their wage (−2.17% as opposed to −1.29% for legal immigrants and −1.23% for unskilled natives). This is because with the legalization of incumbent illegal immigrants a higher portion of those that remain illegal are new (unemployed) entrants, i.e. workers who have recently crossed the border in order to search for better jobs.[26] Hence, following a legalization program, a higher portion of those that remain illegal are workers who are unemployed.

Figure 2 shows the impact of policies that reduce the number of illegal immigrants on the income per native. In the upper panel we show the impact on $\widetilde{Y}_1$ (expression 18), while in the lower panel we exclude unemployment income (expression 19) and we show the impact on $\widetilde{Y}_{1a}$. We comment the results on $\widetilde{Y}_{1a}$. The effects on $\widetilde{Y}_1$ are similar, but somewhat smaller, as unemployment income attenuates the negative income effect of reducing employment. The restrictive immigration policies (deportation, border controls and higher job-search costs) hurt unskilled-firm profits and reduce job creation, as described above. While their effect on overall wages, aggregating skilled and unskilled, is very small (positive for the first and negative for the second group), the negative job-creation effect and the negative effect on firm profits produce an overall negative impact on native per capita income. Hence restrictive policies produce an effect on income per

[26] Notice from equation (10) that an increase in n raises u_{1I}. In steady state, a larger flow of immigrants out of illegal status, due to legalization, must be balanced by a larger flow into it through illegal entry. The legalization of existing immigrants therefore shifts the pool of illegal immigrants towards new entrants who are more likely to be unemployed.

native between 0 and -0.6%. A policy delivering a reduction of illegal immigrants by 50% produces a $0.25 - 0.28\%$ decline in income per native. To the contrary, legalization combines a positive employment effect, a small aggregate wage effect and a positive profit effect and hence it delivers an increase in income per native between 0 and 0.80%. An increase of the legalization rate that reduces the illegal immigrant population by 50%, would increase income per native by 0.45%. Overall native average income is hurt by restrictive policies, both because of reduced profits and reduced employment rates while it is helped by legalization.

Finally, Figure 3 shows the percentage change in the number of total and legal immigrants produced by the different policies. As the native population is kept fixed at 1, these changes can be interpreted as percentage changes in the immigrant population relative to natives. At the initial equilibrium the Mexican immigrant population in the US equals 3.8% of the US working-age population (the average value in 2000-2010). Of those, 1.7% are illegal immigrants and 2.1% are legal immigrants. The top panel of Figure 3 shows that any of the three restrictive policies pushed to the point of eliminating illegal immigrants (-100%) would also imply a reduction of total immigrants: the Mexican population in the US would decrease by about 50%, to only 1.9 percentage points of the native population. If the goal is not only to reduce illegal immigrants but also to discourage legal immigrants and reduce overall immigrants then those polices deliver a strong result reached at the expenses of a weaker native labor market for unskilled and skilled workers, lower profits for firms and lower income per native. To the contrary, the same upper panel of Figure 3 shows that a legalization policy (dotted line) that eliminates illegal immigrants (-100%), substantially increases the legal immigrant population so that total Mexican immigrants in the US increase by about 40% (to 7.6% of US native population). This is because those once illegal are now legalized and a larger flow of legal immigrants is driven to the US because of better labor market and legalization opportunities. Additionally this policy delivers tighter labor markets for native workers, more job creation, lower unemployment and higher income per native. However, wages for native unskilled workers are somewhat reduced. If the goal of policy reform is to encourage legal immigration, promote job creation and reduce the number of illegal immigrants, legalization has a much better performance.

5.1 Effects of Policy Combination

Let us consider here an interesting case of policy combination. In the recent debate about immigration and in the recent immigration reform proposals (e.g. S766 passed by the U.S. Senate in June 2013) the principle that a legalization program may happen when the border is under control, is prominently stated. In our context this may be captured by a combination of increased legalization rate n and decreased opportunities for illegal immigration μ_I so that the total number of immigrants (as percentage of natives) is constant. Such combination would eliminate the beneficial effects of more legal immigrants on the labor market. However the negative effects of this mixed policy on labor market tightness are attenuated relative to purely restrictive measures. The simulation results in this case, reported in the last two columns of Table 2, show that for a reduction of illegal immigrants by 50% and no increase in total immigrants this policy delivers an increase of unskilled natives' unemployment of 0.35% of its initial value and an increase of skilled natives' unemployment by 0.03% of its initial value (as opposed to increases by $0.95 - 1.14\%$ and $0.55 - 0.58\%$, respectively, when the restrictive-only policies are used). Similarly the income loss for natives would be very small (-0.05% using this combined policy as opposed to -0.28%). This combination essentially delivers a replacement of illegal immigrants with legal immigrants in the population with much smaller adverse effects on native labor market outcomes than purely restrictive measures.

Finally, it is worth commenting briefly on how the policies used to reduce illegal Mexicans immigrants in the US affect the labor market outcomes of the workers that remain in Mexico. As shown in the last 3 rows of Table A1 in the Appendix, all restrictive immigration measures (border control, increases search cost and deportations) lead to higher job creation (i.e. a tighter labor market) in Mexico and lower unemployment rates for Mexicans, but at the cost of lower wages. In fact, the restrictive immigration measures help increase job creation in Mexico, through their negative impact on the wage of Mexican workers. More specifically, by lowering the value of migration opportunity to the US (and thereby discouraging migration), restrictive policies worsen the outside option of Mexican workers and as a result their bargaining power and wage. In turn, this benefits Mexican firms who can now appropriate of larger profits per job created, leading to more vacancy posting in the Mexican labor market. Legalization, by contrast, has exactly the opposite effects: it improves the outside option and wage of Mexican workers, thereby reducing firm profits, job creation and employment in Mexico.

6 Robustness Checks and Extensions

6.1 Robustness to Key Parameters

The parameterization of the baseline specification is based on the best data available. However, in some cases there is a range of reasonable uncertainty about some of the statistics and the parameters we are matching. For some important parameters we show the simulated effects of policies in a range indicated by the literature as plausible. These checks are performed in Tables 3-6 that reproduce the simulations reported in Table 2, with each table devoted to one specific policy. Table 3 shows the effects of tighter border controls, Table 4 of higher search costs, Table 5 considers increase in deportation rates and Table 6 increase in legalization probability. The tables show robustness checks on five parameters. For other parameters that are less relevant we perform robustness checks in the Appendix (see Table A2-A5, which mirror the structure of Tables 3-6). A first key moment is given by the legal immigrant-native wage gap. The significant job-creation effect from immigrants, in fact, derives from their lower wage that corresponds, in part, to a lower outside option for them. In order to check the robustness of our main results we target a smaller immigrant-native wage gap, of -15% in Specifications (3) and (4) of Tables 3-6.[27] We then consider in Specifications (5) and (6) an illegal-legal immigrant wage gap of -5% (rather than -7.5%), which is in line with the more recent estimates of Barcellos (2010).[28] The return rate of immigrants is also an important determinant of their value to a firm. Hence, we check that our results are robust to a much higher exogenous "natural"return rate of legal immigrants, and in Specifications (7) and (8) we double d_L. As immigrants' role in enhancing job creation is linked to their lower income when unemployed, relative to natives, we consider a much lower level of unemployment benefits for natives. In Specifications (9) and (10) we reduce unemployment income to 50% of wage, rather than 71% in both countries. Finally, as in the optimal job creation decision, future events matter, thus, we analyze the effect of changing the interest (discount) rate to a lower value equal to 2% per year, which is closer to the short-run (3-months), rather than long-run (30 years), real interest rate.

[27] This is at the low end of the estimates for the US (Borjas and Friedberg 2009) and in line with differentials between immigrants and natives as surveyed by Kerr and Kerr (2012) once we control for their observable characteristics.

[28] The values of π_L and π_I that match a smaller native-immigrant wage gap of -15% are 0.225 and 0.312, respectively. Those matching a smaller illegal-legal immigrant wage gap of -5% are 0.301 and 0.352, respectively.

Tables 3-6 follow the same structure and are described below. Let's first consider Table 3, which examines the effect of tightening border controls. That case, under the baseline configuration of parameters (Specifications (1) and (2)), is the one that produces the most damaging effect on job opportunities for unskilled natives (with deportation being a close second). A 50% reduction in illegal immigrants reduces labor market tightness for unskilled workers by 3.07% and for skilled by 1.31%, implying an increase in the unemployment rate by 1.14 and 0.57%, respectively. These results are not very sensitive to reducing the immigrant-native wage gap to 15%, or the illegal-legal premium to 5%, or the interest rate to 2%, nor to doubling the return rate. In all cases unskilled unemployment increases between 0.84 and 1.19% in response to this policy. Similarly, the skilled unemployment rate increased between 0.53 and 0.58%. The only change that somewhat reduces the adverse job-creation effect of border controls is if we assume much lower unemployment benefits for natives. In this case a 50% reduction in illegal immigrants increases unemployment rates of unskilled natives by only 0.69%. As far as wage effects on natives are concerned, the changes in parameters have an even smaller effect. Comparing across columns, the policy reducing illegal immigrants by 50% has a small positive effect in the range of $0.51 - 0.56\%$ on the wages of unskilled and a small negative effect $(-0.32\%/-0.36\%)$ on the wages of skilled natives in each scenario.

