NBER WORKING PAPER SERIES

THE LABOR MARKET EFFECTS OF REDUCING UNDOCUMENTED IMMIGRANTS

Andri Chassamboulli
Giovanni Peri

Working Paper 19932
http://www.nber.org/papers/w19932

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
February 2014

The Labor Market Effects of Reducing Undocumented Immigrants
Andri Chassamboulli and Giovanni Peri
NBER Working Paper No. 19932
February 2014
JEL No. E24,J15,J64

ABSTRACT

A key controversy in US immigration reforms is how to deal with undocumented workers. Some policies aimed at reducing them, such as increased border security or deportation will reduce illegal immigrants as well as total immigrants. Other policies, such as legalization would decrease the illegal population but increase the legal one. These policies have different effects on job creation as they affect the firm profits from creating a new job. Economists have never analyzed this issue. We set up and simulate a novel and general model of labor markets, with search and legal/illegal migration between two countries. We then calibrate it to the US and Mexico labor markets and migration. We find that policies increasing deportation rates have the largest negative effect on employment opportunities of natives. Legalization, instead has a positive employment effect for natives. This is because repatriations are disruptive of job matches and they reduce job-creation by US firms. Legalization instead stimulates firms' job creation by increasing the total number of immigrants and stimulating firms to post more vacancies some of which are filled by natives.

Andri Chassamboulli
University of Cyprus
CY-1678, Nicosia
Cyprus
andricha@ucy.ac.cy

Giovanni Peri
Department of Economics
University of California, Davis
One Shields Avenue
Davis, CA 95616
and NBER
gperi@ucdavis.edu

1 Introduction

The current theoretical and empirical literature on the labor market effects of immigration considers the number of immigrants as an exogenous variable. Most studies, then analyze the consequences of increasing the number and/or changing the skill distribution of immigrants on native labor market outcomes. The number and type of immigrants entering a country, however, is not a “policy variable”. It is the outcome of economic and social pull forces and policy barriers and controls. Nevertheless, in the economic literature on the effect of immigration, very little attention is paid to the specific policies used to influence immigration and their potentially different effects on labor markets. Moreover, those analysis rarely differentiate between legal and illegal immigrants and their effects on natives.

If one moves outside of academia, however, the perception of legal and illegal immigration is sharply differentiated, with most people and politicians approving of (and often praising) legal immigrants but many of them strongly criticizing (and often vilifying) illegal ones. Moreover a large part of the very vigorous policy debate, in the US, is around what policies should be used to reduce the number of (or ideally eliminate) undocumented immigrants in the United States. Everybody agrees that the presence of undocumented is an anomaly to be solved but there is harsh disagreement on how to solve it. Is border enforcement the only policy needed? What would be the solution for those already in the US? Will we need massive deportation? or "self deportation"? or is legalization the most reasonable and practical option and what are its long-run consequences? These are the main issues that (as we write) generate disagreement and bog down any possibility of immigration reform.

There is also a very clear perception that the US government should consider these policies not only based on the effectiveness in reducing the number of undocumented immigrants but also with an eye to the other consequences that policies would have. First, the effects on undocumented immigrants (their rights and safety) should be considered. Equally important, however, are their effects on labor markets opportunities of US workers and on the economic success of US firms: will fewer illegal immigrants free jobs for Americans or cause firms to close? Moreover, the incentive that these policies can produce on perspective immigrants should be considered: will legalization cause a wave of new immigrants? Economists, so far, have not produce a framework to analyze quantitatively these effects in a coherent structure and hence they have been marginal to this debate.

This paper begins to fill this gap.

We propose a novel model representing two connected labor markets (parameterized, in the quantitative analysis, to be those in US and Mexico), in which workers search for employment. Firms create jobs and search frictions in the market exist. Legal and Illegal migration opportunities arises from the poor to the rich country because of working incentives. This model, that incorporates several crucial realistic aspects of labor markets and migration, which would not be captured by a classical demand-supply framework, is used to analyze different policies aimed at reducing illegal immigration. The quantitative predictions of the model are used to evaluate the labor market implications on natives and immigrants, of different policies to reduce undocumented Mexican immigrants in the US.

The model builds on the search and job-posting model of Chassamboulli and Palivos (forthcoming) and extends it to two countries. We also include the migration decision and we endogenize it as function of several policy parameters and of labor market conditions. The possibility of migration creates economic opportunities to the potential migrants of the poorer country as they can increase their salary and the value of search. It also creates opportunities to the firms of the richer country who could hire immigrants at lower salary cost, increasing their profits and the value of job posting. While firms in the rich country and workers in the poor country are helped by migration, the group of workers in the rich country can be hurt by immigration, as competition on the labor market may become steeper. However, the model shows that a larger share of immigrants and the option of hiring them drives the rich country firms to create more job-openings. This is because labor market frictions generate match-specific surplus and, as immigrants are paid less than natives (because of their a worse outside option), a larger share of immigrants increases the expected profit from creating a job. This drives firm to create more jobs. Some native workers are employed (ex-post) in some of those job-openings. Hence, in equilibrium, more immigrants produce (for reasonable parameter values) lower unemployment rates and higher wages for natives because they stimulate higher job creation per unemployed.

In this framework, undocumented immigration that allows access to the labor market of the rich country, albeit at worse conditions and with the risk of deportation, can be attractive for poor country's workers and for rich country's firms. Cheaper workers are available, firms increase their profit and more jobs are created. These features seem to capture exactly the economic incentives that have lead to undocumented immigration in the US. The paper asks: how can we reduce undocumented immigration in the least costly way for US firms and workers?

The four policies that we analyze are the following: (i) Reducing the opportunities of illegal immigration (more border enforcement), (ii) increasing the costs that undocumented face in looking for a job (hostile environment, no access to any social benefits), (iii) increasing the frequency of deportations and, finally, (iv) increasing legalization rates sometimes called "amnesty". In looking at the labor market effects of these policies, legal immigrant, illegal immigrant and native workers are considered to be equally productive and perfect substitutes in production, so that we can focus on their differences in terms of outside options and bargaining positions as driver of the outcomes. Immigrants, in fact have different outside options and hence different wages from natives in equilibrium, even for identical productivity. We assume that job posting by a firm cannot target a specific type of worker in terms of nativity and immigration status. However different workers can be paid different salaries once the match is realized, because of their different bargaining position. We endogenize migration incentives by considering that workers in the poor country search for migration opportunities (as well as for local jobs). They take them if the expected benefit from those, net of migration costs, is larger than the expected value of continuing to search for a domestic job. Heterogeneity across individuals in their emigration costs implies that only a fraction of poor-country workers will migrate.

While we show and discuss some analytical results, our key results are obtained from simulations. We use a set of parameters from the literature and we calibrate the remaining to match the average moments of the US and Mexico labor market and migration variables (wages, employment rates, migration and return rates for legal and illegal migrants, unemployment benefits) for the 2000-2010 period. Then we simulate changes in each policy to achieve a certain percentage reduction of undocumented and we calculate the corresponding effects on labor market outcomes. The first important implication of our model is that, as legal immigrants and (even more) illegal immigrants have worse outside options than natives, a larger share of either group in the labor force of the richer country increases the profits of firms, and hence job creation. Market tightness is higher with a larger share of immigrants, which implies lower unemployment rates and higher wages for natives workers too. These two results (first shown in Chassamboulli and Palivos, forthcoming) stem from the job-creation side of the economy. They are present as long as immigrants receive lower wage per unit of productivity, because of their worse outside option/lower bargaining power. This is a very reasonable assumption, supported by a large body of empirical work that shows immigrants earning lower wages than natives, even when controlling for all observables.[1] Interestingly, this implies that immigration policies reducing overall immigration have a negative effect on employment and wages of natives. Moreover policies have a particularly bad effect on job creation if they also reduce the surplus that firms obtain from hiring illegal immigrants. For these reasons, deportation has the most disruptive and negative effect on the labor market. Increasing the deportation rate, in fact, reduces the number of illegal and overall immigrants; it also reduces the value of hiring an undocumented to a firm (as it increases the probability of breaking the match due to deportation). As such, for a given reduction of undocumented immigrants, increased deportation usually generates a strong negative job-creation effect on US firms and hence the largest negative impact on the wage and employment of natives. To the other end of the spectrum, legalization, by decreasing undocumented but not decreasing the total number of immigrants and not altering significantly the surplus for a firm from hiring an undocumented, has the smallest negative effect on job creation. In fact, under reasonable parameter values, legalization produces an increase in total immigrants and it provides a job-creating stimulus by increasing the expected profit of job creation. Legalization increases the number of legal immigrants because some illegal are legalized and also because the value of migrating increases and more migrants are attracted to the richer country. Hence legalization produces a reduction in undocumented with actually positive labor market effects for natives (higher wages and lower unemployment rate). Reducing illegal immigration opportunities (border enforcement) and increasing the cost of job search for undocumented (hostile environment) have also negative effect on wages and employment of natives. Their magnitude is similar to, albeit smaller than, the effects of deportation.

The main quantitative implications of our simulations are that by increasing the deportation rate of immigrants to achieve a 50% reduction in their number would produce an increase in the native unemployment rate by about 1.6% of its initial value. The wage of natives would be reduced by 0.08% of their value. However, the same reduction achieved with a legalization program would produce a decrease in the native unemployment rate by about 4% of its initial value and it would increase native wages by 0.19% of their initial value. Several robustness checks and extensions are provided and they do not change the

[1] See for a survey Kerr and Kerr (2011).

main results.

The rest of the paper is organized as follows. Section 2 reviews the existing literature on undocumented immigration and labor market outcomes especially within the frame of search and matching models. Section 3 presents the model and provides intuition for its main results and the working of different mechanisms. We then describe in Section 4 the policy experiments that we will be considering. Section 5 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 6 shows the main effects obtained by simulating four different policies that would achieve a reduction of the number of undocumented immigrants in the rich country. In Section 7 we present some checks that the results are robust to reasonable variations of the parameter values and we show an extension to the model to the case in which illegal immigrants have no bargaining power. Section 8 concludes the paper.

2 Literature Review

There is a vast empirical literature on the effect of immigration on US labor market outcomes (see the Meta-Analysis by Longhi, Nyikamp and Poot (2005), (2008) for a review of several important recent findings). Most of it uses a simple neoclassical labor demand-supply approach to derive a reduced form equation (e.g. Borjas 2003) or a slightly more structural approach to estimate 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 explicitly differentiate between legal and illegal immigration when looking at labor market implications.

The paper most closely related to ours is Chassamboulli and Palivos (forthcoming). In that paper immigration is exogenous, only the receiving country is analyzed and only legal immigrants exists. The labor market consequences on native workers are analyzed using a search and matching model, which provides the basis for the model in this paper. Chassamboulli and Palivos (forthcoming) simulate the effects of different inflows of immigrants and identify the important job-creation effect of immigrants stemming from the fact that the surplus generated by immigrants for the firm is larger than the surplus generated by natives because their wages are lower. The novelties of this paper, relative to that contribution is that we explicitly model the migration decision from Mexico, that we allow for undocumented immigrants characterized by higher labor search costs and risk of deportation and that we analyze the effect of specific policies.

Palivos (2009) is one of the very few papers analyzing the welfare effects of undocumented immigrants on natives. Liu (2010) is the only other model, to the best of our knowledge, that analyzes the effects of undocumented immigration on the receiving country using a search and matching model. In his model, Liu (2010), only includes undocumented immigrants and assumes that 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, and particularly undocumented, are disadvantaged relative to natives in terms of job search conditions and unemployment benefits (they receive lower or no benefits) and we include also the possibility that undocumented are subject to the risk of deportation. In our model what is commonly refereed to as "exploitation" of undocumented, namely them being paid lower salaries, is due to their worse bargaining position vis-a-vis their employer relative to natives.

Also 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 affect significantly the impact of immigration on employment and wages of natives. E.g. Angrist and Kugler (2003) show that more protective labor markets result in larger impact of immigration on unemployment. D'Amuri and Peri (2013) also show that labor reallocation and wage effects can be larger in markets with lower rigidities.

3 The Model

We describe here the main features of the model. The details and the derivation of the specific equations are described in the Appendix (A). We consider two countries indexed using the subscript $i = [1, 2]$. 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 interest rate. Time is continuous. In absence of migration, country 1 has higher wages and more employment opportunities than country 2. Hence, when migration is allowed, some workers have incentives to migrate from country 2 to country 1 to maximize their income. No worker has incentives to migrate from country 1 to country 2. Migration can be legal (authorized) or illegal (unauthorized). We denote with I and L, respectively, the number of illegal and legal migrant workers in country 1. The labor force born in country 1, natives (N), is normalized to 1 while individuals born in country 2 are of measure F (foreign). The total labor force of country 1 consists of natives, legal and illegal immigrants and is given by $1 + I + L$. The measure of total labor force in country 2 is $F - I - L$. As they turn out to be crucial variables we also define ϕ to be the share of native workers in the unemployment pool of country 1 and λ to be the share of legal among unemployed immigrants of country 1.

In each period, opportunities to migrate are "random draws" occurring at rate μ_x^e, if the worker is employed in country 2, and at rate μ_x^u, if the worker is unemployed. The subscript $x = [I, L]$ indicates the type of the immigration opportunity. Specifically, the worker may find an opportunity to immigrate to country 1 legally (L) or illegally (I). Once in country 1, illegal immigrants face the risk of deportation. They may also obtain legal status with probability n, reflecting the possibility that, even in absence of amnesty, marriage or other special circumstances would allow them the opportunity to naturalize. We assume that $\mu_x^u > \mu_x^e$ and we standardize $\mu_x^e = 0$, $x = [L, I]$. 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 through their networks for migration opportunities. A worker will take up an opportunity to migrate to country 1 only if the benefit exceeds the cost. The migration cost is heterogeneous across individuals and it is distributed according to the CDF $\Phi(\cdot)$ with support $[\underline{z}, \bar{z}]$. Only the fraction of workers with costs lower than expected benefits is willing to migrate. Migration opportunities are not the same as job opportunities in the rich country. Immigrants still need to search for a job, even if for a short time, once in country 1. Hence, the benefit from immigrating to country 1 is the difference between the value of being unemployed (i.e. searching for a job) as an immigrant in country 1 and the value of being unemployed as a native in country 2.[2]

3.1 Search and Matching

Each of the two countries represents a labor market. In each labor market unemployed workers and unfilled vacancies are brought together via a stochastic matching technology $M_i(U_i, V_i)$, where U_i and V_i denote, respectively, the number of unemployed workers and vacancies in country $i = [1, 2]$. We assume that the function $M_i(\cdot)$ exhibits properties

[2] One could think of a model in which firms in country 1 can directly hire workers in country 2 and hence these persons emigrate already with a job. This, however, would imply a really global labor market in which firms posts vacancies accessible to all workers in any country and this seems hardly realistic.

standard in the labor search literature: it is at least twice continuously differentiable, increasing in its arguments, it exhibits constant returns to scale and it satisfies the Inada conditions. Using the property of constant returns to scale, we can write the flow rate of a match for an unemployed worker as $M(U_i, V_i)/U_i = m(\theta_i)$. The flow rate of a match for a vacancy is $M(U_i, V_i)/V_i = q(\theta_i)$, where $\theta_i = V_i/U_i = m(\theta_i)/q(\theta_i)$ represents the measure of market i tightness.