The effects on native outcomes described in Table 3 are very similar to those obtained with higher deportation rates and shown in Table 5. The negative and quantitatively similar effect of this policy on labor market tightness of unskilled and skilled natives, and the fact that only the reduction of unemployment benefits for natives produces a non negligible attenuation of that effect, suggests these two policies produce very similar effects on labor market outcomes of natives.

Table 4 shows the baseline and robustness checks for the effect of increasing search costs of illegal immigrants. Compared to the two policies discussed above this one has a smaller negative effect on labor market tightness and smaller positive impact on native unemployment. The reason is, while reducing the number of immigrants overall, it also increases firm profit when hiring immigrants. This stimulates job creation. Making immigrants more similar to natives in their outside option (by reducing the wage gap), as in Specifications (3) and (4), reduces the negative impact of this policy on labor market tightness even further. With a 15% wage gap, a policy of increased search costs that cuts illegal immigrants in half produces only a 0.46% increase in the native unskilled

unemployment rate and a 0.51% increase in skilled unemployment rate.

Finally, Table 6 shows the robustness checks when considering legalization and its effects on native labor market outcomes. This is the only "expansionary" policy for the labor market, in that it increases, in the baseline case, the labor market tightness of skilled and unskilled natives. A legalization rate that ensures a reduction of illegal immigrants by 50% reduces unemployment of native unskilled workers by 1.31% and of skilled native workers by 1.20%. This result is robust to changing the legal-illegal gap, changing the interest rate, and to changes in the unemployment benefits of natives. However, it is quite sensitive to increasing the return rate of immigrants. In particular, as the beneficial job market effects of legalization depend on the higher value of a legal immigrant to the firm (relative to a native), an increase in the probability of return for legal immigrants (and termination of the match) can substantially reduce their value to the firm (as one match has lower expected duration). Column (8) shows that with a return rate back to Mexico for legal immigrants double the one estimated in our data, the positive job market effect of legalization is essentially eliminated. Similarly, a smaller wage differential between immigrants and natives (Columns (3) and (4)) would reduce the job-creating effect of having more immigrants and hence the positive impact on tightness. The effects on income per native are also affected by the job-creation effect, so that while always positive in this case, as opposed to being negative for all the scenarios that use restrictive policies, they are larger when the tightness effect is larger, and close to 0 in the case of Columns (7)-(8) in which the tightness of native labor market is almost unchanged.

Summarizing all the checks, the changes in the crucial parameters do not affect the qualitative conclusions from the baseline simulations, but they may attenuate the quantitative effects.[29] Changes that increase the cost of employing legal immigrants (as a reduction of the wage-gap with natives or an increase in the probability of return to Mexico) reduce the beneficial labor market effects of legalization.

[29] Considering the other robustness checks performed in Tables A2-A5 of the appendix, we notice the only parameter change producing a significant attenuation of the negative (positive) effect of restrictive policies (legalization) on job-creation and market tightness is a decrease in the bargaining power of firms (i.e. lower value for β). With higher bargaining power, firms can appropriate larger profits per filled job. Since matches generate larger profits to firms, the disruptive effects of deportations and voluntary returns of immigrants generate a much more significant loss to the firm. For this reason, the job creating effect of more immigrants in the market becomes smaller.

6.2 The role of Immigrant-Native productivity differences

In the baseline specification of the model we have assumed the productivities of immigrants and natives of the same skill level are identical. As a consequence, the wage differences between those two type of workers is fully driven by their different outside option and implies immigrants generate larger profits to firms than natives. This is a crucial condition to obtain the result that legalization tightens the labor market for the unskilled, while the other three policies – by reducing total immigrants – make it weaker. In this section we test further implications by allowing part of the native-immigrant wage gap to be driven by productivity differences. Since the impact on the high-skilled market tightness would simply follow the low-skilled market tightness, we focus on a simpler version of the model in which $\rho = 1$ and the price effect is muted (section 3.2). Further, we only consider the low skilled market. The question we ask is how policies aiming at reducing unskilled illegal immigrants affects market tightness for unskilled workers, when part of the native-immigrant wage gap is due to immigrants being less productive than natives.

In this simpler model, we add the parameter $\Lambda \leq 1$, which captures the productivity of immigrants relative to unskilled natives. We also standardize the productivity of unskilled natives to 1. For the given baseline parameter configuration, the whole immigrant-native wage gap is explained by productivity differences if $\Lambda = 0.76$, while when $\Lambda = 1$ the whole difference is explained by higher search costs for immigrants, implying $\pi_L = 0.69$. In Table 7 we compare the labor market outcomes of unskilled natives and the effects on income per native, of using the four policies, pushed to the point of reducing illegal immigrants by 50%, under different values of Λ and hence of search costs. In the Columns (1)-(4) we consider the extreme case in which the whole wage gap is explained by native-immigrant productivity differences. In Columns (9)-(12) we show the benchmark case in which the whole difference is due to outside options. Columns (5)-(8) show the intermediate case in which about half of the difference is due to productivity. The remaining half is due to different outside options. Confirming our intuition, we see that the legalization policy is the only policy producing the positive labor market tightening effect, reducing unemployment of unskilled natives, as long as the productivity difference between immigrants and natives is not too large. The intermediate case (Columns (5)-(8)) shows legalization has an unemployment reducing effect of 0.32% on native unskilled and it increases income per native by 0.20%, while the other policies increase unemployment rate by $0.33 - 0.65\%$. However, when we move to the case in which the productivity

of immigrants is much smaller than that of natives (as small as possible given the wage gap), as in Columns (1)-(4), the firm's profit from hiring an immigrant becomes smaller than from hiring a native. In this case, we see that legalization – by increasing the total number of immigrants and their share in the unemployment pool – reduces the expected profits of firms. As a result, labor market tightness is also reduced, leading to an increase in the unemployment rate of unskilled natives (by 0.63%). The restrictive measures, on the other hand – by decreasing total immigrants and their share in the unemployment pool – increase the expected profits of firms and the creation of unskilled jobs, causing a decrease in the unemployment of unskilled workers between 0.07 and 0.60%. We think it is unlikely more than half of the wage gap between equally skilled native and immigrants is due to productivity differentials, and hence, we think this check strengthens the relevance of the positive labor-tightening effect of legalization.

7 Conclusions

In this paper we have set up a model to analyze the labor markets of two countries in which firms post job-openings, workers look for vacancies and matches take place over time. Wages are then determined by splitting the surplus obtained from the worker-firm match. Moreover, as one country has higher productivity and higher wages, there is also search for migration opportunities from the poor to the rich country. We have focused on the unskilled workers market in terms of legal and illegal immigrants and matched the theoretical model to the case of Mexico-US labor markets.

This model allows us to study, quantitatively, the effects of different policies aimed at reducing the number of illegal migrants on labor market outcomes of skilled and unskilled native workers in the US. The novelty of the paper is that this is the first model to consider different policies, and to model migration incentives while considering legal and illegal immigrants and capturing their different features on the labor market.

We find, for a reasonable range of parameters values around the values calibrated for the US-Mexico economies circa 2000-2010, unskilled immigrants receive lower pay and generate higher surplus for the firm than unskilled native workers because of worse outside options. This in turn pushes firms to create more jobs per unemployed when there are more immigrants, improving the tightness of the labor market and reducing the unemployment rate of natives. This key mechanism implies policies aimed at reducing illegal immigration that are also restrictive and discourage total immigration (such as forced

repatriation, border controls, increased cost for job search by illegal immigrants) will reduce job-creation of firms and increase unemployment of unskilled native workers. They will also reduce income per native. To the contrary, policies that decrease the number of illegal immigrants but increase the total number of immigrants (such as legalization) will improve job creation, decrease native unemployment and increase income per native.

The innovative and appealing characteristic of this model is that it is much richer than existing 2-country labor market models and allows us to deal separately with sophisticated immigration policies (border control, deportation, legalization). The model can also be easily adjusted to analyze effects of other specific immigration policies, such as increased workplace raids (that may detect and deport illegal working immigrants) or policies increasing deportation of unemployed immigrants. While the quantitative implications of the model are somewhat sensitive to parameter choice, the ranking of the four policies considered – in terms of native unemployment and income per person – is extremely robust and invariant to specific parameter choice, within the range considered. The most beneficial way of reducing illegal immigrants, in terms of unemployment for skilled and unskilled native workers, is by increasing legalization rates.

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A Appendix: Details of the Model

A.1 Bellman Equations

The bellman equations represent the dynamic optimality condition for each possible state of workers and jobs. Those describing the value of unfilled unskilled and skilled vacancies in country 1 and the value of vacancies in country 2 are as follows:

$$
\begin{aligned}
rJ_1^{V,u} &= -c_1^u + q(\theta_1^u)\left[\phi J_{1N}^{F,u} + (1-\phi)(\lambda J_{1L}^F + (1-\lambda)J_{1I}^F) - J_1^{V,u}\right] && (20)\\
rJ_1^{V,s} &= -c_1^s + q(\theta_1^s)\left[J_{1N}^{F,s} - J_1^{V,s}\right] && (21)\\
rJ_2^V &= -c_2 + q(\theta_2)\left[J_2^F - J_2^V\right] && (22)
\end{aligned}
$$

The value of a filled unskilled job to a firm in country 1 is expressed by the following three equations, depending on the origin and legal status of the worker filling the job (native, legal immigrant and illegal immigrant):

$$
\begin{aligned}
rJ_{1N}^{F,u} &= p_1^u - w_{1N}^u - (\sigma_1^u + \tau)\left[J_{1N}^{F,u} - J_1^{V,u}\right] && (23)\\
rJ_{1L}^F &= p_1^u - w_{1L} - (\sigma_1^u + d_L + \tau)\left[J_{1L}^F - J_1^{V,u}\right] && (24)\\
rJ_{1I}^F &= p_1^u - w_{1I} - (\sigma_1^u + d_I + \tau)\left[J_{1I}^F - J_1^V\right] + n\left[J_{1L}^F - J_{1I}^F\right] && (25)
\end{aligned}
$$

The values of a filled skilled job in country 1 and of a job in country 2 are given, respectively, by

$$
\begin{aligned}
rJ_{1N}^{F,s} &= p_1^s - w_{1N}^s - (\sigma_1^s + \tau)\left[J_{1N}^{F,s} - J_1^{V,s}\right] && (26)\\
rJ_2^F &= p_2 - w_2 - (\sigma_2 + \tau)\left[J_2^F - J_2^V\right] && (27)
\end{aligned}
$$

The value of being unemployed is described in the following five equations, relative to each country and worker type:

$$(r+\tau)J_{1N}^{U,s} = b_1^s + m(\theta_1^s)\left[J_{1N}^{E,s} - J_{1N}^{U,s}\right] \tag{28}$$

$$(r+\tau)J_{1N}^{U,u} = b_1^u + m(\theta_1^u)\left[J_{1N}^{E,u} - J_{1N}^{U,u}\right] \tag{29}$$

$$(r+\tau)J_{1L}^{U} = b_1^u - \pi_L + m(\theta_1^u)\left[J_{1L}^{E} - J_{1L}^{U}\right] - d_L\left[J_{1L}^{U} - J_2^U\right] \tag{30}$$

$$(r+\tau)J_{1I}^{U} = b_1^u - \pi_I + m(\theta_1^u)\left[J_{1I}^{E} - J_{1I}^{U}\right] - d_I\left[J_{1I}^{U} - J_2^U\right] + n\left[J_{1L}^{U} - J_{1I}^{U}\right] \tag{31}$$

$$\begin{aligned}(r+\tau)J_2^U = {} & b_2 + m(\theta_2)\left[J_2^E - J_2^U\right] + \mu_I\int_0^{\bar{z}}\max\left[J_{1I}^U - J_2^U - z, 0\right]d\Phi(z) \\ & + \mu_L\int_0^{\bar{z}}\max\left[J_{1L}^U - J_2^U - z, 0\right]d\Phi(z)\end{aligned} \tag{32}$$

Finally the value of being employed in steady state is given by the following five conditions relative to each country and worker type:

$$(r+\tau)J_{1N}^{E,s} = w_{1N}^s - \sigma_1^s\left[J_{1N}^{E,s} - J_{1N}^{U,s}\right] \tag{33}$$

$$(r+\tau)J_{1N}^{E,u} = w_{1N}^u - \sigma_1^u\left[J_{1N}^{E,u} - J_{1N}^{U,u}\right] \tag{34}$$

$$(r+\tau)J_{1L}^{E} = w_{1L} - \sigma_1^u\left[J_{1L}^{E} - J_{1L}^{U}\right] - d_L\left[J_{1L}^{E} - J_2^U\right] \tag{35}$$

$$(r+\tau)J_{1I}^{E} = w_{1I} - \sigma_1^u\left[J_{1I}^{E} - J_{1I}^{U}\right] - d_I\left[J_{1I}^{E} - J_2^U\right] + n\left[J_{1L}^{E} - J_{1I}^{E}\right] \tag{36}$$

$$(r+\tau)J_2^E = w_2 - \sigma_2\left[J_2^E - J_2^U\right] \tag{37}$$

In expressions (20)-(37), w_{1N}^t denotes the wage rate for the type-t native workers of country 1, w_{1L} and w_{1I} the wage for legal and illegal immigrants, respectively, and w_2 the wage rate in country 2.

Expressions such as these have, by now, a relatively familiar interpretation. For instance, consider equation (20). The term $rJ_1^{V,u}$ is the flow-value of an unskilled vacancy in country 1. It equals the flow cost of maintaining the vacancy c_1^u, plus the flow probability that the vacancy is matched with a worker (native or immigrant) multiplied by the expected value gain from such an event which is the expected value of filling a vacancy with a native, legal immigrant and illegal immigrant worker, respectively, times the probability of each of those events. The other equations follow similar interpretations.

A.2 Steady-state Conditions

The condition for steady unemployment of each type are as follows:

$$\sigma_1^s(S - U_{1N}^s) + \tau S = (m(\theta_1^s) + \tau)U_{1N}^s \tag{38}$$

$$\sigma_1^u(1 - S - U_{1N}^u) + \tau(1 - S) = (m(\theta_1^u) + \tau)U_{1N}^u \tag{39}$$

$$\sigma_2(F - I - L - U_2) + \tau F + d_I I + d_L L = (m(\theta_2) + \mu_L\Phi(z_L^*) + \mu_I\Phi(z_I^*) + \tau)U_2 \tag{40}$$

$$\sigma_1^u(L - U_{1L}) + \mu_L\Phi(z_L^*)U_2 + nU_{1I} = [d_L + m(\theta_1^u) + \tau]\, U_{1L} \tag{41}$$

$$\sigma_1^u(I - U_{1I}) + \mu_I\Phi(z_I^*)U_2 = [d_I + n + m(\theta_1^u) + \tau]\, U_{1I} \tag{42}$$

Equations (38) and (39) show that flows into the pools of unemployed skilled and unskilled natives (of country 1) include those whose separate from their jobs (at the exogenous rate σ_1^s and σ_1^u, respectively) and the new labor-force entrants (τS and $\tau(1-S)$, respectively), while flows out of these pools consist of those who find jobs (at the job-finding rate $m(\theta_1^s)$ and $m(\theta_1^u)$, respectively) and those who exit the labor force. The rate at which workers find skilled and unskilled jobs depend on the labor market tightness that prevails in the skilled and unskilled labor market (θ_1^s and θ_1^u), respectively. For the natives of country 2, the flows into unemployment (represented by the left-hand-side of 40) include separations, new entrants, as well as the exogenous return events ($d_I I + d_L L$) that move immigrants back to country 2 as unemployed. On the other hand, the flow of native workers out of the unemployment in country 2 (right-hand-side of 40) includes, both those who find jobs or exit the labor force and those who migrate to country 1 legally or illegally (at rate $\mu_L\Phi(z_L^*)$ and $\mu_I\Phi(z_I^*)$, respectively). Since new immigrants arrive in country 1 without a job, the flow into the pool of unemployed immigrants in country 1 (left-hand-sides of 41 and 42) comes partly from the inflow of new immigrants and partly from the job separations of incumbent immigrants. Flows into the pool of legal unemployed immigrants (left-hand-side of 41) come also from incumbent unemployed immigrants who switch from illegal to legal status (nU_{1I}). The flows of legal immigrants out of unemployment (right-hand-side of 41) can be either due to job finding, exits or due to exogenous return to country 2. Similarly, flows of illegal immigrants out of unemployment (right-hand-side of 42) come from job finding, $m(\theta_1^u)U_{1I}$, from returns, $d_I U_{1I}$, from exits τU_{1I}, and from legalizations, nU_{1I}.