Each firm posts at most one vacancy. The number of vacancies in each market is determined endogenously by free entry. Firms' vacancies cannot be specifically "labelled" for natives or for immigrants only. They are open to all workers. A vacant firm bears a recruitment cost c_i specific to the country, related to expenses of keeping a vacancy and looking for a worker. An unemployed worker in country i receives a flow of income b_i, which can be considered as the opportunity cost of employment, and in addition, pays a per unit of time search cost π_{ij}, where the subscript $j = [N, I, L]$ denotes the worker's origin and status: native (N), illegal immigrant (I) and legal immigrant (L). This status-specific cost allows us to account for the fact that an immigrant worker may face a higher search cost compared to a native worker because he/she is eligible for fewer benefits when unemployed (unemployment insurance, health care, welfare) especially if undocumented. We standardize the search cost of a native worker to 0 and we assume that legal immigrants face lower search cost than illegal immigrants. Specifically, we set $\pi_{1N} = \pi_{2N} = 0$, $\pi_{1I} = \pi_I$, $\pi_{1L} = \pi_L$ and $\pi_I > \pi_L > 0$.

As already mentioned, legal immigrants face zero deportation risk. They have a positive probability of returning home reflecting the possibility of return for personal, family-related or other reasons. Illegal immigrant face the additional risk of being repatriated by deportation. Hence the return probability of illegal immigrants is higher than that of legal immigrants. Let δ_L and δ_I denote the instant return rate of legal and illegal immigrants, respectively. We set $\delta_I \geq \delta_L > 0$ where their difference is the deportation rate. Following return the worker joins the pool of unemployed (in country 2) 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. In country i matches produce output p_i, irrespective of the worker's origin and legal status. Hence we are considering workers of similar productivity differing only in their immigration status. Wages, on the other hand, denoted as w_{ij} differ by country (i)and migration status (j) and are determined by Nash bargaining, where the worker has bargaining power β. After an agreement has been reached, production commences immediately. Moreover, we assume that matches dissolve at the rate s_i, specific to country i. Following a job destruction, the worker and the vacancy enter the corresponding market and search for new trading partners.

3.2 Bellman Equations 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) and producing or empty and searching for a worker (V). We use the common notation J_{ij}^{κ} to denote the present discounted value associated with each state $\kappa = [V, F, U, E]$, where $i = [1, 2]$ denotes the country and $j = [N, I, L]$ the worker's immigration status. Hence in steady state we have fourteen Bellman equations. Four of them describe the value of Employment and four of them the value of Unemployment for workers of each type in each country (eight conditions in total). As for firms, there are four conditions for the value of a filled vacancy (depending on country and type of worker) but only two conditions for the value of unfilled vacancies (one in each country) because unfilled vacancies are open to any worker and not specific to a type. The full set of Bellman equations is in the Appendix A.

While the interested reader could inspect the equations in the Appendix for details let us provide here some intuition of how this model differs from a standard one-country model of search and matching. First, the possibility of finding an opportunity for entry into country 1 (either legal or illegal) increases the value of being unemployed for a country-2 worker relative to the case of closed borders. The net benefit of migrating legally is represented by the difference between the values of being an unemployed legal migrant in country 1 and being unemployed in country 2 net of migration costs: $J_{1L}^{U} - J_{2}^{U} - z$, where z is the individual-specific migration cost. Migrating illegally yields $J_{1I}^{U} - J_{2}^{U} - z$. If the net benefit of migrating is smaller than 0 the worker will continue his search in country 2.[3] Second, the exogenous probability of return (because of unforeseen events or due to deportation) affects negatively the value of being an immigrant to country 1. In the event of a return, in fact, the immigrant will either have to quit his job (if currently employed) or give up searching for a job in country 1 (if currently unemployed) and join

[3] The assumption that only unemployed workers can draw migration opportunities to country 1 is not restrictive. Allowing also employed workers to migrate, however, will produce a different migration cost threshold for employed and unemployed, making the problem notationally cumbersome.

the pool of unemployed workers in country 2. We know, from the migration condition, that this passage implies a loss in value. Specifically, the cost of return for an unemployed (employed) immigrant is given by $J_2^U - J_{1L}^U$ ($J_2^U - J_{1L}^E$), if legal, and $J_2^U - J_{1I}^U$ ($J_2^U - J_{1I}^E$), if illegal.[4] The presence of this exogenous return probability, due to shocks (or deportation for illegal aliens) allows us to incorporate return migration in the model, even if it is economically advantageous for migrants to stay in country 1.

A third important feature of this model is that the value of being unemployed in country 1 is higher for native than for immigrants in spite of identical productivity for two reasons. First, immigrants face the "risk" of return which would force a separation from their job. Second, we assume that immigrants pay a positive search cost denoted as π_x with $x = [L, I]$ representing their worse conditions when unemployed. Hence their flow-unemployment value ($b_1 - \pi_x$) is smaller than that of natives (b_1). The same reasoning also explains why the value of unemployment to an immigrant worker is lower when that immigrant is illegal (J_{1I}^U) than when legal (J_{1L}^U): an illegal immigrant faces a higher search cost ($\pi_I > \pi_L$) and a higher risk of return due to deportation ($\delta_I > \delta_L$).

Exogenous return-events are costly not only to the immigrant workers but also to the firm that employs them. Following return, the job becomes vacant and the firm has to undertake costly search. Hence, a firm employing an illegal (or a legal) immigrant will incur a net cost $J_1^V - J_{1L}^F$ ($J_1^V - J_{1I}^F$), when the workers returns to the home country. Jobs filled by immigrants face a higher separation probability than jobs filled by natives and this feature makes them less valuable to the firm. However, their worse outside option implies that they are paid lower wage and this features makes them more valuable to the firm.

Finally we allow for the possibility that an illegal immigrant is legalized (with probability n). In this case the immigrant receives a surplus $J_{1L}^U - J_{1I}^U$, if unemployed and $J_{1L}^E - J_{1I}^E$, if employed. Obtaining the legal status always yields a positive surplus to the immigrant worker, because as mentioned above, legal immigrants do not face deportation risk and have lower search costs. For the firm, on the other hand, legalization of an employee has two opposite effects. On the one hand firms have to pay higher salary to legalized workers, as their outside options have improved. On the other hand they are less likely to be separated from the jobs which makes the match more valuable. The net effect will depend on the relative size of those effects.

[4] Since $J_{1x}^U > J_2^U$, it must be the case that $J_{1x}^E > J_2^U$, because $J_{1x}^E > J_{1x}^U$.

We assume free-entry on the firm side in each of the two labor markets (country 1 and 2). Hence firms continue to open vacancies up to the point that an additional vacancy makes zero expected profit. In equilibrium this free-entry condition implies:

$$J_i^V = 0, \quad i = [1, 2] \tag{1}$$

3.3 Nash Bargaining

Wages are determined by a Nash bargain between the matched firm and worker. The threat points of the firm and the worker are simply the value of a vacancy and the value of being unemployed, respectively. Let $S_{ij} \equiv J_{ij}^F + J_{ij}^E - (J_{ij}^U + J_i^V)$ denote the surplus of a match between a vacancy and a worker of immigration status j in country i . With Nash-bargaining the wage w_{ij} is set to a level such that the worker gets a share β of the surplus, where β represent the relative bargaining power of workers, and the remaining goes to the firm.[5] That is:

$$\beta S_{ij} = J_{ij}^E - J_{ij}^U \qquad (1-\beta) S_{ij} = J_{ij}^F - J_i^V \tag{2}$$

3.4 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, as described above, is the difference between the value of searching (being unemployed) 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 legally in country 1 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 highest immigration costs that a worker (located in country 2) is willing to pay in order to obtain illegal or legal entry into country 1, are denoted by z_I^* and z_L^*, respectively, and they are:

$$z_I^* = J_{1I}^U - J_2^U \tag{3}$$

$$z_L^* = J_{1L}^U - J_2^U \tag{4}$$

[5] Notice that in this baseline specification we assume that native, legal and illegal immigrants have the same relative power in the Nash-bargaining. Still the wage of legal and illegal immigrants are lower than those of natives because of their worse outside options. In Section 7 we explore the case that illegal immigrants have no bargaining power and receive a take-it-or leave it offer.

Notice that $z_L^* > z_I^*$, because, as mentioned above, 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. $J_{1L}^U > J_{1I}^U$). Intuitively, the benefit from legal entry is higher than that of illegal entry, thus a worker is willing to incur a higher cost in order to obtain the right for legal entry. This also implies that for a given distribution of the migration cost z, in the population, there will always be a larger share of the country 2 population willing to take a legal immigration opportunity than an illegal one.

3.5 The Steady-state Unemployment and Migration Rates

The steady-state conditions determine the stationary number of unemployed (native) workers in country 2, U_2, the number of unemployed natives in country 1, U_{1N}, and the number of unemployed legal and illegal immigrants in country 1, U_{1L} and U_{1I}. The formal conditions are given by (41-44) in the Appendix A.2 and they state that flows into and out of unemployment status for each type of worker in country 1 and in country 2 should be equal.

Two more conditions guarantee the stationarity of the number of legal and illegal immigrants, L and I and hence of their share in unemployment, ϕ and λ. 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 returning to the home country, we obtain the steady-state condition for L:

$$\delta_L L = nI + U_2 \mu_L \Phi(z_L^*) \tag{5}$$

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

$$(\delta_I + n)I = U_2 \mu_I \Phi(z_I^*) \tag{6}$$

The conditions (5), (6) above and those expressing stationarity of unemployment rates (45-48 in the Appendix) can be combined to write the steady-state numbers of illegal and legal immigrants as:

$$I = \frac{\mu_I \Phi(z_I^*) u_2 (F - L)}{\delta_I + n + \mu_I \Phi(z_I^*) u_2} \tag{7}$$

$$L = \frac{\mu_L \Phi(z_L^*) u_2 (F - I) + nI}{\delta_L + \mu_L \Phi(z_L^*) u_2} \tag{8}$$

As expected, the equilibrium number of legal (illegal) immigrants increases (decreases) with the legalization rate n. The number of immigrants of each type (legal or illegal) decreases with the respective return rate and increases with the respective entry rate. Moreover, a change in parameters leading to an increase (decrease) in L, namely an increase (decrease) in $\mu_L \Phi(z_L^*)$ or a decrease (increase) in δ_L, have a negative (positive) impact on I, because a larger (smaller) number of legal immigrants means a smaller (larger) pool of workers located in country 2 available to enter illegally into country 1. However, the converse is not always true. The impact of an increase in $\mu_I \Phi(z_I^*)$ or a decrease in δ_I, both of which increase I is not always negative on L. While the change in those two parameters implies a smaller pool of workers in country 2, available to migrate legally, they also increase the pool of I, some of whom become legal immigrants themselves through legalization (n). If the rate at which existing illegal immigrants become legal is larger than the rate at which the natives of country 2 enter legally into country 1, i.e. if $n > \mu_L \Phi(z_L^*) u_2$, then an increase in I will have a positive impact on L. Hence, an increase in the entry rate of illegal immigrants ($\mu_I \Phi(z_I^*) u_2$), or an decrease in their return rate (δ_I) will have an unambiguously positive impact on I and a negative impact on L only if $n < \mu_L \Phi(z_L^*) u_2$.[6]

Notice, very importantly, that the economic and policy conditions in country 1, relative to country 2, affect the incentives to migrate legally and illegally (and hence the equilibrium stock of migrants I and L) via their effect on the threshold migration costs z_I^* and z_L^*. In particular, as expressed very clearly by conditions (3) and (4), any economic and policy factor that increases the value of being unemployed (through the value of being employed) in country 1 relative to country 2, will encourage immigration. This, in equilibrium, translates in larger stocks of legal L and illegal I immigrants in country 1. Hence this model allows us to evaluate immigration policies accounting for the direct effect on immigrants (through altering the flows into each state) as well as for their indirect "incentive" effects on potential documented and undocumented immigrants, via the impact on return to migration. This is a novel and important feature of this model.

[6] The results derived here assume that both legal and illegal migrants loose their status in country 1 once they return to country 2 and they have to look for a new opportunity (legal or illegal) to go back to country 1 in a new status.

3.6 Equilibrium

3.6.1 Wages

Using the Bellman equations (27) to (40), the zero-expected-profit (free entry) conditions (1) the Nash bargaining conditions (2) and the immigration conditions in (3) and (4), we can solve for the equilibrium wage rates. Those are specific to each type of worker in country 1 (native, legal and illegal immigrants) and to workers of country 2. Their expressions are as follows[7]:

$$
\begin{aligned}
w_{1N} &= A_{1N}p_1 + (1 - A_{1N})b_1 & (9)\\
w_{1L} &= A_{1L}p_1 + (1 - A_{1L})(b_1 - \pi_L) & (10)\\
w_{1I} &= A_{1I}p_1 + (1 - A_{1I})(b_1 - \pi_I) + \Gamma_I n J^F_{1L} & (11)\\
w_2 &= A_2 p_2 + (1 - A_2)\left(b_2 + \mu_I \int_{\underline{z}}^{z_I^*} (z_I^* - z)d\Phi(z) + \mu_L \int_{\underline{z}}^{z_L^*} (z_L^* - z)d\Phi(z)\right) & (12)
\end{aligned}
$$

where $A_{1N} \equiv \frac{\beta(r+s_1+m(\theta_1))}{r+s_1+\beta m(\theta_1)}$, $A_{1L} \equiv \frac{\beta(r+s_1+\delta_L+m(\theta_1))}{r+s_1+\delta_L+\beta m(\theta_1)}$, $A_{1I} \equiv \frac{\beta(r+s_1+\delta_I+n+m(\theta_1))}{r+s_1+\delta_I+n+\beta m(\theta_1)}$, $A_2 \equiv \frac{\beta(r+s_2+m(\theta_2))}{r+s_2+\beta m(\theta_2)}$ and $\Gamma_I \equiv \frac{\beta m(\theta_1)}{r+s_1+\delta_I+n+\beta m(\theta_1)}$.

One can verify by inspecting equations (9) to (12) that an increase in the separation rate of a match, either due to an increase in the exogenous return probability of immigrants (δ_I or δ_L) or due to an increase in the probability of separation (s_i), has a negative impact on the worker's wage. This is because an increase in the separation probability lowers the expected duration of a match and therefore the surplus received from the job (S_{ij}). Since wages are such that the firm and the worker split the expected surplus in fixed proportions, a decrease in the job surplus implies also a decrease in the worker's share of surplus (recall that $J^E_{ij} - J^U_{ij} = \beta S_{ij}$) and thus a decrease in the worker's wage.