By equating the inflow of new legal immigrants, which includes the inflow of new immigrants and the legalization of incumbents, to the outflow of legal immigrants, which

includes exits of the labor force and returns to the home country, we obtain the steady-state condition for L:

$$(d_L + \tau)L = nI + U_2\mu_L\Phi(z_L^*) \tag{43}$$

Likewise, the steady state condition for the number of illegal immigrants, I, implies the inflow of new illegal immigrants equals the flow of illegal immigrants that either return home, obtain the legal status or exit the labor force:

$$(d_I + n + \tau)I = U_2\mu_I\Phi(z_I^*) \tag{44}$$

Then equations (38) to (42) and equations (43) and (44) can be used to derive expressions for the steady-state values of the unemployment rates, unemployment levels $U_{1N}^s, U_{1N}^u, U_{1I}, U_{1L}, U_2$ and numbers of legal and illegal immigrants, I, L (see equations 8 to 14 in the main text).

A.3 Solving the Model

A.3.1 Wages

Using the Bellman equations (20) to (37), the free-entry conditions (4) the Nash bargaining conditions (5) and the immigration conditions in (6) and (7), we can solve for the equilibrium wage rates. Those are specific to each type of worker in country 1 (native, skilled or unskilled, and immigrant legal or illegal) and to workers of country 2. Their expressions are as follows:

$$\begin{aligned}
w_{1N}^s &= \beta p_1^s + (1-\beta)\left[b_1^s + m(\theta_1^s)(J_{1N}^{E,s} - J_{1N}^{U,s})\right] && (45)\\
w_{1N}^u &= \beta p_1^u + (1-\beta)\left[b_1^u + m(\theta_1^u)(J_{1N}^{E,u} - J_{1N}^{U,u})\right] && (46)\\
w_{1L} &= \beta p_1^u + (1-\beta)\left[b_1^u - \pi_L + m(\theta_1^u)(J_{1L}^{E} - J_{1L}^{U})\right] && (47)\\
w_{1I} &= \beta p_1^u + (1-\beta)\left[b_1^u - \pi_I + m(\theta_1^u)(J_{1I}^{E} - J_{1I}^{U})\right] && (48)\\
w_2 &= \beta p_2 + (1-\beta)\left[b_2 + m(\theta_2)(J_2^E - J_2^U) + M\right] && (49)
\end{aligned}$$

The term $M \equiv \mu_I \int_{\underline{z}}^{z_I^*}(z_I^* - z)d\Phi(z) + \mu_L \int_{\underline{z}}^{z_L^*}(z_L^* - z)d\Phi(z)$, in expression (49) measures the expected gain of an immigration opportunity for a native of country 2. A worker's wage is a weighted average of the productivity of the match with a firm, p_i^t, which depends on the country and skill type of the worker, and the outside option available to her (the term in the bracket). The parameter expressing the workers' bargaining power (β) is the weight put on productivity by the Nash-bargaining formula. The outside options of

the workers of country 1 depend on not only their skill type but also on their nativity and immigration status and they are equal to their unemployment flow income plus the expected gain from search. The outside option of native workers of country 2, instead, includes also the expected gain from a migration opportunity (either legal or illegal) to country 1 (M). Anything that improves the worker's outside option will also increase her wage, as it will improve her "threat point" in the wage setting process. This explains why wages rise with the unemployment income b_i^t and the matching rate $m(\theta_i^t)$, and in addition, fall with the search costs π_x.

The wage equations above can be re-written as:

$$w_{1N}^s = A_{1N}^s p_1^s + (1 - A_{1N}^s) b_1^s \tag{50}$$

$$w_{1N}^u = A_{1N}^u p_1^u + (1 - A_{1N}^u) b_1^u \tag{51}$$

$$w_{1L} = A_{1L} p_1^u + (1 - A_{1L}) (b_1^u - \pi_L) \tag{52}$$

$$w_{1I} = A_{1I} p_1^u + (1 - A_{1I}) (b_1^u - \pi_I) + \Gamma_I n J_{1L}^F \tag{53}$$

$$w_2 = A_2 p_2 + (1 - A_2) \left(b_2 + \mu_I \int_{\underline{z}}^{z_I^*} (z_I^* - z) d\Phi(z) + \mu_L \int_{\underline{z}}^{z_L^*} (z_L^* - z) d\Phi(z) \right) \tag{54}$$

where $A_{1N}^s \equiv \frac{\beta(r+\sigma_1^s+\tau+m(\theta_1^s))}{r+\sigma_1^s+\tau+\beta m(\theta_1^s)}$ $A_{1N}^u \equiv \frac{\beta(r+\sigma_1^u+\tau+m(\theta_1^u))}{r+\sigma_1^u+\tau+\beta m(\theta_1^u)}$, $A_{1L} \equiv \frac{\beta(r+\sigma_1^u+\tau+d_L+m(\theta_1^u))}{r+\sigma_1^u+\tau+d_L+\beta m(\theta_1^u)}$, $A_{1I} \equiv \frac{\beta(r+\sigma_1^u+\tau+d_I+n+m(\theta_1^u))}{r+\sigma_1^u+\tau+d_I+n+\beta m(\theta_1^u)}$, $A_2 \equiv \frac{\beta(r+\sigma_2+\tau+m(\theta_2))}{r+\sigma_2+\tau+\beta m(\theta_2)}$ and $\Gamma_I \equiv \frac{\beta m(\theta_1^u)}{r+\sigma_1^u+\tau+d_I+n+\beta m(\theta_1^u)}$.

A.3.2 The immigration costs threshold

Using equations (30)-(32) and equations (47)-(49) we can write the equilibrium conditions for z_I^* and z_L^* in equations (6) and (7) as a function of endogenous wages and productivity:

$$(1 - \beta) z_I^* = \frac{[\eta w_{1L} + (1 - \eta) w_{1I} - \beta p_1^u] - [w_2 - \beta p_2]}{r + \tau + \eta d_L + (1 - \eta) d_I} \tag{55}$$

$$(1 - \beta) z_L^* = \frac{[w_{1L} - \beta p_1^u] - [w_2 - \beta p_2]}{r + \tau + d_L} \tag{56}$$

where $\eta \equiv \frac{n}{r+\tau+n+d_L}$. These two equations can be used to solve for z_I^* and z_L^* in terms of market tightness, θ_1^u, θ_1^s, θ_2 and parameters.

A.3.3 Zero-expected-profit conditions and vacancy posting

Using (4), equations (20), (21) and (22) can be written as:

$$\frac{c_1^u}{q(\theta_1^u)} = \phi J_{1N}^{F,u} + (1-\phi)\left[\lambda J_{1L}^F + (1-\lambda) J_{1I}^F\right] \tag{57}$$

$$\frac{c_1^s}{q(\theta_1^s)} = J_{1N}^{F,s} \tag{58}$$

$$\frac{c_2}{q(\theta_2)} = J_2^F \tag{59}$$

where ϕ and λ defined above are, respectively, the native share of total unskilled unemployment and the share of legal immigrants among unemployed immigrants.

The values accrued to jobs filled by workers of different types can be written as follows:

$$J_{1N}^{F,u} = \frac{p_1^u - w_{1N}^u}{r+\tau+\sigma_1^u} \tag{60}$$

$$J_{1N}^{F,s} = \frac{p_1^s - w_{1N}^s}{r+\tau+\sigma_1^s} \tag{61}$$

$$J_{1L}^F = \frac{p_1^u - w_{1L}}{r+\tau+\sigma_1^u+d_L} \tag{62}$$

$$J_{1I}^F = \frac{p_1^u - w_{1I} + n\left[J_{1L}^F - J_{1I}^F\right]}{r+\tau+\sigma_1^u+d_I} \tag{63}$$

$$J_2^F = \frac{p_2 - w_2}{r+\tau+\sigma_2} \tag{64}$$

Substituting the equilibrium wages (given in equations (50) to (54)) into equations (60) to (64) the values of filled vacancies can be written as:

$$J_{1N}^{F,s} = (1-\beta)S_{1N}^s = \frac{(1-\beta)(p_1^s - b_1^s)}{r+\tau+\sigma_1^s+\beta m(\theta_1^s)} \tag{65}$$

$$J_{1N}^{F,u} = (1-\beta)S_{1N}^u = \frac{(1-\beta)(p_1^u - b_1^u)}{r+\tau+\sigma_1^u+\beta m(\theta_1^u)} \tag{66}$$

$$J_{1L}^F = (1-\beta)S_{1L} = \frac{(1-\beta)(p_1^u - b_1^u + \pi_L)}{r+\tau+\sigma_1^u+d_L+\beta m(\theta_1^u)} \tag{67}$$

$$J_{1I}^F = (1-\beta)S_{1I} = \frac{(1-\beta)\left(p_1^u - b_1^u + \pi_I\right) + n\left(J_{1L}^F - J_{1I}^F\right)}{r+\tau+\sigma_1^u+d_I+\beta m(\theta_1^u)} \tag{68}$$

$$J_2^F = (1-\beta)S_2 = \frac{(1-\beta)(p_2 - b_2 - M)}{r+\tau+\sigma_2+\beta m(\theta_2)} \tag{69}$$

With the above expressions substituted in, the zero-profit conditions in (57 to 59) can

be written as:

$$p_1^u = b_1^u + \frac{\frac{c_1^u Bu}{q(\theta_1^u)(1-\beta)} - (1-\phi)\frac{B_u}{B_L}\left[\lambda\pi_L + (1-\lambda)\left(\frac{B_L}{B_I}\pi_I + \frac{n}{B_I}\pi_L\right)\right]}{\phi + (1-\phi)\frac{B_u}{B_L}\left[\lambda + (1-\lambda)\left(\frac{B_L+n}{B_I}\right)\right]} \tag{70}$$

$$p_1^s = b_1^s + \frac{c_1^s B_s}{q(\theta_1^u)(1-\beta)} \tag{71}$$

$$p_2 = b_2 + \frac{c_2 B_2}{q(\theta_2)(1-\beta)} + \mu_I \int_{\underline{z}}^{z_I^*} (z_I^* - z) d\Phi(z) + \mu_L \int_{\underline{z}}^{z_L^*} (z_L^* - z) d\Phi(z) \tag{72}$$

where $B_u = r+\tau+\sigma_1^u+\beta m(\theta_1^u)$, $B_L = B_u+d_L$, $B_I = B_u+d_I+n$, $B_s = r+\tau+\sigma_1^s+\beta m(\theta_1^s)$ and $B_2 = r+\tau+\sigma_2+\beta m(\theta_2)$. The left-hand side of each of the above equations, which is the productivity of a match, represents the revenue and the right-hand side the expected cost to an unfilled vacancy from being matched randomly with a worker.

Figures and Tables

Table 1: Parameterisation and Matched Moments

Parameter	*From the literature:*	*Matched moments:*
ε=0.5	Petrongolo and Pissarides (2001).	
β=0.5	Satisfies the Hosios (1990) condition.	
r=0.004	Monthly interest rate. Average 1980-2010 for the US 30-year treasury bills – GDP deflator	
ρ=0.5	Implies elasticity skilled-unskilled equal 2 (Ottaviano and Peri , 2012).	
$\underline{z}$ =0	Normalization.	
	Measured from the data:	
F=1/3	The average ratio of Mexican-born to US-born population for the 2000s.*	
d_L=0.0023	Our calculations from several sources (see text)	
d_I=0.0039	Our calculations from several sources (see text)	
n=0.0006	Our calculations from several sources (See text)	
σ_1^u=σ_2=0.032	The monthly unskilled separation rate in Mexico and the US. †	
σ_1^s=0.024	The monthly skilled separation rate in the US. †	
S=0.54	The share of skilled labor force in the US. ††	
τ=0.00061	The US native population growth rate. ††	
	Jointly calibrated to match moments of the data:	
α=0. 643	The skill wage premium in the US.	$\left(\frac{w_{1N}^S}{w_1^u}-1\right)$=0.68 ††
ξ_1=0.113	The employment rate of unskilled workers in the US.	$(1-u_1^u)$=0.73 ††
ξ_2=0.060	The employment rate of unskilled workers in Mexico.	$(1-u_2)$= 0.59 ₸
p_2=0.135	The wage ratio between US and Mexico, equated to to the ratio of income per person in the two countries.	$\frac{\bar{w}_1}{w_2}$= 4 ‡
b_1^s= 0.419 b_1^u=0.249 b_2=0.086	The ratio of unemployment to employment income of 71% for both countries and both skill types (Hall and Milgrom, 2008).	$\frac{b_1^s}{w_1^s}=\frac{b_1^u}{w_1^u}=\frac{b_2}{w_2}=0.71$
π_L=0.301	The native-legal immigrant wage gap: -20% (Borjas and Friedberg, 2009).	$\left(\frac{w_{1L}^u-w_{1N}^u}{w_{1L}^u}\right)$=-0.20
π_I=0.381	The legal-illegal immigrant wage gap: -7.5% (Rivera Batiz, 1999 and Kossoudji and Cobb-Clark, 2012).	$\left(\frac{w_{1I}^u-w_{1L}^u}{w_{1I}^u}\right)$=-0.075
c_1^u=0.146	The ratio of Mexican immigrants to the US-native labor force.	$I+L=0.038$ ǂ
c_1^s=0.068	The employment rate of skilled workers in the US: 0.87.	$(1-u_{1N}^s)$=0.87 ††
c_2= 0.028	The proportion of legal immigrants in the total number of Mexican immigrants: 56% (Hoefer et al, 2012).	$\frac{L}{I+L}$=0.56
$\frac{\mu_I}{\bar{z}}$=0.0166% $\frac{\mu_L}{\bar{z}}$=0.0039%	The vacancy to unemployment ratio in Mexico and the US.	$\theta_1^s=\theta_1^u=\theta_2$=0.62 ¥

* http://www.oecd-ilibrary.org/statistics.

** http://www.migrationinformation.org/DataHub/charts/fb-mexicans.cfm.

† Matched data from the Current Population Survey.

†† IPUMS USA data, 2000-2010.

₸ IPUMS International data.

‡ Penn World Table, version 7.1, available at: https://pwt.sas.upenn.edu/php site/pwt index.php.

ǂ IPUMS in 2000.

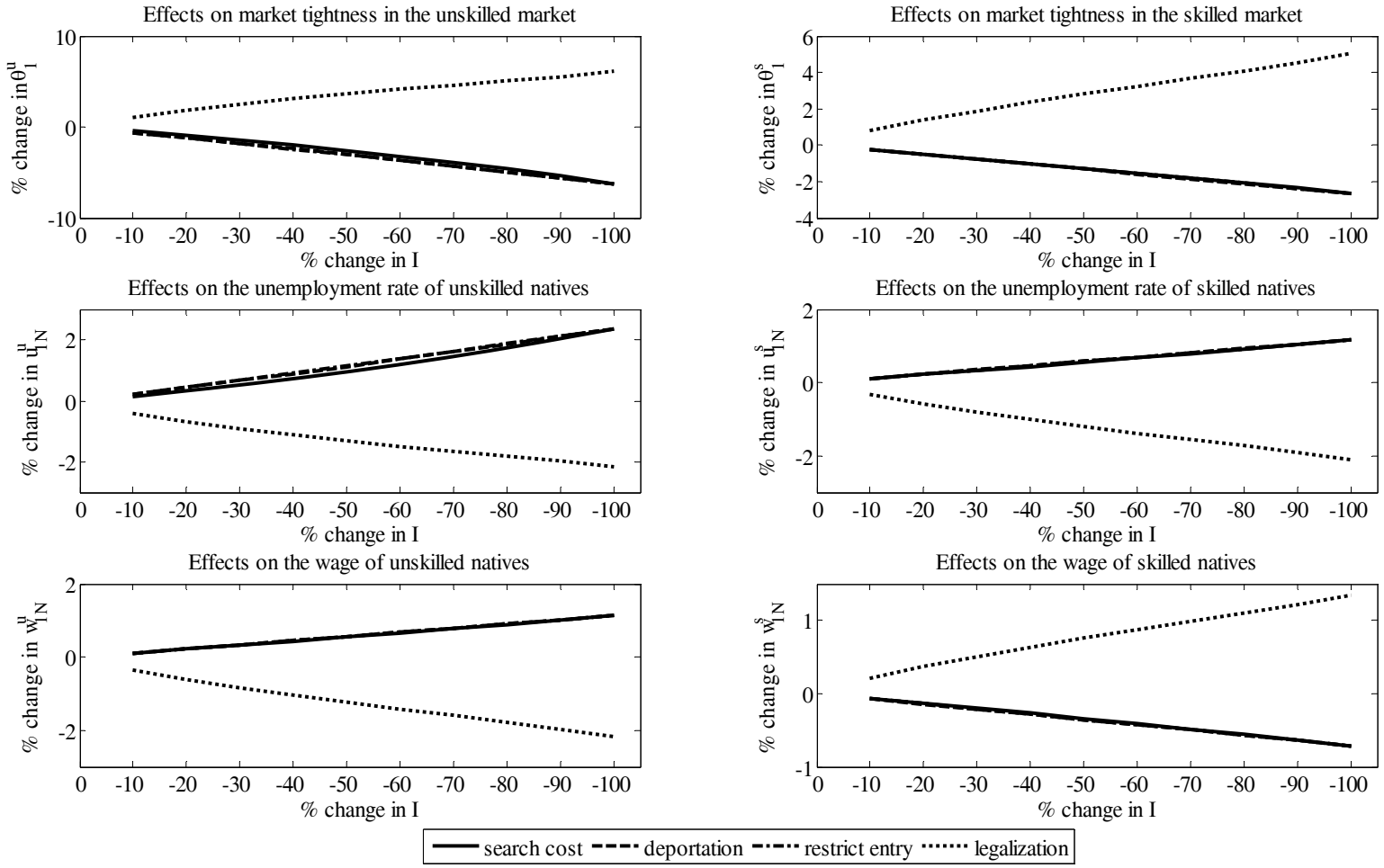
¥ Conference Board's Help-Wanted Index.