Inspection of (9) and (10) also shows that the equilibrium wage of a native worker is higher than that of a legal immigrant worker i.e. $w_{1N} > w_{1L}$ despite the fact that they are all equally productive. This happens for two reasons. The first reason stems from the different outside option: immigrants face a higher search cost (i.e. $\pi_L > 0$), which forces them to accept lower wages. This effect is captured by the second term in the wage expression. The second reason relates to the disruptive effects that exogenous return shocks have on the values of jobs. Because working immigrants have a positive probability of exogenous return $\delta_L > 0$, jobs filled by immigrants have shorter expected

[7] A more intuitive expression of wages that helps to understand their dependence on productivity and outside options is presented in Appendix A.3.

duration than jobs filled by natives. Hence, they generate a smaller surplus and thus earn lower wages. This effect can be seen by noticing that $A_{1N} > A_{1L}$ and hence the native wage puts more weight on the (larger) term p_1. The same two reasons contribute to making the wage of illegal lower than the wage of legal immigrants. Their search cost is even higher than of legal immigrants (i.e. $\pi_I > \pi_L$), and because they can be deported their probability of return is higher than for legal immigrants (i.e. $\delta_I > \delta_L$).

3.6.2 The immigration costs threshold

Using equations (34), (35), (36), the zero-expected-profit conditions (1) and the Nash bargaining conditions (2) we can write the equilibrium conditions for z_I^* and z_L^* in equations (4) and (3) as follows:

$$\begin{aligned} (r+\delta_I)z_I^* + n(z_I^* - z_L^*) + M &= b_1 - b_2 - \pi_I + \Gamma_I\left[(p_1 - b_1)(1+n\Gamma_L) + \pi_I + n\Gamma_L\pi_L\right] \\ &\quad - \frac{\beta\theta_2 c_2}{(1-\beta)} \qquad (13) \\ (r+\delta_L)z_L^* + M &= b_1 - b_2 - \pi_L + \Gamma_L(p_1 - b_1 + \pi_L) - \frac{\beta\theta_2 c_2}{(1-\beta)} \qquad (14) \end{aligned}$$

where Γ_I is defined above while $M \equiv \mu_I \int_{\underline{z}}^{z_I^*}(z_I^* - z)d\Phi(z) + \mu_L \int_{\underline{z}}^{z_L^*}(z_L^* - z)d\Phi(z)$ and $\Gamma_L = \frac{\beta m(\theta_1)}{r+s_1+\delta_L+\beta m(\theta_1)}$. These two equations can be used to solve for z_L^* and z_I^* in terms of θ_1, θ_2 and model parameters. The cost thresholds z_I^* and z_L^* determine the rate at which natives of country 2 migrate into country 1. In equilibrium they are equal to the (illegal and legal) immigration surplus, namely the difference between the value of searching for a job in country 1 and the value of searching for a job in country 2. When the benefit from illegal (legal) entry into country 1 increases, then z_I^* (z_L^*) also increases and a larger share of country-2 workers accept opportunities for illegal (legal) entry. Hence their inflow to country 1 increases. These variables capture the incentive channel through which any policy or economic change affect potential immigrants.

We show in the Appendix A.4 that an increase of θ_1 and a fall of θ_2 and an increase in π_I (π_L) have a negative impact on z_I^* (z_L^*). A tighter labor market and more generous unemployment benefits for immigrants in country 1 will all attract immigrants, while a tighter labor market in country 2 will reduce migration. An increase in the return probability of illegal (legal) immigrants, $\delta_I(\delta_L)$ has also a negative impact on z_I^* (z_L^*) because it lowers both their wage and the expected duration of their stay.

It can also be shown that both z_I^* and z_L^* increase when the arrival rate of either legal or illegal immigration opportunities (μ_I or μ_L) decreases. This occurs because a decrease in the immigration opportunities rate lowers the value of outside option in country 2 and thus the wage, w_2. Hence the benefit from taking advantage of an immigration opportunity is larger and therefore a worker is willing to pay a higher cost in order to enter into country 1 when the chances that he will get another opportunity for entry in the future are smaller. A decrease in μ_I (μ_L) has also a direct negative impact on the entry rate of illegal (legal) immigrants, $\mu_I \Phi(z_I^*) u_2$ ($\mu_L \Phi(z_L^*) u_2$). So even if it increases the proportion of those who migrate, $\Phi(z_I^*)$ ($\Phi(z_L^*)$) the overall impact of a decrease in μ_I (μ_L) on the entry rate of illegal (legal) immigrants into country 1 may still be negative.

3.6.3 Zero-expected-profit conditions and vacancy posting

Using (1), equations (27) and (28) can be written as:

$$\frac{c_1}{q(\theta_1)} = \phi J_{1N}^F + (1-\phi)\left[\lambda J_{1L}^F + (1-\lambda) J_{1I}^F\right] \tag{15}$$

$$\frac{c_2}{q(\theta_2)} = J_2^F \tag{16}$$

where $\phi = \frac{U_{1N}}{U_{1N}+U_{1I}+U_{1L}}$ is the native share of total unemployment and $\lambda = \frac{U_{1L}}{U_{1I}+U_{1L}}$ represents the share of unemployed immigrants that is legal. These two are zero expected profit conditions for country 1 and 2, respectively, stating that the expected cost of posting a vacancy (left-hand-side) equals the expected benefit from a filled job (right-hand-side). Hence they determine the vacancy posting (job creation) behavior of firms. If the benefit exceeds the cost, opening vacancies is profitable and firms open more vacancies per unemployed worker until all rents are exhausted. Crucially an increase in the value of filled vacancies will trigger more job creation. This is the channel through which the proportion of immigrants and of illegal among them will affect job creation.

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

$$J_{1N}^F = \frac{p_1 - w_{1N}}{r + s_1} \tag{17}$$

$$J_{1L}^F = \frac{p_1 - w_{1L}}{r + s_1 + \delta_L} \tag{18}$$

$$J_{1I}^F = \frac{p_1 - w_{1I} + n\left[J_{1L}^F - J_{1I}^F\right]}{r + s_1 + \delta_I} \tag{19}$$

$$J_2^F = \frac{p_2 - w_2}{r + s_2} \tag{20}$$

The value to the firm of a filled job increases with the productivity of the job, p_i, and decreases with the worker's wage, w_{ij} and with the probability that the match will dissolve.

This is equal to s_1 or s_2, if the job is filled by a native worker (in country 1 or 2) while it is equal to $s_1 + \delta_I$, if the job is filled by an illegal immigrant and equal to $s_1 + \delta_L$, if the job is filled by a legal immigrant. Notice also from (19) that the value of a job filled by an illegal immigrant depends also on the probability that that immigrant will become legal. The legalization of an existing illegal immigrant will likely have a negative impact on the value to the firm that employs that immigrant as it is likely that $J_{1L}^F < J_{1I}^F$, because by obtaining the legal status an immigrant receives higher wages due to better bargaining position.

Substituting the wage expressions into (17)-(20) and subtracting from each other one obtains the following expressions[8]:

$$J_{1N}^F - J_{1L}^F = \frac{w_{1L} - w_{1N}}{r + s_1 + \delta_L} + \frac{\delta_L}{r + s_1 + \delta_L}\left[\frac{p_1 - w_{1N}}{r + s_1}\right] \tag{21}$$

$$J_{1L}^F - J_{1I}^F = \frac{w_{1I} - w_{1L}}{r + s_1 + \delta_I + n} + \frac{(\delta_I - \delta_L)}{r + s_1 + \delta_I + n}\left[\frac{p_1 - w_{1I}}{r + s_1 + \delta_L}\right] \tag{22}$$

Given that $w_{1L} < w_{1N}$, then $J_{1N}^F < J_{1L}^F$ as long as δ_L is sufficiently small. This means that a firm generates higher surplus from a legal immigrant worker when the equilibrium wage differential between native and legal immigrant workers is mainly due to the immigrants' worse outside option relative to native workers (i.e. higher search cost). If instead the difference in wage is due mainly to a difference in probability of breaking the working match, due to the disruptive effect of return, then the surplus of an immigrant to a firm may be lower than that of a native. Likewise, given that $w_{1I} < w_{1L}$, then $J_{1L}^F < J_{1I}^F$ as long as the difference between the return probabilities of employed illegal and legal immigrants $(\delta_I - \delta_L)$ which represent the deportation rate, is sufficiently small. In that case the primary reason behind the legal-illegal immigrant wage gap is that the latter are willing to accept lower wages because unemployment is more costly to them (i.e. they face a higher search cost). In a situation with low deportation probability and significantly lower outside option of illegal and legal immigrants, relative to natives, hiring immigrants will generate a higher value for the firm than hiring a native and hence, because of free entry, it will create more vacancy posting (job-creation) by the firm.

The steady-state equilibrium values of θ_1 and θ_2 are given by the two zero-profit conditions (15) and (16) after substituting for ϕ and λ using (45) to (48), for z_I^* and z_L^* using (53) and (54), for w_{1N}, w_{1I}, w_{1L} and w_2 using (9)-(12) and for J_{1N}^F, J_{1I}^F, J_{1L}^F and J_2^F using (55) to (58). Having determined θ_1^* and θ_2^* we can get then equilibrium values

[8] See Appendix for details.

of $J^F_{1N}, J^F_{1I}, J^F_{1L}$ and J^F_2, by simply substituting the equilibrium values of θ_1 and θ_2 into (55) to (58) then we can obtain z^*_I, z^*_L by solving simultaneously (13) and (14), we then substitute into (9)-(12) and obtain w_{1N}, w_{1I}, w_{1L} and w_2 and finally into (45)-(48) to obtain $U_{1N}, U_{1I}, U_{1L}, U_2, I$ and L. This constitutes a system of 26 equations in 26 unknown, however we can partition it and solve it recursively in blocks.

4 Policies to Reduce the Number of Undocumented Immigrants

The rich structure of the model presented above allows us to capture different policies for reducing undocumented immigration and analyze their effects on labor markets. In particular we focus on four possible strategies: (i) reduced opportunities of illegal entry (naturally thought as increased border control), (ii) increased cost to stay as illegal immigrants, obtained by increasing job-search cost of undocumented, (iii) increased probability of deportation of undocumented and (iv) increased possibility of legalization. As we will see all these measures can reduce the number of illegal immigrants. They have, however, different implications on native wages and job creation as well as different incentive effects on potential legal and illegal immigrants from country 2. We first describe them in terms of variations of the exogenous parameters of the model and we briefly describe the channels through which they affect the labor market outcomes of natives and legal immigrants. Then we examine quantitatively their impact on labor market outcomes for natives and on legal migration, by simulating numerically their effects on a calibrated model.

4.1 Parameterization of Policies

Our exercise consists in varying the key parameters affecting undocumented immigration one at a time, leaving the remaining parameters unchanged. Starting from values for the stock of immigrants and for labor market variables that match Mexico and the US around the period 2000-2010 we evaluate the consequences on unemployment, wages and net output per person of natives and legal immigrants, for a given percentage reduction of undocumented immigrants achieved using one of the four different policy instruments. The reduction in opportunities for illegal entry, due to tighter border control, is captured by a decrease in the parameter μ_I . This implies that in each period of time, individuals of country 2 draw fewer opportunities to migrate illegally to country 1. Policies that increase the cost for undocumented to search in country 1 are captured in our model by an increase in the parameter π_I. This can represent a reduction of benefits available to an undocumented immigrant when not employed (health care, children education) or the need to undertake costly procedures to hide or disguise themselves when searching. Policies that increase the probability of deportation of an illegal alien are captured by an increase of δ_I instead. This parameter represents the flow probability of returning to country 2 for an illegal immigrant and it is the sum of the frequency of exogenous return shocks (family or individual needs) and deportation frequency. Finally country 1 can increase the legalization rate of undocumented that in our model is captured by the parameter n. A sudden and large increase of n can be seen as a legalization.

4.2 Channels of Policy Effects

All policies described above alter directly the flow of undocumented migrants into or out of country 1. They also alter the incentive for migration and the bargaining power of illegal immigrants. Hence they change the incentives to create jobs in country 1 (and in country 2) through their impact on the expected profits of opening vacancies (right-hand-sides of (15) and (16)). If their impact on expected profits (surplus to the firm) is positive, they will induce job creation, thereby raising the vacancy to unemployment ratio and increasing the tightness of the labor market in country 1. In turn, as evident from equations (45) to (47) the increase in the market tightness θ_1 will cause the unemployment rates of both immigrant and native workers in country 1 to fall. It will also cause native wages to rise as workers' outside option improves. The opposite happens if such policies cause the expected firm surplus from job creation to fall. Firms would then open fewer vacancies, unemployment would rise and native wages fall. We provide some intuition of the effect of these policies when a new steady state is reached, hence our analysis is a comparative static one.

There are three main channels through which policies aimed at reducing undocumented immigrants affect the incentives of country 1 firms to create jobs and hence affect native wage and employment. We will describe them in turn here.

First, they alter the composition of the unemployment pool in terms of nativity. Restrictive policies aimed at reducing the number of illegal immigrants, such as the first three listed above (border controls, increased search cost and increased deportation rates), reduce the total proportion of immigrants in the unemployment pool (i.e. will cause an increase in ϕ). This is not necessarily true for the fourth policy, legalization, which can decrease undocumented immigrants without reducing total immigrants. For this reason we will discuss legalization more in detail in the next section. This effect is very important as an increase in ϕ would shift the weights in the expression describing the value of opening a vacancy in country 1 (expressed in 15) from $[\lambda J_{1L}^F + (1-\lambda)J_{1I}^F]$ to J_{1N}^F. The impact of this shift on job creation in country 1 depends on the size of J_{1N}^F relative to $[\lambda J_{1L}^F + (1-\lambda)J_{1I}^F]$. As discussed above, if the equilibrium wage gap between immigrants and natives is significant and primarily due to the worse outside option of the former[9] then $J_{1I}^F > J_{1N}^F$ and $J_{1L}^F > J_{1N}^F$. Hence a decline in the proportion of immigrants in the unemployment pool, due to restrictive immigration policies for undocumented, will reduce the firm surplus from creating a job, leading to lower job creation (lower θ_1).

Second, immigration policies aimed at reducing undocumented would, in general, increase λ, the fraction of documented workers among unemployed immigrants. Such a change in the composition of immigrants in terms of legal status will shift weight from J_{1I}^F to J_{1L}^F in the expression $[\lambda J_{1L}^F + (1-\lambda)J_{1I}^F]$ on the right hand of (15). If, due to their better outside option, legal immigrants earn higher wages than illegal immigrants then $J_{1I}^F > J_{1L}^F$. Hence this shift will also lower the expected profits of firms, thereby reducing job creation incentives.

Suppose that the difference in outside option between legal and illegal immigrants and natives and legal immigrants, respectively, is sufficiently large so that $J_{1I}^F > J_{1L}^F > J_{1N}^F$. In this case the above-mentioned increases in ϕ and λ, will both have a negative effect on expected profit of jobs in country 1, leading to lower job creation.

Third anti-illegal policies that either increase the search cost for undocumented (π_I) or increase their deportation probability (δ_I) can also influence the expected profits from job-creation in country 1, directly. Those two policies, however, will have an opposite effect on the expected profit of firms of country 1. An increase in π_I worsens the outside option of illegal immigrants and hence lowers their wage with a positive impact on the firm's surplus from employing illegal immigrants. The increased deportation policy, by increasing the probability of breaking a match, decreases instead the profit from an illegal immigrant and hence reduces incentives for job posting. Hence, as we will investigate further below, the same reduction in the number of illegal immigrants achieved through

[9] We will see in the calibration below that this is the case empirically relevant.

an increase in π_I should have a smaller negative impact on job creation as it will increase J_{1I}^F while an increase in δ_I will reduce J_{1I}^F and have a further negative impact on job creation (via reducing the value of vacancy posting).[10]

4.3 Legalization

As the other policies aimed at reducing illegal immigration an increase in the legalization rate affects the market tightness, employment and wages in country 1. The effects operate through its impact on the composition of unemployed workers in terms of legal status and nativity (changes in ϕ and λ) and through its direct impact on the value accrued to jobs filled by illegal immigrants, J_{1I}^F. The main difference with the other policies is that legalization may decrease the number of undocumented without reducing the total number of immigrants in country 1. In fact, by increasing the incentives to migrate it may actually increase overall immigrants as well. The positive effect on job creation implied by a potential increase in total immigrants will mitigate the negative effect on job creation due to the reduction of undocumented.