Table 2: Baseline Case, Simulations of Policy Effects on Outcomes for Native Workers (percentage changes)

	Increased border control (decrease in μ_I)		Higher search cost (increase in π_I)		Increased rates of deportation (increase in d_I)		Legalization (increase in n)		Policy Combination (increase in n, (decrease in μ_I)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I: stock of illegal Immigrants	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50
Percentage Change in the Policy Parameter	-10.40	-51.03	2.27	10.89	7.40	52.04	275.66	1985.3	65.64, -8.30	590.49, -39.19
Unskilled market, outcomes for natives, percentage change										
θ_1^u: market tightness	-0.60	-3.07	-0.41	-2.55	-0.59	-3.03	1.10	3.66	-0.19	-0.96
u_{1N}^u: unemployment rate of natives	0.22	1.14	0.15	0.95	0.22	1.13	-0.40	-1.31	0.07	0.35
w_{1N}^u: wage of natives	0.11	0.56	0.11	0.55	0.11	0.56	-0.34	-1.23	0.00	0.01
Skilled market, outcomes for natives, percentage change										
θ_1^s: market tightness	-0.26	-1.31	-0.24	-1.26	-0.26	-1.32	0.77	2.81	-0.01	-0.06
u_{1N}^s: unemployment rate	0.11	0.57	0.11	0.55	0.11	0.58	-0.33	-1.20	0.01	0.03
w_{1N}^s: wage	-0.07	-0.35	-0.07	-0.34	-0.07	-0.35	0.21	0.75	0.00	-0.02
Native income per person, percentage change										
$\widetilde{Y}_1$: income per native	-0.03	-0.13	-0.02	-0.12	-0.03	-0.13	0.06	0.23	0.00	-0.02
$\widetilde{Y}_{1a}$: income per native net of unemployment benefits	-0.05	-0.28	-0.04	-0.25	-0.05	-0.28	0.13	0.45	-0.01	-0.05

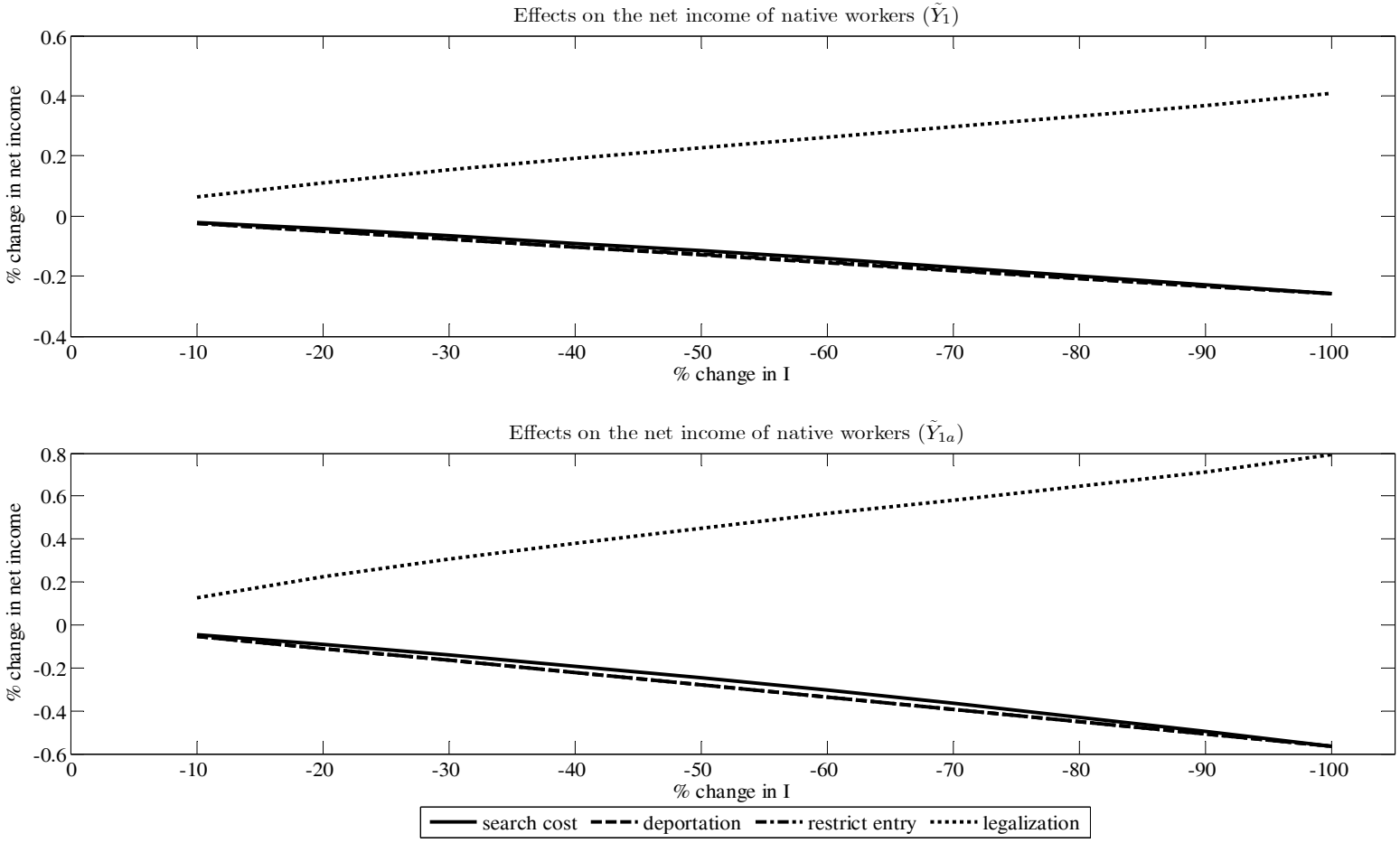
Note: Each entry represents the percentage change in the corresponding variable described in the row header. The top two rows show the percentage change in the number of illegal immigrants and in the policy parameters. The next three rows show the labor market outcomes for unskilled natives, the following three rows show the labor market outcomes for skilled natives and the last two rows show income per native. The columns correspond to different policy changes. Columns (1) and (2) represent the effects of increases in border controls. Columns (3) and (4) show the impact of increased search costs for illegal immigrants. Columns (5) and (6) show the effects of an increase in the probability of deportation. Columns (7) and (8) show the effects of an increase in the legalization rate. Columns (9) and (10) show the effects of an increase in the legalization probability and an increase in border control that keeps total immigrants unchanged. The values of the parameters used in the simulation are those reported in Table 1.