Let's first consider, the impact of an increase in the legalization probability on J_{1I}^F,the value of a job filled by an undocumented. This can be either positive or negative. More specifically, taking the derivative of (57) with respect to n gives:

$$\frac{\partial J_{1I}^F}{\partial n} = \frac{J_{1L}^F - J_{1I}^F}{r + s_1 + \delta_I + \beta m(\theta_1)} \tag{23}$$

An increase in n has a negative impact on J_{1I}^F if $J_{1L}^F < J_{1I}^F$, i.e., only if the firm generates a higher surplus from employing an immigrant when that immigrant is illegal (rather than legal). As shown in equation (22), illegal immigrants generate larger profits to firms, when they are willing to accept significantly lower wages than legal immigrants (because of worse outside options), whereas, their deportation probability is not very high. The intuition is straightforward. A firm that is employing an illegal immigrant faces a higher separation probability but can pay that immigrant a lower wage. If that immigrant becomes legal, then the probability that she will return to her country decreases, but she will also bargain for a higher wage. An increase in n will therefore have a negative impact

[10] Looking at country 2, all types of immigration policies that reduce illegal immigration and immigration overall have a positive impact on the expected profits of firms. This is because policies reducing migration benefits and migration flows to country 1 have a negative impact on the outside option and therefore wage of workers located in country 2 (w_2) and a positive impact on the expected firm surplus from a job in country 2, J_2^F.

on the profits of firms if the wage difference between legal and illegal immigrants is large, while the difference in their return probability is small.

Turning to the impact of legalization on the relative composition of the unemployment pool in terms of nativity and immigration status, it is in general ambiguous. There are however reasonable parameter configurations such that an increase in n raises immigrants as share of unemployed and this 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 that the rate by which immigrants return home is on average lower. Second, because a higher value of n raises z_I^* because the expected value of being illegal rises due to the higher chances of legalization and this attracts new illegal immigrants into the country. In the general case, where $\mu_L > 0$, a higher n will also deter the entry of legal immigrants through its negative impact on z_L^*. Because of this negative effect on (legal) immigrant entry, we cannot be sure that the overall impact on the number of unemployed immigrants will be positive. We can therefore conclude that an increase in unemployment share of immigrants (i.e. a decrease in ϕ) following an increase in n is more likely to occur when μ_L is small.

It is also reasonable to expect that an increase in n will cause a shift in the pool of unemployed immigrants towards legal immigrants (will increase λ). But because of the above-mentioned effects on z_I^* and z_L^*, which work in the opposite direction, it is difficult to establish it analytically.

We will see that for the relevant parameter range an increase in n (legalization) lowers ϕ and raises λ, thereby shifting the weights in expression (15) from J_{1N}^F to $[\lambda J_{1L}^F + (1-\lambda) J_{1I}^F]$ and from J_{1I}^F to J_{1L}^F. As $J_{1I}^F > J_{1L}^F > J_{1N}^F$, these compositional changes involve two opposite effects on the job-creation of 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.

5 Parameterization of the Model

We parameterize the model by combining three types of parameters. Some are taken from the literature. Others are measured by us from US and Mexican the data. Finally a third group is chosen to jointly match some moments of those same data. The parameter choice is summarized in Table 1. In this section we describe in detail the sources and the methods used to calculate them. For some key parameters we will perform robustness checks in Section 7.

We use a Cobb-Douglas matching function, $M_i = \xi_i U_i^{\varepsilon} V_i^{1-\varepsilon}$, $i = [1, 2]$ with constant return to scale to U and V. 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). One period in the model economy represents one month. We use the monthly interest rate $r = 0.4\%$ which implies a yearly real rate of about 5%. This is a commonly used value.

The job destruction rate of US jobs is set to $s_1 = 0.034$. This is Hall's (2005) estimate, using CPS data, and it is a value commonly used in the literature. As we do not have better estimates for Mexico, we use the same value for Mexico, $s_2 = 0.034$. The Mexican population in working age, F is set to $\frac{1}{3}$ of the US population in working age which is standardized to 1.[11] We also normalize the US productivity to $p_1 = 1$.

From Masferrer and Roberts (2009), the total number of returnees to Mexico each year (excluding deportation and averaged over the period 2001-2005) was about 245,000 per year, while as of 2001, the total Mexican-born population in the US was about 9.1 millions.[12] This means that the yearly return migration rate for Mexican migrants (legal or not) can be obtained as the ratio of returnees (0.245 million) to residents (9.1 million), which equals 0.027. We consider this to be the "normal" exogenous rate of return for Mexican immigrants and we apply it to legal Mexican immigrants. In order to compute the yearly return rate of undocumented Mexican immigrants we add to the normal return rate the deportation rate of non-criminal Mexicans. More specifically, applying the same exogenous return rate of 0.027 to the undocumented 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 undocumented 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-

[11] The population 15-65 in Mexico as of 2010 was 72 million, while in the US it was 209 million (source http://www.oecd-ilibrary.org/statistics). This produces a ratio of 1/2.9. The corresponding value for 2000 was 1/3.1. Hence 1/3 is a reasonable average for the 2000's.

[12] This number comes from the Migration Policy Institute, "Data Hub" available here: http://www.migrationinformation.org/DataHub/charts/fb-mexicans.cfm.

criminal Mexicans deported per year so that the total number of previously undocumented 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 undocumented Mexicans (5.2 million) gives the return+deportation rate of the undocumented Mexicans equal to 0.0453 yearly. Based on these values and recalling that our model uses monthly rates we set the monthly return rates by converting the yearly ones: $(1-\delta_L)^{12} = (1-0.027)$ and $(1-\delta_I)^{12} = (1-0.0453)$. This gives $\delta_L = 0.0023$ and $\delta_I = 0.0039$ corresponding to a return probability of 0.23% and 0.39% per month respectively both of which are rather low relative to the separation rate of jobs, equal to 3.4% per month.

The legalization rate of undocumented is calculated for the period 2009-2010 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 undocumented. Hence about 50,000 undocumented Mexican immigrants per year were naturalized (via marriage and other specific circumstances). The estimate of undocumented Mexicans in 2010 was around 6.8 millions (out of a total of 12 million Mexicans immigrants in the US in that year [13]) so that the "naturalization rate" per year for undocumented Mexicans 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 rate we use, equal to a probability of legalization equal to 0.06% per month.

We jointly calibrate the remaining 12 parameters of the model (c_1, c_2, b_1, b_2, $\bar{z}$, μ_L, μ_I, ξ_1, ξ_2, π_L, π_I and p_2) to match the following targets. We target the ratio of employment/population in working age (16-65) for the native workers in the US and in Mexico, which using IPUMS International data averaged at 82% and 55%, respectively between 1990 and 2000. We use the Conference Board's Help-Wanted Index (HWI) to calculate the vacancy to unemployment ratio which is equal to 0.62 and assume that the vacancy to unemployment ratio in Mexico takes the same value. As baseline value we then set the native-immigrant wage gap in the US at -25% which is the average value of this gap in year 2000 from Borjas and Friedberg (2009). We target the wage ratio between US and Mexico to be equal to 4 which is close to the ratio of income per person in the two countries, according to Penn World Table, version 7.1[14], in the years 2000-2010. We use Hall and

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

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

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 $b_1 = 0.71w_{1N}$ and $b_2 = 0.71w_2$. We set the ratio of Mexican immigrants to the US native labor force to $(L + I) = 0.038$ (from IPUMS in 2000) 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 due to legalization, such as Rivera-Batiz (1999) and Kossoudji and Cobb-Clark (2002) we set the legal-illegal immigrant wage gap to a baseline value of -10% but that gap could be as large as -20%.

These are 11 targets, while the parameters we need to identify are 12. Under the assumption that the distribution of migration costs is uniform over the interval $[0, \bar{z}]$ where we have standardized the lower bound to 0, then the individual values of μ_L, μ_I and $\bar{z}$ do not matter. What only matters is the share of the population distribution below each value of the arrival rates μ_L, μ_I. Because of the assumption of uniform distribution the relevant parameters and shares are therefore $\widetilde{\mu_L} \equiv \frac{\mu_L}{\bar{z}}$ and $\widetilde{\mu_I} \equiv \frac{\mu_I}{\bar{z}}$ and we match those. The values of the parameters matching the above targets are as follows: $c_1 = 0.412$, $c_2 = 0.048$, $b_1 = 0.672$, $b_2 = 0.166$, $\pi_I = 1.613$, $\pi_L = 1.180$, $\xi_1 = 0.197$, $\xi_2 = 0.053$, $p_2 = 0.262$, $\tilde{\mu}_I = 0.000035$ and $\tilde{\mu}_L = 0.00000667$. The last two coefficients seem very low. However, they imply illegal emigration rate equal to $\Phi(z_I^*)\mu_I = 0.000566$, which is equal to a 0.05% per month and a legal migration rate of $\Phi(z_L^*)\mu_L = 0.000293$ equal to 0.03% per month. In yearly rate, combining the two types of migration, this gives a probability of almost 1% per year, which is close to a total migration rate of 1% per year from Mexico to the US. This is exactly the average rate observed in the 2000's.

As discussed above, whether the surplus to the firm from hiring a native, J_{1N}^F is greater or lower than that from hiring an illegal or legal immigrant, J_{1L}^F or J_{1I}^F , is a determinant of whether the reduction in the number of immigrants has a positive or negative impact on the job creation of country 1. With targeted immigrant-native and legal-illegal wage gaps of -25% and -10%, and using the choice of the remaining parameters as described above, the calibration discussed above yields $J_{1I}^F = 5.71 J_{1N}^F$ and $J_{1L}^F = 4.50 J_{1N}^F$. 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. This is because despite the somewhat higher separation probability of immigrants their salary differential with natives ensures a significantly larger surplus to the firm. This in turn implies that the presence of immigrants produces a significant job-creating effect on the economy of country 1.

6 Simulated Effects of Policies

6.1 Comparison of four Policies

Our parameterization, based on the summary statistics of US and Mexico for the decade 2000-2010, focuses on the period during which the presence of undocumented Mexican immigrants peaked in the US. Whit this parameterization we simulate the effects of the four different policies aimed at reducing the number of illegal immigrants, described above. We will focus on the effects of those policies on the labor market outcomes of natives and legal immigrants, on the number of legal and total immigrants and on the total income to natives. We will also consider the effect on the overall income accruing to natives. This is measured as total wage income of natives plus firm profits plus unemployment income minus cost of keeping vacancies open. This assumes that firms (employers) are natives and it is given by the following equation:

$$Y_1 = (L + I + 1 - U_{1N} - U_{1L} - U_{1I})p_1 + b_1 U_{1N} - c_1 v_1 - w_{1I}(I - U_{1I}) - w_{1L}(I - U_{1L}) \quad (24)$$

Alternatively, we can subtract the unemployment income from total native income (if we think that it is generated as transfers from wages and profits) and obtain the following alternative definition:

$$Y_{1a} = Y_1 - b_1 U_{1N} \quad (25)$$

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 5% and 100%, where 100% implies that no undocumented is left). We then show the percentage effects on native unemployment, wages, income and total immigrants, for each policy. While Table A1-A4 in the appendix show the numerical effects on each endogenous variable, and for each policy simulation, in each of Figures 1-8 we show the impact on the variables of interest as percentage of its initial value, one at the time, comparing different policies in the same graph and plotted against the reduction of undocumented immigrants also as a percentage of their initial number.

Figure 1 shows the impact on labor market tightness (Vacancies/Unemployment) of each of four policies. The solid trajectory captures the effect of increasing the job search costs for undocumented immigrants (increase in π_I), the dashed trajectory shows the effect of increasing the deportation rate (δ_I) the dash and dots trajectory shows the effects of increasing border security (hence reducing μ_I) and the dotted line represents the effect of increasing the legalization rate (n). The horizontal axis shows the decrease in undocumented (I) as percentage of their initial number produced by each policy. The vertical axis shows the effect on the outcome variable, in this case labor market tightness, as percentage of its initial value. The percentage changes in the policy parameters needed to obtain the same change in undocumented may be different from policy to policy (see first row in the tables A1-A4 in the appendix). The comparison we are showing in the figures is between the "side effects" on the labor market outcomes of natives from different policies that deliver a certain percentage reductions of undocumented.

The effects shown in Figure 1, are key to understand all the others. Increases in search costs, deportation frequency and border controls all decrease the labor market tightness in the US. This is because these restrictive measures decrease the share of immigrants overall, and some also reduce the value of an employed undocumented worker to the firm. Therefore they make it less profitable for firms to create jobs. Recall that firms expect lower surplus from a new job with a lower immigrant share in the market. Notice that an increase in search cost is the policy with the least negative effect among those three. This is because while it decreases the total number of immigrants such policy also increases the firm surplus per undocumented (by worsening their outside option). The second effect partly offsets the first. However Figure 1 shows that this positive effect reduces only minimally the negative impact on market tightness. The only policy with a significantly different effect on labor market tightness is the increase in the legalization rate. This policy increases (rather than decreasing) the market tightness because it increases legal (and total) immigration by pushing undocumented to be legal and by encouraging more immigration to the US. Hence, it strengthens the job-creation of firms. The job creation effect is stronger than the increase in supply because in the potential pool of job applicants the percentage of immigrants increases and hence firms create more job openings per unemployed to take advantage of the higher expected surplus.

Figure 2 then shows that the effects on the unemployment rate[15] mimic those on market tightness. For a 50% reduction in undocumented workers achieved through tighter border control, the native unemployment rate is pushed to be 1.64% higher than before (using the base-value of 18 percentage points as unemployment rate in the US, this implies

[15] The variable "unemployment" in our model captures all non-employed, namely one minus the ratio of employed/population in working age.

an increase of unemployment by 0.3 percentage points[16]). The same reduction in undocumented immigrants achieved via increased deportation increases native unemployment by 1.61%, while an increase in job search costs for undocumented only increases native unemployment by 1.45%. However if the same reduction is achieved via increased legalization rate the unemployment of natives would actually be *reduced* by 4.04% (or 0.72 percentage points). The simulation suggests that the US labor market is made tighter by a policy that legalizes immigrants because that policy increases total immigration and firms create more jobs to take advantage of the ensuing profit opportunities. Some of those jobs would go to natives. In layman language, legalization encourages firms to create jobs in the perspective of hiring legal immigrants and this expansion benefits native workers as well. Inspection of tables A1-A4 in the appendix shows that the same effects are obtained also on employment (and non-employment) of legal immigrants. Hence the increased job creation by firms, from a legalization program, benefit natives and legal immigrants. To the contrary increased job search costs, border enforcement and deportation would hurt job creation and employment of legal immigrants as well.

Figures 3 and 4 show that the higher or lower labor market tightness translate into effects on wages of native and immigrants. A tighter labor market increases the bargaining power of workers and allows them to get higher wages, while lower tightness has the opposite effect. While wages are rather rigid in this model so that the effects on those are only fractions of a percentage point (for natives), we still see that legalization increases native wages (+0.19% for a decrease of undocumented by 50%) while the other policies decrease native wages (a decrease of 0.07-0.08% for the same change in undocumented). In general we also notice that increased border controls and deportation rates are the policies with most adverse effects on labor market tightness, wage and unemployment of natives and legal immigrants. This is because they reduce the inflow (or increase the outflow) of undocumented and hence they reduce the pool of immigrants and they reduce the value of a job filled by an immigrant to the firm (as they increase the possibility of him/her being repatriated, breaking a valuable match). A policy of increased job search cost for undocumented has a negative impact on tightness, however, as it increases the value of a job filled by undocumented for the firm, this attenuates slightly the effect.

The policies have very different effects on the wage of undocumented (Figure 5). In particular increased search costs, by making undocumented weaker in bargaining (as

[16] As we targeted the employment/population ratio, what we call unemployment here is actually non-employment.

their outside option becomes worse) imply that they will accept lower wages. A policy that reduces undocumented by 50% would also reduce their wages by 4.3%. Figure 5 shows also that deportation is the second most harmful policy for labor market outcomes of undocumented immigrants, while the legalization policy, as it does not decrease the bargaining power of undocumented (rather it may increase it), does not have much effect on their wage.

Figures 6 and 7 show that the impact of policies on the income of natives, including native wages, profits and unemployment income (in Figure 6) or including only wages and profits and excluding unemployment income (in Figure 7). As the size of the native population does not change across scenarios (nor across policies) the percentage change in income reported in those figures can also be interpreted as a change in income per capita for natives in the US. Let us comment the results reported in Figure 7, which only includes wages and profits. The effects reported in Figure 6 are similar, but quantitatively smaller. The restrictive immigration policies (deportation, border controls and higher job search costs) hurt firm profits and job creation. Hence their effect would combine the negative wage effect on natives with a negative effect on firm profits. Hence they produce a decline in income per native between 0 and 0.7%. A policy delivering a reduction of undocumented by 50% would produce a 0.4-0.5% reduction in income per native. To the contrary legalization combines a positive wage effect and a positive profit effect and hence it delivers an increase in income per native between 0 and 1.5%. An increase of the legalization rate that reduces the undocumented population by 50%, would increase income per native by 1.1%.

Finally Figures 8 and 9 show the percentage change in the number of total and documented immigrants produced by the different policies. As the native population is kept fixed at 1, these changes can be interpreted as changes in the immigrant population relative to natives. Keep in mind that the initial equilibrium include a total Mexican immigrant population equal to about 3.8% of the US population (the average value in 2000-2010) with 1.7% undocumented and 2.1% documented immigrants. Figure 8 shows that any of the three restrictive policies pushed to the point of eliminating undocumented immigrants (-100%) would also imply a reduction of the overall immigrants Mexican population in the US by about 40%, to only 2.3 percentage points of the native population. If the goal is not only to reduce undocumented but also to discourage documented and reduce overall immigrants then those polices deliver a strong result. This, as we have seen, happens at the expenses of a weaker native labor market and causes lower income per native. To the contrary Figure 8 shows that a legalization policy that eliminates undocumented, substantially increases the documented population so that total Mexican immigrants increase by about 70% (to 6.4% of US native population). This is a significant increase, in that not only those once undocumented are now documented but a larger flow of documented immigrants would enter the US because of better incentives to migrate due to tighter labor markets. This takes place with the additional benefit of tighter labor markets, more job creation, lower unemployment and higher income per native. If the goal of policy reform is to encourage legal immigration, promote job creation and reduce the number of undocumented, legalization has a much better performance.

Let us mention an interesting case of policies 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 only when immigration is under control is prominently stated. In our context this may be captured by a combination of increased legalization rate n and decreases 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 results (shown in Table A5 of the Appendix) show that for a reduction of illegal immigrants by 50% and no increase in total immigrants this policy delivers an increase of natives' unemployment of 0.38% of its initial value (as opposed to a 1.6-1.7% increases stemming from restrictive-only policies). Similarly the wage and income loss for natives would be very small (-0.02 to -0.04%). This combination essentially delivers a replacement of illegal immigrants with legal immigrants in the population of country 1 with much smaller adverse effects on native labor market outcomes than purely restrictive measures.

7 Checks and Extensions

7.1 Checks on Key Parameter-Value Range

The substantial job-creation effect from immigrants derives from their lower wage that corresponds, in part, to a lower outside option for them. In order to see if our main results are robust we target a smaller immigrant-native wage gap and a lower illegal-legal immigrant wage gap and we re-do the policy experiments. Specifically we target a immigrant-native wage gap of -15% (rather than -25%) which is at the very low end of estimated for the US (Borjas and Friedberg 2009) and an illegal-legal immigrant wage gap of -5% (rather than -10%), which also is very low. We then check that our results are robust to a much higher exogenous "natural" return rate of legal immigrants (we double it) and to a much lower level of unemployment benefits for natives (we reduce unemployment income to 50% of wage, rather than 71% in both countries). The policy effects with these different parameter assumptions are all shown in Tables 2-5.

The effect of increasing search costs for undocumented are shown in Table 2, those of increasing deportation rates are reported in Table 3. Table 4 shows the effects of increased border controls and Table 5 those of increased legalization rates. Each table shows the impact on all the endogenous variables of a policy reducing by 10% or 50% the undocumented population. The first 2 columns of each table (2 to 5) show that with an initial immigrant-native gap of -15% the negative labor market effects of the restrictive immigration policies are attenuated and the positive labor market effects of legalization are also attenuated. With a smaller wage gap immigrants are more similar to natives and they have a smaller job-creating effect on firms. Hence the restrictive measures have less of a depressive effect on labor market and legalization provides a lower boost. Nevertheless, even in this case restrictive policies achieving a 50% decrease in illegal immigrants *increase* the unemployment rate of natives between 0.6 and 1.2%, while legalization *reduces* it by 0.7%. This parameter change is the one producing the largest quantitative effect.

Columns 3 and 4 of Tables 2-5 show the policy effects when we consider a baseline of -5% legal-illegal immigrants wage gap. The restrictive policies increase native unemployment by 1.3-1.5%, while legalization decreases it by 2.13%. Again the effects are smaller than in the baseline but still significant and in the same direction as before. Doubling the exogenous return rate of legal immigrants (shown in columns 5 and 6 of Tables 2-5) implies that their value to the firm is reduced. Hence the expected surplus for a firm when legal immigrants are a large share of unemployment is lower. This is because legal immigrants will have larger probability of breaking a productive working match due to return. In this case the benefits from legalization on job creation are reduced. An increase in legalization rate producing 50% reduction in illegal immigrants will only decrease native unemployment by 0.4% in this case, while the restrictive measures will increase it by 1.3 to 1.5%.

Finally columns 7 and 8 show the simulated results when unemployment benefits for natives are significantly lower in both countries. In this case, again, natives will receive a lower pay and will be more similar to immigrants than before because their outside option deteriorates. This reduces the benefits from having a large share of immigrants. Still legalization produces an unemployment rate reduction of 2.51% for natives, and the restrictive undocumented immigration policies generate an increase between 0.9 and 1% of native unemployment.

The changes in these crucial parameters do not affect the qualitative conclusions from the simulations but they attenuate the quantitative effects. They confirm the importance of the difference in native and immigrant outside option as determinant of native-immigrant wage difference and of the job-creation effect of immigrants. Intuitively, these results confirm the "complementarity" principle, namely the more different native and immigrants are the more profitable is for firms to hire immigrants. However here the action is not on the production side, but on the difference in outside options. Immigrants with worse outside options stimulate job creation and decrease native unemployment.

7.2 "Take-it-or-leave it" wage offers to immigrants

In this section we explore an interesting and rather extreme variation of the wage determination mechanism. We consider that illegal immigrants have no bargaining power whatsoever and hence employers make a take-it-or-leave-it proposition to them. As evident from (51) a smaller bargaining power means that the workers receive a smaller share of the surplus, hence a smaller wage. In the limiting case, where an illegal immigrant worker has no bargaining power (i.e. $\beta = 0$ for illegal immigrants) firms extracts all match surplus and thus $J_{1I}^E - J_{1I}^U = 0$. In this case firms make a take-it-or-leave it wage offer that is equal to the monopsonistic wage, i.e. the wage that makes the worker indifferent between accepting the job or remaining unemployed.[17]

Setting $J_{1I}^E - J_{1I}^U = 0$ implies that firms will pay immigrants $w_{1I} = b_1 - \pi_I - n\beta S_{1L}$. Notice that if $n = 0$ the monopsonistic wage is simply the worker's unemployment flow income. As $n > 0$, then the firm sets a lower wage because if the worker becomes legal he

[17]We keep the assumption that search is random, in the sense that workers cannot direct their search towards particular wages. Firms will therefore negotiate the wage if they meet with a native or a legal immigrant worker, whose bargaining power is positive, but will make a take-it-or leave it offer if they meet with an illegal immigrant worker. Firms have no incentive to set the wage of illegal immigrants below the monopsonistic wage, because the job will remain vacant and no incentive to set a higher wage, since it will lower their profits without improving their matching probability.

will gain some bargaining power and thus extract a share β of the resulting match surplus, S_{1L}. Hence before legalization, when the worker has no bargaining power, the firm extracts the expected gain from legalization reducing the wage even further. Substituting the above expression for wage into the value for the firm of a job filled by an illegal immigrant (as for equation 57) gives:

$$J_{1I}^F = \frac{p_1 - b_1 + \pi_I + nS_{1L}}{r + s_1 + \delta_I + n} \tag{26}$$

The condition that determines the threshold z_I^* also changes to take into account that illegal immigrants have no bargaining power. Setting $\Gamma_I = 0$ in (13) gives the new condition. The rest of wages, values of filled jobs (match surpluses), equilibrium conditions, and the steady-state conditions for unemployment and the numbers of legal and illegal immigrants remain unchanged.

There are two things to note. First, in this case an increase in n has a direct negative impact on the illegal immigrant's wage as it increases future wage perspectives and makes the immigrants willing to take a lower "take-it-or-leave-it" wage. It also has a positive impact on the firm surplus as wages of undocumented are reduced. Second the low wage of undocumented will also affect the incentive to migrate illegally because it reduces its benefits. Hence the beneficial effect of legalization on labor market tightness, due to the increase in total immigrants is attenuated in this case by the fact that legal immigrants are much more costly to the firm than illegal ones and they generate a significantly lower surplus with less incentives to job creation.

Tables 6 to 9 show the impact of the different policies on all the endogenous variables, in the case of take-it or leave-it offers. Let's focus on the effects on native unemployment rate and native wage and income. In this case increased deportation (Table 7) and increased border control (Table 8) options create an even larger reduction in labor market tightness. The first measure increases native unemployment by around 1.6% and the second by 1.68% for a decrease in undocumented by 50%. The same change has an effect of reducing by 0.07-0.08% native wage and by 0.18% their income. The same reduction achieved through higher search costs (Table 6) has very small (but still negative) effects on native wage/income and positive on native unemployment. On the other hand, the positive market tightness effects of legalization, driven by an increase in total immigrants, is reduced by the depressing effect on job creation produced by more legal (relative to illegal) immigrants. Hence for an undocumented reduction by 50% the native unemployment is almost unchanged (-0.07%) and so are their wages and income (+0.01%). We also notice by inspecting Table 9 that the legal immigrant population increases much less than in the baseline case (+34% versus +79% for a reduction by 50% of illegal aliens) and this is because immigration becomes less attractive for illegal (some of whom turn into legal) and the cost threshold for migration declines.

Finally notice that in this case (Table 6) an increase in job search cost for undocumented has only a very small effect on labor market tightness and for low percentage decreases of undocumented that effect is actually positive. The reason is that now an increase in search cost will translate one for one on lower wages to undocumented. Hence, while the number of undocumented decreases as the search cost increases, the surplus to the firm per job, filled by undocumented, increases. These two effects almost offset each other keeping the effect on market tightness low. This effect is evident from looking at the wage of undocumented (in Table 6 relative to Table A1). While in the standard case, higher search costs leading to a 50% decrease in undocumented, decrease the wage of undocumented by about 4.3%, in the "take-it-or-leave-it" wage scenario the wage of undocumented decrease by 33%!

8 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 wages there is also search for migration opportunities (documented or undocumented) from the poor to the rich country. In equilibrium there are migration flows and return flows.

This model allows us to study qualitatively and, once we have calibrated the parameters to the US-Mexico case, quantitatively, the effects of different policies aimed at reducing the stock of illegal migrants on labor market outcomes of US natives and legal migrants. The novelty of the paper is that this is the first model to approach the analysis of immigration policies accounting for the impact on migration incentives and considering the effect of legal and illegal immigrants on job creation incentives of firms as well as on native wages.

We find that for values of the parameters calibrated on the US-Mexico labor markets and migration circa 2000-2010, immigrants, because of their worse outside options receive lower pay and generate higher surplus for the firm than native workers. This in turn pushes firms to create more jobs per unemployed when there are more immigrants, improving the labor market perspectives (wages and employment) of natives too. This key mechanism implies that 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 undocumented) will reduce job-creation of firms and worsen labor market outcomes of native workers. They will also reduce income per native and firm profits. To the contrary, policies that decrease the number of undocumented 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 the existing 2-country labor market models and allows us to deal separately with sophisticated immigration policies (border control, versus deportation for instance). The model can be easily adjusted also to analyze effects of other specific immigration policies, such as increased workplace raids (that may detect undocumented working immigrants) or policies toughening federal checks on unemployed immigrants. While the quantitative implications of the model are somewhat sensitive to the parameter choice the ranking of the four policies considered, in terms of their impact on all the native outcomes (wages, unemployment and income per person) is extremely robust and invariant to specific parameter choice, in the range considered. The most beneficial way of reducing undocumented immigrants, in terms of native outcomes, is by increasing legalization rates. Second is an increase in the job search cost of undocumented, then border enforcement. The last and most disruptive policy, for the economy and for the wage and labor markets opportunities of natives, is an increase in deportation rates.

References

[1] Angrist Joshua D. and Adriana D. Kugler, (2003). "Protective or Counter-Productive? Labour Market Institutions and the Effect of Immigration on EU Natives," *Economic Journal*, Royal Economic Society, vol. 113(488), pages F302-F331, 06.

[2] Borjas, George J. (2003). "The Labor Demand Curve Is Downward Sloping: Reexamining The Impact Of Immigration On The Labor Market," *Quarterly Journal of Economics*, MIT Press, vol. 118(4), pages 1335-1374, November.

[3] Borjas, George J. and Rachel M. Friedberg, (2009). "Recent Trends in the Earnings of New Immigrants to the United States," NBER Working Paper No. 1540, October 2009, Cambridge Mass.

[4] Chassamboulli, Andri and Theodore Palivos, (forthcoming) "A Search-Equilibrium Approach to the Effects of Immigration on Labor Market Outcomes," forthcoming, *International Economic Review*.