Figure 1: Effects of Policies on Native Labor Market Outcomes



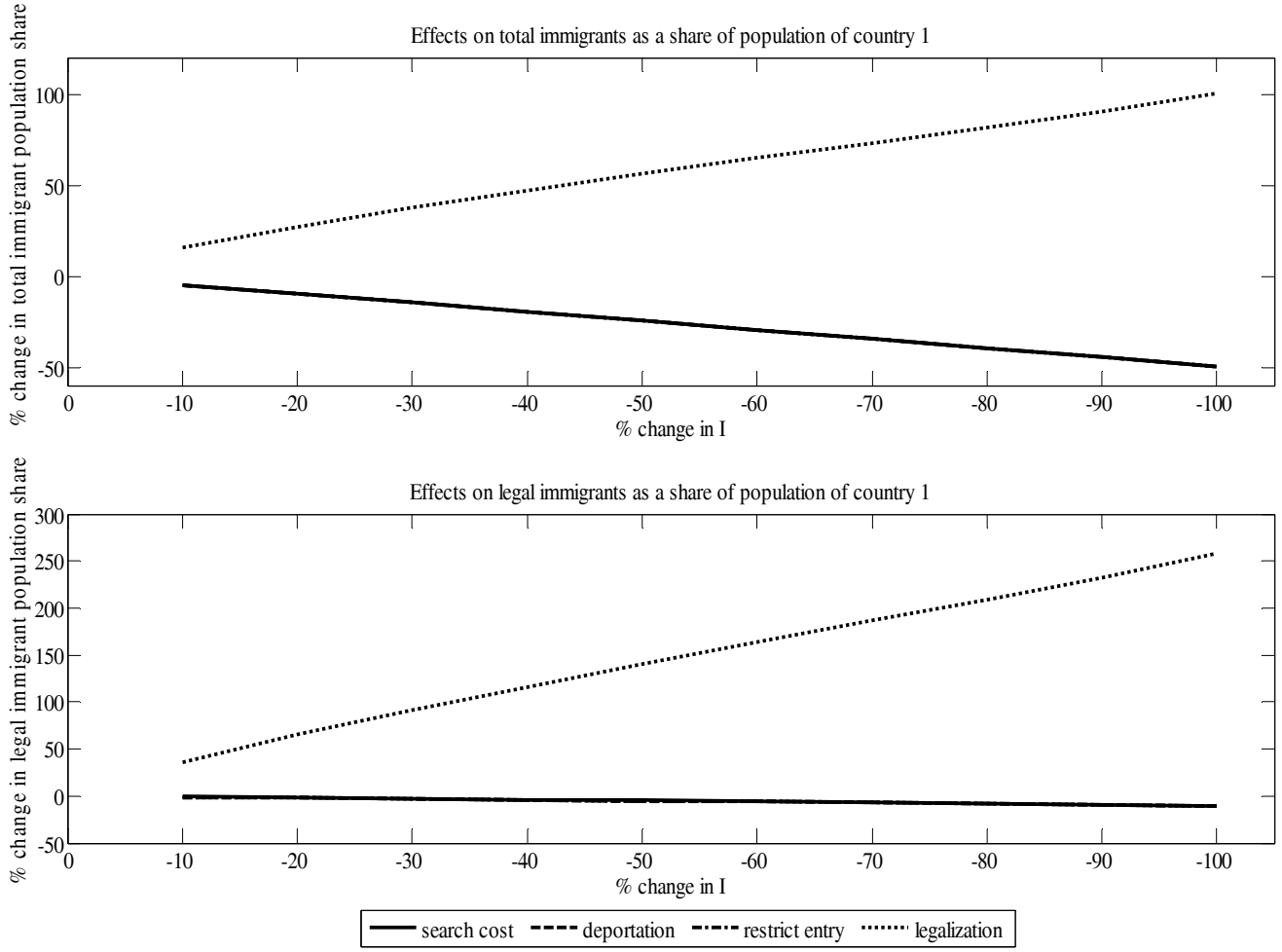
Note: Each Panel shows the percentage change of an outcome for native workers in the vertical axis against the percentage change in the number of illegal immigrants on the horizontal axis produced by four differennt policies. The variables represented are labor market tightness (top two panels), unemployment rate (middle panels) and wages (bottom panels). The left panels show variables relative to unskillled native workers while the right panels represent the variables relative to skilled ones.

Figure 2 :Effects of Policies on Income per Native



Note: The top panel represents the percentage change of income per native (vertical axis) corresponding to a percentage change in the number of illegal immigrants (horizontal axis) produced by four different policies. The reduction in the number of illegal immigrants ranges from 10 to 100% (no illegal immigrants left). The definition of income per native in the top panel includes income when unemployed. The bottom panel shows a similar graph, when we use the alternative definition of income per native that excludes income when unemployed.

Figure 3: Effects of policies on Total and Legal Immigrants



Note: The top panel represents the percentage change of total immiggrants (vertical axis) corresponding to a percentage change in the number of illegal immigrants (horizontal axis) produced by four different policies. The reduction in the number of illegal immigrants ranges from 10 to 100% (no illegal immigrants left). The bottom panel represents the percentage change of legal immiggrants (vertical axis) corresponding to a percentage change in the number of illegal immigrants (horizontal axis) produced by four different policies. The reduction in the number of illegal immigrants ranges from 10 to 100% (no illegal immigrants left).

Table 3: The Effects of Tighter Border Controls, Robustness Checks

	Baseline Specification		*-15% native-immigrant wage gap*		*-5% legal-illegal wage gap*		*Double d_L*		*Reduce the ratio of unemployment to employment income to 0.5*		*Lower real interest rate r=2% per year*	
Specifications:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I: stock of illegal Immigrants	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50
μ_I: entry rate for illegal immigrants	-10.40	-51.03	-10.54	-51.46	-10.51	-51.35	-10.33	-50.86	-10.74	-51.95	-10.38	-50.97
Unskilled market, outcomes for natives, percentage change												
θ_1^u: market tightness	-0.60	-3.07	-0.44	-2.26	-0.54	-2.73	-0.57	-2.91	-0.37	-1.86	-0.63	-3.18
u_{1N}^u: unemployment rate of natives	0.22	1.14	0.16	0.84	0.20	1.02	0.21	1.09	0.13	0.69	0.23	1.19
w_{1N}^u: wage of natives	0.11	0.56	0.11	0.55	0.11	0.55	0.10	0.51	0.11	0.54	0.11	0.56
Skilled market, outcomes for natives, percentage change												
θ_1^s: market tightness	-0.26	-1.31	-0.25	-1.24	-0.25	-1.28	-0.24	-1.21	-0.15	-0.74	-0.26	-1.32
u_{1N}^s: unemployment rate	0.11	0.57	0.11	0.54	0.11	0.56	0.10	0.53	0.06	0.32	0.11	0.58
w_{1N}^s: wage	-0.07	-0.35	-0.07	-0.33	-0.07	-0.34	-0.06	-0.32	-0.07	-0.34	-0.07	-0.36
Native income per person, percentage change												
$\widetilde{Y}_1$: income per native	-0.03	-0.13	-0.02	-0.11	-0.02	-0.12	-0.02	-0.12	-0.03	-0.13	-0.02	-0.12
$\widetilde{Y}_{1a}$: income per native net of unemployment benefits	-0.05	-0.28	-0.05	-0.23	-0.05	-0.26	-0.05	-0.26	-0.04	-0.20	-0.05	-0.28

Note: Each entry represents the percentage change in the corresponding variable described in the row header. The top two rows show the percentage change in illegal immigrants and in the policy parameter μ_I. The next three rows show the labor market outcomes for unskilled natives, the following three rows show the labor market outcomes for skilled natives and the last two rows show income per native. The columns correspond to different robustness checks. Columns (1) and (2) represent the baseline specification. Columns (3) and (4) show the case when we have calibrated parameters to obtain a native-immigrant wage gap of -15% (rather than -20%). Columns (5) and (6) show the case when we have calibrated parameters to obtain a legal-illegal wage gap of -5% (rather than -7.5%). Columns (7) and (8) show the case when we set the return rate d_L to be double the value in the baseline case. Columns (9) and (10) show the case when we calibrate the parameters to obtain a ratio of unemployment to employment income of 0.5. Columns (11) and (12) show the case when we set the interest rate to 2%.

Table 4: The Effects of Higher Search Cost: Robustness Checks

	Baseline Specification		*-15% native-immigrant wage gap*		*-5% legal-illegal wage gap*		*Double d_L*		*Reduce the ratio of unemployment to employment income to 0.5*		*Lower real interest rate r=2% per year*	
Specifications:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I: stock of illegal Immigrants	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50
π_I: search cost for illegal immigrants	2.27	10.89	5.28	25.86	3.37	16.32	2.13	10.28	1.71	8.21	2.43	11.72
Unskilled market, outcomes for natives, percentage change												
θ_1^u: market tightness	-0.41	-2.55	-0.07	-1.24	-0.28	-2.02	-0.40	-2.43	-0.27	-1.61	-0.42	-2.62
u_{1N}^u: unemployment rate of natives	0.15	0.95	0.03	0.46	0.10	0.75	0.15	0.90	0.10	0.59	0.15	0.98
w_{1N}^u: wage of natives	0.11	0.55	0.10	0.53	0.10	0.54	0.10	0.51	0.11	0.53	0.11	0.56
Skilled market, outcomes for natives, percentage change												
θ_1^s: market tightness	-0.24	-1.26	-0.22	-1.16	-0.23	-1.22	-0.23	-1.17	-0.14	-0.72	-0.24	-1.27
u_{1N}^s: unemployment rate	0.11	0.55	0.10	0.51	0.10	0.53	0.10	0.51	0.06	0.31	0.11	0.56
w_{1N}^s: wage	-0.07	-0.34	-0.06	-0.31	-0.06	-0.33	-0.06	-0.31	-0.07	-0.33	-0.07	-0.34
Skilled market, outcomes for natives, percentage change												
$\widetilde{Y}_1$: income per native	-0.02	-0.12	-0.01	-0.09	-0.02	-0.10	-0.02	-0.11	-0.02	-0.12	-0.02	-0.11
$\widetilde{Y}_{1a}$: income per native net of unemployment benefits	-0.04	-0.25	-0.02	-0.17	-0.04	-0.22	-0.04	-0.23	-0.03	-0.19	-0.04	-0.24

Note: Each entry represents the percentage change in the corresponding variable described in the row header. The top two rows show the percentage change in illegal immigrants and in the policy parameter π_I. The next three rows show the labor market outcomes for unskilled natives, the following three rows show the labor market outcomes for skilled natives and the last two rows show income per native. The columns correspond to different robustness checks. Columns (1) and (2) represent the baseline specification. Columns (3) and (4) show the case when we have calibrated parameters to obtain a native-immigrant wage gap of -15% (rather than -20%). Columns (5) and (6) show the case when we have calibrated parameters to obtain a legal-illegal wage gap of -5% (rather than -7.5%). Columns (7) and (8) show the case when we set the return rate d_L to be double the value in the baseline case. Columns (9) and (10) show the case when we calibrate the parameters to obtain a ratio of unemployment to employment income of 0.5. Columns (11) and (12) show the case when we set the interest rate to 2%.