[5] D'Amuri Francesco and Giovanni Peri, (2012). "Immigration, Jobs and Employment Protection: Evidence from Europe Before and During the Great Recession," Working Papers 1215, University of California, Davis, Department of Economics.

[6] Hall, Robert E. (2005). "Employment Efficiency and Sticky Wages: Evidence from Flows in the Labor Market," *The Review of Economics and Statistics*, MIT Press, vol. 87(3), pages 397-407, August.

[7] Hall Robert E. and Paul R. Milgrom, (2008). "The Limited Influence of Unemployment on the Wage Bargain," *American Economic Review*, American Economic Association, vol. 98(4), pages 1653-74, September.

[8] Hill, Laura, Magnus Lofstrom and Joseph Hayes, (2010). "Immigrant Legalization: Assessing the Labor Market Effects," Public Policy Institute of California, Report, 2010.

[9] Hoefer, Michael, Nancy Rithina and Bryan Baker, (2012). "Estimates of the Unauthorized Immigrant Population Residing in the United States: January 2011," Department of Homeland Security, Washington D.C.

[10] Hosios, Arthur J. (1990). "On the Efficiency of Matching and Related Models of Search and Unemployment," *Review of Economic Studies*, Wiley Blackwell, vol. 57(2), pages 279-98, April.

[11] Kerr, Sari Pekkala and William R. Kerr, (2011) "Economic Impacts of Immigration: A Survey," *Finnish Economic Papers*, Finnish Economic Association, vol. 24(1), pages 1-32, Spring.

[12] Kossoudji, Sherrie A. and Deborah A. Cobb-Clark, (2002). "Coming out of the Shadows: Learning about Legal Status and Wages from the Legalized Population," *Journal of Labor Economics* , vol. 20(3), pages 598-628, July 2002.

[13] Lee, James, (2012). "U.S. Naturalizations 2011," Department of Homeland Security, available at: http://www.dhs.gov/xlibrary/assets/statistics/publications/natz_fr_2011.pdf.

[14] Liu, Xiangbo, (2010). "On the Macroeconomic and Welfare Effects of Illegal Immigration,"*Journal of Economic Dynamics and Control*, vol. 34, pages 2547-2567.

[15] Longhi Simonetta, Peter Nijkamp and Jacques Poot, (2005). "A Meta-Analytic Assessment of the Effect of Immigration on Wages," *Journal of Economic Surveys*, Wiley Blackwell, vol. 19(3), pages 451-477, 07.

[16] Longhi Simonetta, Peter Nijkamp and Jacques Poot, (2008). "Meta-Analysis Of Empirical Evidence on The Labour Market Impacts of Immigration," *Region et Developpement*, LEAD, Universite du Sud - Toulon Var, vol. 27, pages 161-191.

[17] Manacorda Marco, Alan Manning and Jonathan Wadsworth, (2012). "The Impact of Immigration on The Structure of Wages: Theory and Evidence from Britain," *Journal of the European Economic Association*, European Economic Association, vol. 10(1), pages 120-151, 02.

[18] Masferrer C. and B. Roberts, (2009). "Going Back Home? The Ambiguities of Contemporary Mexican Return Migration," Conference at UT Austin, 2009.

[19] Ottaviano Gianmarco I.P. and Giovanni Peri, (2012). "Rethinking The Effect of Immigration on Wages," *Journal of the European Economic Association*, European Economic Association, vol. 10(1), pages 152-197, 02.

[20] Palivos, Theodore, (2009). "Welfare Effects of Illegal Immigration," *Journal of Population Economics*, vol. 22, pages 131-144.

[21] Passel, Jeffrey and Randolph Capps, (2004). "Undocumented Immigrants: Facts and Figures," The Urban Institute Washington D.C., available at: http://www.urban.org/publications/1000587.html).

[22] Pissarides Christopher A. and Barbara Petrongolo, (2001). "Looking into the Black Box: A Survey of the Matching Function," *Journal of Economic Literature*, American Economic Association, vol. 39(2), pages 390-431, June.

[23] Rivera-Batiz, Francisco L. (1999) "Undocumented Workers in the Labor Market: An Analysis of the Earnings of Legal and Illegal Mexican Immigrants in the United States," *Journal of Population Economics*, vol. 12, pages 91-116, Spring.

A Appendix: Details of the Model

A.1 Bellman Equations

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

$$
\begin{aligned}
rJ_1^V &= -c_1 + q(\theta_1)\left[\phi J_{1N}^F + (1-\phi)(\lambda J_{1L}^F + (1-\lambda)J_{1I}^F) - J_1^V\right] && (27)\\
rJ_2^V &= -c_2 + q(\theta_2)\left[J_2^F - J_2^V\right] && (28)
\end{aligned}
$$

The value to the firm of filled Jobs is expressed by the following four equations, depending on the type of worker filling the job (native, legal immigrant and illegal immigrant) and on the country (1 and 2):

$$
\begin{aligned}
rJ_{1N}^F &= p_1 - w_{1N} - s_1\left[J_{1N}^F - J_1^V\right] && (29)\\
rJ_{1L}^F &= p_1 - w_{1L} - (s_1+\delta_L)\left[J_{1L}^F - J_1^V\right] && (30)\\
rJ_{1I}^F &= p_1 - w_{1I} - (s_1+\delta_I)\left[J_{1I}^F - J_1^V\right] + n\left[J_{1L}^F - J_{1I}^F\right] && (31)\\
rJ_2^F &= p_2 - w_2 - s_2\left[J_2^F - J_2^V\right] && (32)
\end{aligned}
$$

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

$$
\begin{aligned}
rJ_{1N}^U &= b_1 + m(\theta_1)\left[J_{1N}^E - J_{1N}^U\right] && (33)\\
rJ_{1L}^U &= b_1 - \pi_L + m(\theta_1)\left[J_{1L}^E - J_{1L}^U\right] - \delta_L\left[J_{1L}^U - J_2^U\right] && (34)\\
rJ_{1I}^U &= b_1 - \pi_I + m(\theta_1)\left[J_{1I}^E - J_{1I}^U\right] - \delta_I\left[J_{1I}^U - J_2^U\right] + n\left[J_{1L}^U - J_{1I}^U\right] && (35)\\
rJ_2^U &= b_2 + m(\theta_2)\left[J_2^E - J_2^U\right] + \mu_I\int_0^{\bar{z}} \max\left[J_{1I}^U - J_2^U - z, 0\right] d\Phi(z)\\
&\quad + \mu_L\int_0^{\bar{z}} \max\left[J_{1L}^U - J_2^U - z, 0\right] d\Phi(z) && (36)
\end{aligned}
$$

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

$$rJ_{1N}^E = w_{1N} - s_1\left[J_{1N}^E - J_{1N}^U\right] \tag{37}$$

$$rJ_{1L}^E = w_{1L} - s_1\left[J_{1L}^E - J_{1L}^U\right] - \delta_L\left[J_{1L}^E - J_2^U\right] \tag{38}$$

$$rJ_{1I}^E = w_{1I} - s_1\left[J_{1I}^E - J_{1I}^U\right] - \delta_I\left[J_{1I}^E - J_2^U\right] + n\left[J_{1L}^E - J_{1I}^E\right] \tag{39}$$

$$rJ_2^E = w_2 - s_2\left[J_2^E - J_2^U\right] \tag{40}$$

In expressions (27)-(40), w_{ij} denotes the wage rate for individual of type j in country i.

Expressions such as these have, by now, a relatively familiar interpretation. For instance, consider equation (27). The term rJ_1^V is the flow-value of a vacancy in country 1. It equals the flow cost of maintaining the vacancy c_1, 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:

$$s_1(1 - U_{1N}) = m(\theta_1)U_{1N} \tag{41}$$

$$s_2(F - I - L - U_2) + \delta_I I + \delta_L L = (m(\theta_2) + \mu_L\Phi(z_L^*) + \mu_I\Phi(z_I^*))U_2 \tag{42}$$

$$s_1(L - U_{1L}) + \mu_L\Phi(z_L^*)U_2 + nU_{1I} = \left[\delta_L + m(\theta_1)\right]U_{1L} \tag{43}$$

$$s_1(I - U_{1I}) + \mu_I\Phi(z_I^*)U_2 = \left[\delta_I + n + m(\theta_1)\right]U_{1I} \tag{44}$$

Equation (41) shows that the natives of country 1 flow into unemployment at the exogenous rate s_1 (job destruction) and exit unemployment at the job-finding rate $m(\theta_1)$ that depends on the country 1 labor market tightness θ_1. For the natives of country 2, the flows into unemployment (represented by the left-hand-side of 42) include separations as well as the exogenous return-events ($\delta_I I + \delta_L L$) 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 42) includes both those who find jobs 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 43 and 44) 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 43) 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 43) can be either due to job finding or due to exogenous return to country 2. Similarly, flows of illegal immigrants out of unemployment (right-hand-side of 44) come partly from job finding, $m(\theta_1)U_{1I}$, partly from returns, $\delta_I U_{1I}$, and partly from legalizations, nU_{1I}.

Then equations (41) to (44) and equations (5) and (6) in the main text can be used to derive expressions for the steady-state values of the unemployment rate and unemployment level U_{1N}, U_{1I}, U_{1L} and U_2 for each group of workers (native, illegal and legal immigrants in country 1 and natives in country 2):

$$u_{1N} = U_{1N} = \frac{s_1}{s_1 + m(\theta_1)} \tag{45}$$

$$u_{1I} = \frac{U_{1I}}{I} = \frac{s_1 + \delta_I + n}{s_1 + \delta_I + n + m(\theta_1)} \tag{46}$$

$$u_{1L} = \frac{U_{1L}}{L} = \frac{s_1 + \delta_L - n\frac{I}{L}(1 - u_{1I})}{s_1 + \delta_L + m(\theta_1)} \tag{47}$$

$$u_2 = \frac{U_2}{F - I - L} = \frac{s_2}{s_2 + m(\theta_2)} \tag{48}$$

where, consistently with the rest of the notation, U_{ij} (u_{ij}) denote the unemployment level (unemployment rate) in country $i = [1, 2]$ of workers of type $j = [I, L, N]$. As it is conventional, all unemployment rates increase with the relative separation probability s_i and decrease with the matching probability $m(\theta_i)$. The unemployment rates of illegal and legal immigrants, u_{1I} and u_{1L}, increase also with the probability of exogenous return δ_I and δ_L, respectively that in steady state act in a similar way as a separation rate. Return rates in fact move workers out of employment in country 1 (as separation rates), and while those workers flow to country 2, rather than to the unemployment pool of country 1, the steady state conditions (5)-(6) ensure that there is an equal flow of migrants from country 2 to unemployment in country 1, hence reproducing the effect of separation. Notice that while the legalization rate (as we will show below) increases the steady state value of legal immigrants, L and decreases the steady state number of illegal immigrants I, it also increases the unemployment rate among illegal u_{1I} and decreases it among legal, u_{1L}. The reason is that in steady state a higher flow out of illegal status (due to legalization) must be balanced by a larger flow into it, which can only be provided by new illegal entry. As those new illegal entrants are unemployed, the unemployment rate of that group rises. Symmetrically for legal immigrants a higher legalization rate implies a larger flow into the legalized pool and for a given flow out, this must be balanced by a lower flow of new legal immigrants, with a decrease of unemployed new legal immigrants.

A.3 Wages

To understand the intuition behind the conditions that determine wages we can write equations (9) to (12) in the text as follows:

$$w_{1N} = \beta p_1 + (1-\beta)\left[b_1 + m(\theta_1)(J_{1N}^E - J_{1N}^U)\right] \quad (49)$$

$$w_{1L} = \beta p_1 + (1-\beta)\left[b_1 - \pi_L + m(\theta_1)(J_{1L}^E - J_{1L}^U)\right] \quad (50)$$

$$w_{1I} = \beta p_1 + (1-\beta)\left[b_1 - \pi_I + m(\theta_1)(J_{1I}^E - J_{1I}^U)\right] \quad (51)$$

$$w_2 = \beta p_2 + (1-\beta)\left[b_2 + m(\theta_2)(J_2^E - J_2^U) + M\right] \quad (52)$$

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 (52) 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, which only depends on the country, 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 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 and the matching rate $m(\theta_i)$, and in addition, fall with the search costs π_x.[18]

[18] It should be noted that in expression (51) the probability of deportation δ_I, and the probability of legalization n affect wages only thought their impact on $J_{1I}^E - J_{1I}^U$. This is because we are assuming that the probabilities of deportation and legalization are independent of employment status. It should be noted that if we were to assume that illegal immigrants were more likely to become legal or that their deportation probability was lower when employed than unemployed the wage expression (51) would contain a term depending on those. In that case, immigrants would accept jobs at even lower wages, because by so doing they could improve their chances of becoming legal or they would reduce their deportation risk.

A.4 Immigration Cost Thresholds

Equations (13) and (14) in the text can be written in a more intuitive way as a function of the endogenous wages:

$$(1-\beta)z_I^* = \frac{[\alpha w_{1L} + (1-\alpha)w_{1I} - \beta p_1] - [w_2 - \beta p_2]}{r + \alpha\delta_L + (1-\alpha)\delta_I} \tag{53}$$

$$(1-\beta)z_L^* = \frac{[w_{1L} - \beta p_1] - [w_2 - \beta p_2]}{r + \delta_L} \tag{54}$$

where $\alpha \equiv \frac{n}{r+n+\delta_L}$. Expressions (53) and (54) make clear that the benefits from immigrating to country 1 increase when the wage that an immigrant worker can obtain in country 1 increases relative to the wage that she can obtain at home and when the return probability is small which implies that an immigrant worker's stay in country 1 is expected to last long. Essentially the terms in square brackets on the right hand side of equation (53) are the flow value from being unemployed in country 1 for an illegal immigrant and the flow value from unemployment in country 2. The difference depends positively on the wage differential and also on the productivity differential (as the endogenous wages grow faster than βp_i with an increase in p_i). Similarly the terms in square brackets on the right hand side of (54) is the difference between the flow value from being unemployed as legal immigrant in country 1 and being unemployed in country 2.

Since illegal immigrants may become legal with probability n, their expected wage is a weighted average of the wage they can get as illegal, w_{1I}, and the wage they can get if they become legal, w_{1L}, with the weight on w_{1L} (w_{1I}) increasing (decreasing) as the probability of becoming legal (n) increases. Likewise, their return probability is a weighted average of δ_I and δ_L, and the weight on δ_L is larger when n is larger. The expected duration of an immigrant's stay in country 1 matters for incentives to enter into country 1, since, as shown in the above equations, the effective discount rate for the benefits from entering into country 1 is the discount rate r plus the return probability δ_L, if entry is legal, and the average return probability $\alpha\delta_L + (1-\alpha)\delta_I$, if entry is illegal. Given that $w_{1L} > w_{1I}$ and $\delta_L > \delta_I$, an increase in n implies an increase in the benefit from illegal entry and therefore an increase in z_I^*. By obtaining the legal status an immigrant worker can both bargain for a higher wage and reduce his return probability, thus when the probability of legalization increases the benefit from illegal entry also increases.

A.5 Value of a Filled Vacancy

Substituting the equilibrium wages (given in equations (9) to (12)) into equations (17) to (20) the values of filled vacancies can be written as:

$$J^F_{1N} = (1-\beta)S_{1N} = \frac{(1-\beta)(p_1-b_1)}{r+s_1+\beta m(\theta_1)} \tag{55}$$

$$J^F_{1L} = (1-\beta)S_{1L} = \frac{(1-\beta)(p_1-b_1+\pi_L)}{r+s_1+\delta_L+\beta m(\theta_1)} \tag{56}$$

$$J^F_{1I} = (1-\beta)S_{1I} = \frac{(1-\beta)\left(p_1-b_1+\pi_I\right)+n\left(J^F_{1L}-J^F_{1I}\right)}{r+s_1+\delta_I+\beta m(\theta_1)} \tag{57}$$

$$J^F_{2} = (1-\beta)S_{2} = \frac{(1-\beta)(p_2-b_2-M)}{r+s_2+\beta m(\theta_2)} \tag{58}$$

Obviously if $\delta_I = \delta_L = 0$ and $\pi_L = \pi_I = 0$, implying $w_{1N} = w_{1I} = w_{1L}$, then $J^F_{1N} = J^F_{1I} = J^F_{1I}$ and the firm is indifferent between hiring an immigrant (legal or illegal) or a native worker. In general, however, the value of a filled job to the firm depends on the worker's origin and legal status, since as explained above, immigrants legal or illegal and native workers earn different wages and in addition jobs filled by immigrants have lower expected duration. More specifically, subtracting (56) from (55) and (57) from (56) gives the two expressions (21) and (22) in the text.

Tables

Table 1

Parameterisation of the model	
ε=0.5	Petrongolo and Pissarides (2001).
β=0.5	Satisfies the Hosios (1990) condition.
r=0.004	Monthly interest rate.
s_1=s_2=0.034	Hall (2005).
p_1=1, $\underline{z}$ =0	Normalizations.
Measured from the data:	
F=$1/3$	The average ratio of Mexican to US population for the 2000s.*
δ_L=0.0023	Our calculations from several sources (see text).
δ_I=0.0039	Our calculations from several sources (see text).
n=0.0006	Our calculations from several sources (See text).
Jointly calibrated to match:	
ξ_1=0.197	The employment rate of US-native workers: 0.82. †
ξ_2=0.053	The employment rate in Mexico: 0.55.†
p_2=0.262	The wage ratio between US and Mexico, equal to 4, close to the ratio of income per person in the two countries.‡
b_1=0.672 b_2=0.166	The ratio of unemployment to employment income of 71% for both countries (Hall and Milgrom, 2008).
π_L=1.180	The native-immigrant wage gap: -25% (Borjas and Friedberg, 2009).
π_I=1.613	The legal-illegal immigrant wage gap: -10% (e.g. Rivera-Batiz, 1999 and Kossoudji and Cobb-Clark, 2012).
c_1=0.412	The ratio of Mexican immigrants to the US-native labor force: $I + L = 0.038.$ ⱡ
c_2=0.048	The proportion of legal immigrants in the total number of Mexican immigrants: 56% (Hoefer et al, 2012).
$\tilde{\mu}_L$=0.0067% $\widetilde{\mu_I}$=0.035%	The vacancy to unemployment ratio in Mexico and the US: 0:620.¥

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

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

† IPUMS International data.

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

ⱡ IPUMS in 2000.

¥ Conference Board's Help-Wanted Index.

Table 2: Higher search cost (increase in π_I)
(percentage changes)

	-15% native-immigrant wage gap		*-5% legal-illegal wage gap*		*Double δ_L*		*Reduce the ratio of unemployment to employment income to 0.5*	
I	-10	-50	-10	-50	-10	-50	-10	-50
π_I	7,69	28,71	3,00	11,56	1,92	7,50	1,88	7,31
θ_1	-0,20	-1,45	-0,68	-3,18	-0,72	-3,26	-0,47	-2,12
u_{1N}	0,08	0,60	0,28	1,30	0,30	1,33	0,19	0,87
u_{1L}	0,16	0,94	0,35	1,64	0,37	1,66	0,27	1,22
u_{1I}	0,08	0,58	0,27	1,27	0,29	1,30	0,19	0,85
w_{1N}	0,00	-0,03	-0,01	-0,06	-0,01	-0,06	-0,02	-0,07
w_{1L}	-0,01	-0,09	-0,08	-0,40	-0,08	-0,37	-0,06	-0,28
w_{1I}	-2,11	-9,18	-1,29	-5,44	-0,97	-4,04	-0,92	-3,77
Y_1	-0,01	-0,07	-0,03	-0,14	-0,03	-0,14	-0,04	-0,17
Y_{1a}	-0,02	-0,17	-0,08	-0,36	-0,08	-0,37	-0,06	-0,28
$z_I^\star$	-9,58	-48,91	-10,15	-50,92	-10,18	-50,98	-10,47	-52,04
$z_L^\star$	0,15	0,36	-0,29	-1,61	-0,29	-1,46	-0,21	-1,11
L	-2,19	-9,04	-2,08	-9,01	-1,08	-4,57	-1,76	-7,60
φ	0,21	0,88	0,21	0,88	0,19	0,80	0,21	0,85
λ	3,51	16,70	3,56	16,71	3,88	17,72	3,69	17,21
L/(L+I+1)	-1,99	-8,23	-1,89	-8,19	-0,91	-3,85	-1,57	-6,81
(L+I) /(L+I+1)	-5,35	-24,23	-5,29	-24,21	-4,73	-21,36	-5,12	-23,31
θ_2	4,03	13,95	1,96	6,80	1,58	5,57	0,71	2,46
u_2	-1,11	-3,90	-0,54	-1,88	-0,44	-1,54	-0,20	-0,68
w_2	-0,19	-0,68	-0,11	-0,40	-0,09	-0,31	-0,08	-0,27
Y_2	0,75	3,01	0,70	2,87	0,63	2,58	0,67	2,75
Y_{2a}	1,42	5,29	1,02	3,97	0,89	3,49	0,75	3,03

Table 3: Increased rates of deportation (increase in δ_I) (percentage changes)

	-15% native-immigrant wage gap		*-5% legal-illegal wage gap*		*Double δ_L*		*Reduce the ratio of unemployment to employment income to 0.5*	
I	-10	-50	-10	-50	-10	-50	-10	-50
δ_I	6,96	33,30	6,04	28,80	5,37	25,58	5,44	25,59
θ_1	-0,63	-2,66	-0,88	-3,74	-0,86	-3,62	-0,56	-2,34
u_{1N}	0,26	1,09	0,36	1,53	0,35	1,48	0,23	0,96
u_{1L}	0,34	1,44	0,44	1,87	0,43	1,81	0,31	1,31
u_{1I}	0,83	4,19	0,86	4,14	0,79	3,76	0,67	3,26
w_{1N}	-0,01	-0,05	-0,02	-0,07	-0,02	-0,07	-0,02	-0,08
w_{1L}	-0,04	-0,17	-0,11	-0,47	-0,10	-0,41	-0,07	-0,31
w_{1I}	-0,21	-1,07	-0,31	-1,52	-0,32	-1,52	-0,30	-1,46
Y_1	-0,03	-0,12	-0,04	-0,16	-0,04	-0,16	-0,04	-0,18
Y_{1a}	-0,07	-0,30	-0,10	-0,43	-0,10	-0,41	-0,07	-0,31
$z_I^\star$	-4,09	-21,07	-5,13	-26,13	-5,66	-28,84	-5,81	-29,70
$z_L^\star$	-0,05	-0,21	-0,53	-2,30	-0,42	-1,83	-0,33	-1,41
L	-1,89	-8,14	-2,10	-9,07	-1,06	-4,54	-1,80	-7,70
φ	0,20	0,83	0,20	0,85	0,18	0,77	0,20	0,83
λ	3,39	15,91	3,33	15,75	3,70	16,95	3,49	16,35
L/(L+I+1)	-1,70	-7,34	-1,90	-8,25	-0,89	-3,82	-1,61	-6,91
(L+I) /(L+I+1)	-5,19	-23,65	-5,30	-24,24	-4,72	-21,34	-5,13	-23,37
θ_2	1,89	8,05	1,12	4,61	1,02	4,16	0,44	1,78
u_2	-0,52	-2,23	-0,31	-1,28	-0,28	-1,15	-0,12	-0,49
w_2	-0,09	-0,39	-0,06	-0,27	-0,06	-0,23	-0,05	-0,20
Y_2	0,70	2,87	0,70	2,86	0,63	2,56	0,67	2,75
Y_{2a}	1,02	4,20	0,88	3,61	0,79	3,24	0,72	2,95

Table 4: Increased border control (entry restrictions) (decrease in μ_I) (percentage changes)

	-15% native-immigrant wage gap		*-5% legal-illegal wage gap*		*Double δ_L*		*Reduce the ratio of unemployment to employment income to 0.5*	
I	-10	-50	-10	-50	-10	-50	-10	-50
μ_I	-9,87	-49,47	-9,40	-47,36	-8,94	-45,34	-9,47	-47,59
θ_1	-0,65	-2,72	-0,90	-3,81	-0,87	-3,69	-0,57	-2,37
u_{1N}	0,27	1,11	0,37	1,56	0,36	1,51	0,23	0,97
u_{1L}	0,34	1,46	0,45	1,90	0,44	1,84	0,31	1,32
u_{1I}	0,26	1,09	0,36	1,52	0,35	1,47	0,23	0,95
w_{1N}	-0,01	-0,05	-0,02	-0,07	-0,02	-0,07	-0,02	-0,08
w_{1L}	-0,04	-0,17	-0,11	-0,48	-0,10	-0,42	-0,07	-0,31
w_{1I}	-0,07	-0,29	-0,14	-0,58	-0,15	-0,62	-0,11	-0,45
Y_1	-0,03	-0,12	-0,04	-0,17	-0,04	-0,16	-0,04	-0,19
Y_{1a}	-0,07	-0,31	-0,10	-0,44	-0,10	-0,42	-0,07	-0,31
$z_I^\star$	-0,17	-0,72	-0,95	-4,13	-1,38	-6,03	-1,08	-4,66
$z_L^\star$	-0,04	-0,16	-0,54	-2,33	-0,43	-1,86	-0,34	-1,45
L	-1,97	-8,38	-2,12	-9,14	-1,08	-4,58	-1,80	-7,72
φ	0,21	0,87	0,21	0,88	0,19	0,80	0,21	0,85
λ	3,61	16,93	3,54	16,67	3,88	17,71	3,68	17,17
L/(L+I+1)	-1,77	-7,58	-1,92	-8,32	-0,90	-3,85	-1,61	-6,93
(L+I) /(L+I+1)	-5,23	-23,81	-5,31	-24,29	-4,73	-21,36	-5,14	-23,38
θ_2	2,31	9,26	1,22	4,82	1,05	4,16	0,44	1,73
u_2	-0,64	-2,57	-0,33	-1,33	-0,29	-1,15	-0,12	-0,48
w_2	-0,11	-0,45	-0,07	-0,28	-0,06	-0,23	-0,05	-0,19
Y_2	0,71	2,90	0,70	2,86	0,63	2,57	0,67	2,75
Y_{2a}	1,10	4,43	0,90	3,64	0,80	3,25	0,72	2,95

Table 5: Legalization (increase in n)
(percentage changes)

	-15% native-immigrant wage gap		*-5% legal-illegal wage gap*		*Double δ_L*		*Reduce the ratio of unemployment to employment income to 0.5*	
I	-10	-50	-10	-50	-10	-50	-10	-50
n	87,26	227,79	90,10	229,45	95,48	237,52	164,85	282,46
θ_1	0,40	1,71	1,32	5,18	0,25	0,96	2,84	6,10
u_{1N}	-0,16	-0,70	-0,54	-2,13	-0,10	-0,39	-1,17	-2,51
u_{1L}	-0,95	-2,69	-1,35	-4,12	-1,15	-3,44	-2,93	-5,09
u_{1I}	1,56	9,44	1,28	8,26	1,87	10,80	3,92	14,94
w_{1N}	0,01	0,03	0,03	0,10	0,00	0,02	0,09	0,20
w_{1L}	0,02	0,11	0,16	0,64	0,03	0,11	0,37	0,80
w_{1I}	-0,10	-0,68	0,13	0,40	-0,15	-0,97	0,12	-0,33
Y_1	0,02	0,08	0,06	0,23	0,01	0,04	0,23	0,49
Y_{1a}	0,05	0,20	0,15	0,59	0,03	0,11	0,38	0,81
$z_I^\star$	7,20	27,50	8,52	31,00	9,32	33,09	38,17	71,90
$z_L^\star$	-0,08	-0,45	0,74	2,73	0,00	-0,12	1,26	2,13
L	21,26	69,47	22,47	70,75	12,96	44,91	55,39	104,48
φ	-0,34	-1,46	-0,38	-1,52	-0,15	-0,59	-1,42	-3,23
λ	12,05	35,52	12,47	35,75	8,33	28,06	22,48	40,93
L/(L+I+1)	20,93	68,06	22,11	69,29	12,83	44,38	54,04	101,38
(L+I) /(L+I+1)	8,36	31,42	9,10	32,40	3,37	12,95	30,31	58,90
θ_2	-3,71	-18,52	-2,10	-9,88	-1,65	-7,68	-4,40	-12,55
u_2	1,02	4,99	0,58	2,69	0,45	2,09	1,20	3,40
w_2	0,17	0,83	0,12	0,55	0,09	0,41	0,47	1,32
Y_2	-1,24	-5,47	-1,31	-5,44	-0,48	-1,98	-4,98	-11,94
Y_{2a}	-1,86	-8,67	-1,65	-7,09	-0,75	-3,26	-5,49	-13,43

Table 6: Take it or leave it offer, Higher search cost (increase in π_I)
(percentage changes)

I	-10	-20	-30	-40	-50	-60	-70	-80	-90
π_I	593.69	659.20	695.90	720.76	739.11	753.34	764.74	774.08	781.86
θ_1	0.29	0.35	0.23	-0.03	-0.39	-0.83	-1.32	-1.84	-2.38
u_{1N}	-0.12	-0.14	-0.10	0.01	0.16	0.34	0.54	0.75	0.97
u_{1L}	-0.04	0.01	0.13	0.30	0.51	0.74	0.99	1.25	1.51
u_{1I}	-0.12	-0.14	-0.09	0.01	0.16	0.33	0.53	0.74	0.95
w_{1N}	0.01	0.01	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.05
w_{1L}	0.03	0.04	0.03	0.00	-0.05	-0.10	-0.15	-0.21	-0.27
w_{1I}	-6.77	-13.49	-20.12	-26.63	-32.98	-39.14	-45.11	-50.85	-56.37
Y_1	0.01	0.01	0.01	-0.01	-0.02	-0.04	-0.06	-0.08	-0.11
Y_{1a}	0.03	0.04	0.02	-0.01	-0.05	-0.10	-0.16	-0.22	-0.28
$z_I^\star$	-9.13	-18.46	-27.95	-37.57	-47.29	-57.10	-66.97	-76.90	-86.86
$z_L^\star$	0.64	1.06	1.30	1.41	1.41	1.32	1.17	0.98	0.75
L	-2.15	-4.18	-6.08	-7.87	-9.53	-11.08	-12.53	-13.88	-15.13
φ	0.21	0.41	0.58	0.74	0.89	1.02	1.14	1.25	1.35
λ	3.52	6.94	10.25	13.45	16.52	19.47	22.29	24.97	27.53
L/(L+I+1)	-1.96	-3.81	-5.54	-7.18	-8.71	-10.14	-11.47	-12.72	-13.88
(L+I) /(L+I+1)	-5.33	-10.46	-15.37	-20.07	-24.54	-28.80	-32.83	-36.65	-40.26
θ_2	5.62	10.24	14.04	17.17	19.73	21.85	23.59	25.02	26.20
u_2	-1.56	-2.85	-3.92	-4.81	-5.55	-6.15	-6.66	-7.07	-7.42
w_2	-0.26	-0.49	-0.68	-0.83	-0.97	-1.08	-1.17	-1.24	-1.31
Y_2	0.78	1.47	2.08	2.62	3.11	3.55	3.94	4.29	4.61
Y_{2a}	1.71	3.15	4.37	5.41	6.31	7.07	7.73	8.31	8.81