Table 5: The Effects of Higher Deportation Rates: Robustness Checks

	Baseline Specification		*-15% native-immigrant wage gap*		*-5% legal-illegal wage gap*		*Double d_L*		*Reduce the ratio of unemployment to employment income to 0.5*		*Lower real interest rate r=2% per year*	
Specifications:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I: stock of illegal Immigrants	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50
d_I: return rate for illegal immigrants	7.40	52.04	8.55	62.93	8.03	57.91	7.26	50.93	6.72	45.22	6.85	48.36
Unskilled market, outcomes for natives, percentage change												
θ_1^u: market tightness	-0.59	-3.03	-0.44	-2.23	-0.53	-2.70	-0.57	-2.88	-0.36	-1.86	-0.62	-3.16
u_{1N}^u: unemployment rate of natives	0.22	1.13	0.16	0.83	0.19	1.00	0.21	1.07	0.13	0.69	0.23	1.18
w_{1N}^u: wage of natives	0.11	0.56	0.11	0.55	0.11	0.56	0.10	0.52	0.11	0.54	0.11	0.57
Skilled market, outcomes for natives, percentage change												
θ_1^s: market tightness	-0.26	-1.32	-0.25	-1.25	-0.26	-1.29	-0.24	-1.22	-0.15	-0.74	-0.26	-1.33
u_{1N}^s: unemployment rate	0.11	0.58	0.11	0.55	0.11	0.57	0.11	0.54	0.06	0.32	0.12	0.58
w_{1N}^s: wage	-0.07	-0.35	-0.07	-0.34	-0.07	-0.35	-0.07	-0.33	-0.07	-0.34	-0.07	-0.36
Native income per person, percentage change												
$\widetilde{Y}_1$: income per native	-0.03	-0.13	-0.02	-0.11	-0.02	-0.12	-0.02	-0.12	-0.03	-0.14	-0.02	-0.12
$\widetilde{Y}_{1a}$: income per native net of unemployment benefits	-0.05	-0.28	-0.05	-0.23	-0.05	-0.26	-0.05	-0.26	-0.04	-0.20	-0.05	-0.28

Note: Each entry represents the percentage change in the corresponding variable described in the row header. The top two rows show the percentage change in illegal immigrants and in the policy parameter d_I. The next three rows show the labor market outcomes for unskilled natives, the following three rows show the labor market outcomes for skilled natives and the last two rows show income per native. The columns correspond to different robustness checks. Columns (1) and (2) represent the baseline specification. Columns (3) and (4) show the case when we have calibrated parameters to obtain a native-immigrant wage gap of -15% (rather than -20%). Columns (5) and (6) show the case when we have calibrated parameters to obtain a legal-illegal wage gap of -5% (rather than -7.5%). Columns (7) and (8) show the case when we set the return rate d_L to be double the value in the baseline case. Columns (9) and (10) show the case when we calibrate the parameters to obtain a ratio of unemployment to employment income of 0.5. Columns (11) and (12) show the case when we set the interest rate to 2%.

Table 6: The Effects of Higher Legalization Rates: Robustness Checks

	Baseline Specification		*-15% native-immigrant wage gap*		*-5% legal-illegal wage gap*		*Double d_L*		*Reduce the ratio of unemployment to employment income to 0.5*		*Lower real interest rate r=2% per year*	
Specifications:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I: **stock of illegal Immigrants**	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50	-10	-50
n: **legalization rate**	275.6	1985.3	165.8	1482.5	156.43	1408.2	169.84	1536.8	408.02	2339.2	429.53	2255.6
Unskilled market, outcomes for natives, percentage change												
θ_1^u: **market tightness**	1.10	3.66	0.13	0.60	0.45	2.18	-0.01	-0.05	1.12	2.78	2.15	4.80
u_{1N}^u: **unemployment rate of natives**	-0.40	-1.31	-0.05	-0.22	-0.16	-0.79	0.00	0.02	-0.41	-1.00	-0.77	-1.70
w_{1N}^u: **wage of natives**	-0.34	-1.23	-0.16	-0.78	-0.15	-0.74	-0.05	-0.26	-0.55	-1.53	-0.60	-1.48
Skilled market, outcomes for natives, percentage change												
θ_1^s: **market tightness**	0.77	2.81	0.34	1.68	0.33	1.66	0.11	0.55	0.73	2.04	1.36	3.39
u_{1N}^s: **unemployment rate**	-0.33	-1.20	-0.15	-0.72	-0.15	-0.72	-0.05	-0.24	-0.32	-0.88	-0.58	-1.44
w_{1N}^s: **wage**	0.21	0.75	0.09	0.45	0.09	0.45	0.03	0.15	0.34	0.95	0.37	0.91
Native income per person, percentage change												
$\widetilde{Y}_1$: **income per native**	0.06	0.23	0.02	0.11	0.03	0.13	0.01	0.03	0.11	0.31	0.11	0.27
$\widetilde{Y}_{1a}$: **income per native net of unemployment benefits**	0.13	0.45	0.04	0.19	0.05	0.27	0.01	0.05	0.16	0.44	0.23	0.54

Note: Each entry represents the percentage change in the corresponding variable described in the row header. The top two rows show the percentage change in illegal immigrants and in the policy parameter n. The next three rows show the labor market outcomes for unskilled natives, the following three rows show the labor market outcomes for skilled natives and the last two rows show income per native. The columns correspond to different robustness checks. Columns (1) and (2) represent the baseline specification. Columns (3) and (4) show the case when we have calibrated parameters to obtain a native-immigrant wage gap of -15% (rather than -20%). Columns (5) and (6) show the case when we have calibrated parameters to obtain a legal-illegal wage gap of -5% (rather than -7.5%). Columns (7) and (8) show the case when we set the return rate d_L to be double the value in the baseline case. Columns (9) and (10) show the case when we calibrate the parameters to obtain a ratio of unemployment to employment income of 0.5. Columns (11) and (12) show the case when we set the interest rate to 2%.

Table 7: The Role of Native-Immigrant Productivity Differences, Different Policies Effect on Unskilled Natives

	Wage gap due to productivity only $\Lambda = 0.76,\ \pi_L = 0$				Wage gap due to productivity and search cost $\Lambda = 0.90,\ \pi_L = 0.45$				Wage gap due to search cost only $\Lambda = 1,\ \pi_L = 0.78$			
Specification	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Policy Parameter	μ_I	π_I	d_I	n	μ_I	π_I	d_I	n	μ_I	π_I	d_I	n
I: stock of illegal Immigrants	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
Change in Policy parameter	-49.01	191.20	67.45	1282.74	-49.98	44.54	64.72	1369.42	-49.55	18.48	56.92	1647.81
Unskilled market, outcomes for natives, percentage change												
θ_1^u: market tightness	0.25	1.66	0.20	-1.72	-1.75	-0.90	-1.76	0.89	-3.05	-2.55	-3.03	3.80
u_{1N}^u: unemployment rate of unskilled natives	-0.09	-0.60	-0.07	0.63	0.65	0.33	0.65	-0.32	1.13	0.95	1.13	-1.36
w_{1N}^u: wage of unskilled natives	0.01	0.04	0.00	-0.04	-0.04	-0.02	-0.04	0.02	-0.07	-0.06	-0.07	0.09
Native income per person, percentage change												
$\widetilde{Y}_1$: income per native	0.09	0.16	0.09	0.00	-0.07	-0.02	-0.07	0.10	-0.18	-0.15	-0.18	0.22
$\widetilde{Y}_{1a}$: income per native net of unemployment benefits	0.13	0.36	0.13	-0.16	-0.25	-0.11	-0.25	0.20	-0.51	-0.43	-0.51	0.62

Note: Each entry represents the percentage change in the corresponding variable described in the row header. The top two rows show the percentage change in illegal immigrants and in the policy parameter. The next three rows show the labor market outcomes for unskilled natives and the last two rows show income per native. The columns correspond to effects achieved using four different policies used to reduce illegal immigrants by 50%. Columns (1)-(4) show the effects when we calibrate the whole native-immigrant wage gap to be due to productivity differences. Columns (5)-(8) show the case in which the calibration allows half of the native-immigrant wage gap to be due to productivity differences and the remaining half to different outside options. Columns (9)-(12) show the case when the whole native-immigrant wage gap is due to different outside options.