Table 7: Take it or leave it offer, Enforcement of deportation (increase in δ_I)
(percentage changes)

I	-10	-20	-30	-40	-50	-60	-70	-80	-90
δ_I	7.55	14.93	22.16	29.25	36.20	43.04	49.76	56.38	62.91
θ_1	-0.92	-1.76	-2.53	-3.23	-3.87	-4.46	-5.00	-5.48	-5.93
u_{1N}	0.38	0.72	1.04	1.32	1.59	1.83	2.04	2.24	2.42
u_{1L}	0.45	0.87	1.25	1.60	1.92	2.22	2.49	2.73	2.96
u_{1I}	1.00	2.00	2.99	3.98	4.98	5.99	7.00	8.03	9.08
w_{1N}	-0.02	-0.03	-0.05	-0.06	-0.07	-0.09	-0.10	-0.11	-0.11
w_{1L}	-0.11	-0.20	-0.29	-0.37	-0.45	-0.51	-0.58	-0.63	-0.68
w_{1I}	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Y_1	-0.04	-0.08	-0.12	-0.15	-0.18	-0.21	-0.23	-0.26	-0.28
Y_{1a}	-0.11	-0.21	-0.30	-0.38	-0.46	-0.53	-0.59	-0.65	-0.70
$z_I^\star$	-3.45	-6.95	-10.52	-14.15	-17.84	-21.58	-25.38	-29.23	-33.13
$z_L^\star$	-0.38	-0.72	-1.04	-1.32	-1.57	-1.80	-2.01	-2.19	-2.36
L	-2.26	-4.37	-6.33	-8.15	-9.85	-11.42	-12.87	-14.21	-15.45
φ	0.21	0.39	0.56	0.72	0.86	0.99	1.11	1.21	1.31
λ	3.20	6.33	9.37	12.32	15.17	17.92	20.56	23.09	25.51
L/(L+I+1)	-2.06	-3.99	-5.78	-7.46	-9.02	-10.47	-11.81	-13.05	-14.19
(L+I) /(L+I+1)	-5.39	-10.57	-15.52	-20.24	-24.74	-29.02	-33.06	-36.89	-40.49
θ_2	2.44	4.72	6.83	8.80	10.63	12.33	13.90	15.36	16.71
u_2	-0.67	-1.30	-1.89	-2.44	-2.96	-3.44	-3.88	-4.30	-4.68
w_2	-0.11	-0.22	-0.32	-0.42	-0.51	-0.59	-0.67	-0.74	-0.81
Y_2	0.74	1.40	2.00	2.53	3.02	3.46	3.85	4.21	4.53
Y_{2a}	1.14	2.18	3.13	3.99	4.77	5.48	6.13	6.72	7.25

Table 8: Take it or leave it offer , Restrictions on entry (decrease in μ_I)
(percentage changes)

I	-10	-20	-30	-40	-50	-60	-70	-80	-90
μ_I	-9.92	-19.86	-29.80	-39.75	-49.71	-59.67	-69.64	-79.61	-89.58
θ_1	-0.98	-1.87	-2.69	-3.43	-4.10	-4.71	-5.26	-5.77	-6.22
u_{1N}	0.40	0.77	1.10	1.40	1.68	1.93	2.15	2.36	2.54
u_{1L}	0.47	0.91	1.31	1.67	2.00	2.31	2.58	2.83	3.06
u_{1I}	0.39	0.75	1.07	1.37	1.64	1.88	2.10	2.30	2.48
w_{1N}	-0.02	-0.04	-0.05	-0.07	-0.08	-0.09	-0.10	-0.11	-0.12
w_{1L}	-0.11	-0.21	-0.31	-0.39	-0.47	-0.54	-0.61	-0.67	-0.72
w_{1I}	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Y_1	-0.04	-0.08	-0.12	-0.15	-0.18	-0.20	-0.23	-0.25	-0.27
Y_{1a}	-0.11	-0.21	-0.31	-0.39	-0.47	-0.54	-0.60	-0.66	-0.71
$z_I^\star$	0.13	0.25	0.36	0.45	0.54	0.62	0.69	0.75	0.81
$z_L^\star$	-0.35	-0.67	-0.96	-1.23	-1.48	-1.70	-1.91	-2.10	-2.27
L	-2.42	-4.66	-6.73	-8.64	-10.40	-12.02	-13.51	-14.88	-16.13
φ	0.22	0.42	0.60	0.76	0.91	1.04	1.16	1.27	1.37
λ	3.41	6.75	10.00	13.16	16.21	19.15	21.98	24.68	27.25
L/(L+I+1)	-2.22	-4.27	-6.18	-7.94	-9.56	-11.06	-12.44	-13.70	-14.86
(L+I) /(L+I+1)	-5.48	-10.74	-15.76	-20.54	-25.10	-29.41	-33.49	-37.35	-40.97
θ_2	3.32	6.27	8.91	11.26	13.36	15.24	16.92	18.43	19.79
u_2	-0.92	-1.74	-2.47	-3.13	-3.73	-4.26	-4.74	-5.17	-5.56
w_2	-0.16	-0.30	-0.42	-0.54	-0.64	-0.74	-0.82	-0.90	-0.97
Y_2	0.76	1.44	2.05	2.60	3.09	3.53	3.93	4.28	4.60
Y_{2a}	1.31	2.48	3.52	4.45	5.28	6.02	6.68	7.28	7.81

Table 9: Take it or leave it offer, Legalization (increase in n)
(percentage changes)

I	-10	-20	-30	-40	-50	-60	-70	-80	-90
n	51.17	87.47	116.20	140.35	161.43	180.33	197.60	213.63	228.67
θ_1	0.07	0.12	0.15	0.17	0.18	0.18	0.16	0.14	0.12
u_{1N}	-0.03	-0.05	-0.06	-0.07	-0.07	-0.07	-0.07	-0.06	-0.05
u_{1L}	-0.41	-0.72	-0.96	-1.14	-1.27	-1.38	-1.46	-1.52	-1.57
u_{1I}	0.80	1.67	2.63	3.66	4.77	5.97	7.27	8.66	10.16
w_{1N}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
w_{1L}	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01
w_{1I}	-0.39	-0.81	-1.27	-1.78	-2.34	-2.96	-3.64	-4.39	-5.22
Y_1	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Y_{1a}	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
$z_I^\star$	-1.07	-2.15	-3.22	-4.30	-5.37	-6.43	-7.48	-8.51	-9.53
$z_L^\star$	0.10	0.19	0.27	0.33	0.39	0.44	0.48	0.52	0.55
L	9.72	17.65	24.20	29.69	34.32	38.25	41.61	44.48	46.95
φ	-0.05	-0.10	-0.14	-0.17	-0.19	-0.21	-0.23	-0.24	-0.25
λ	7.98	14.50	19.90	24.45	28.32	31.64	34.52	37.02	39.22
L/(L+I+1)	9.66	17.54	24.06	29.51	34.12	38.02	41.36	44.22	46.68
(L+I) /(L+I+1)	1.46	2.69	3.71	4.56	5.26	5.83	6.28	6.64	6.91
θ_2	0.72	1.43	2.12	2.80	3.46	4.09	4.71	5.30	5.87
u_2	-0.20	-0.39	-0.59	-0.77	-0.95	-1.13	-1.30	-1.47	-1.62
w_2	-0.03	-0.07	-0.10	-0.13	-0.16	-0.19	-0.22	-0.25	-0.28
Y_2	-0.19	-0.34	-0.47	-0.58	-0.67	-0.74	-0.80	-0.84	-0.87
Y_{2a}	-0.06	-0.10	-0.12	-0.12	-0.10	-0.06	-0.02	0.04	0.10

Figures

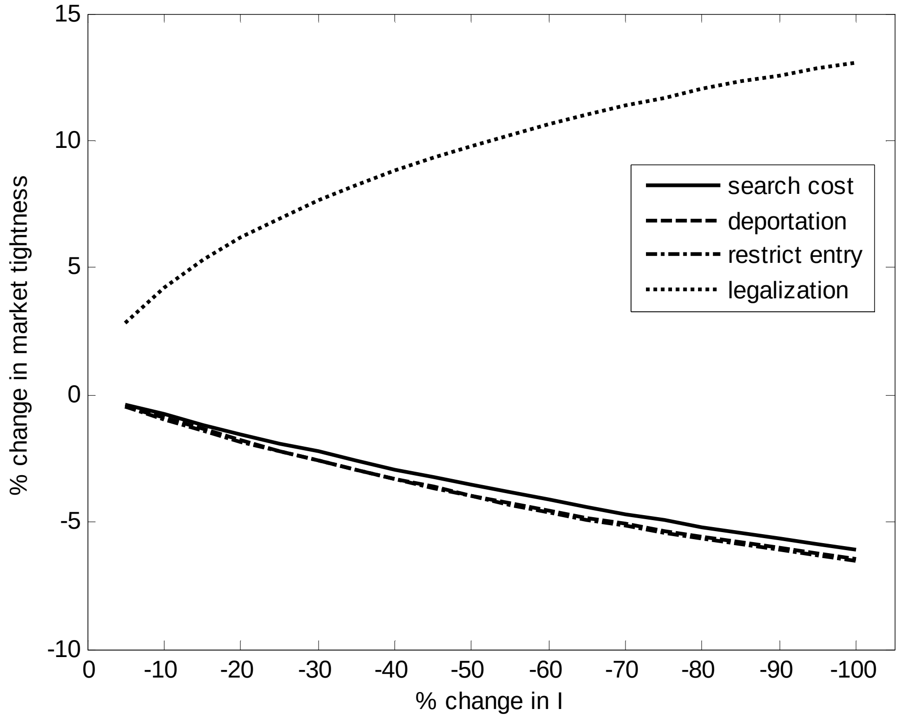


Figure 1: Effects on market tightness

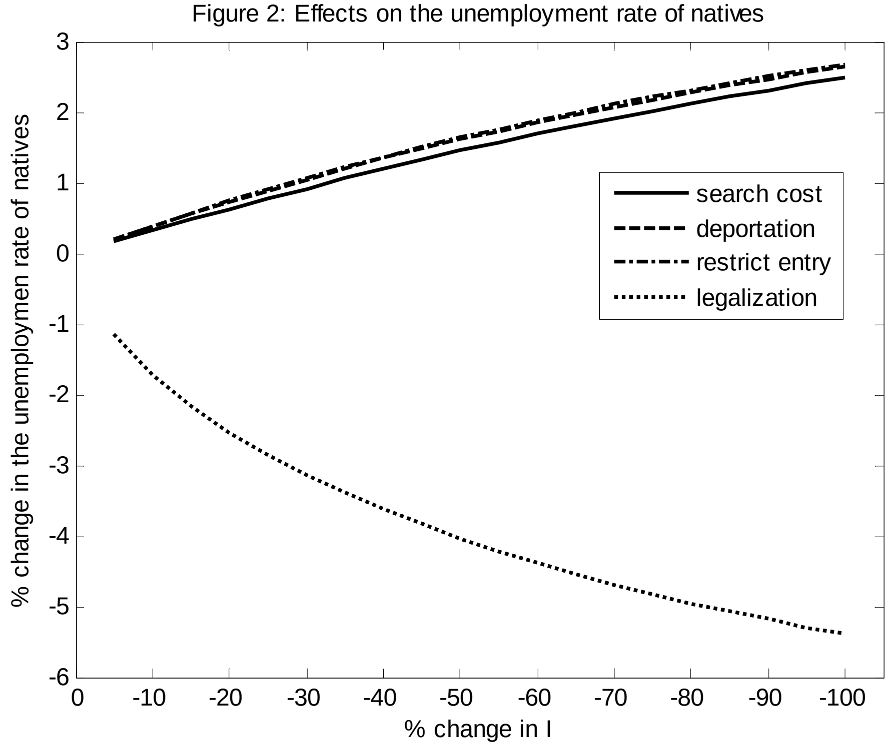


Figure 2: Effects on the unemployment rate of natives

Figure 3: Effects on the wage of natives

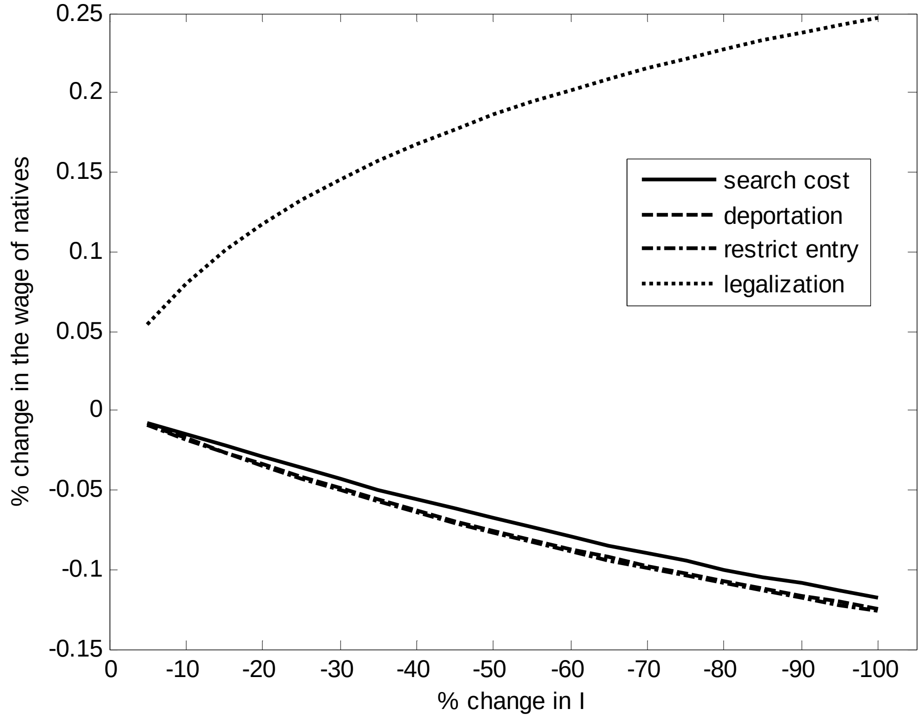


Figure 4: Effects on the wage of legal immigrants

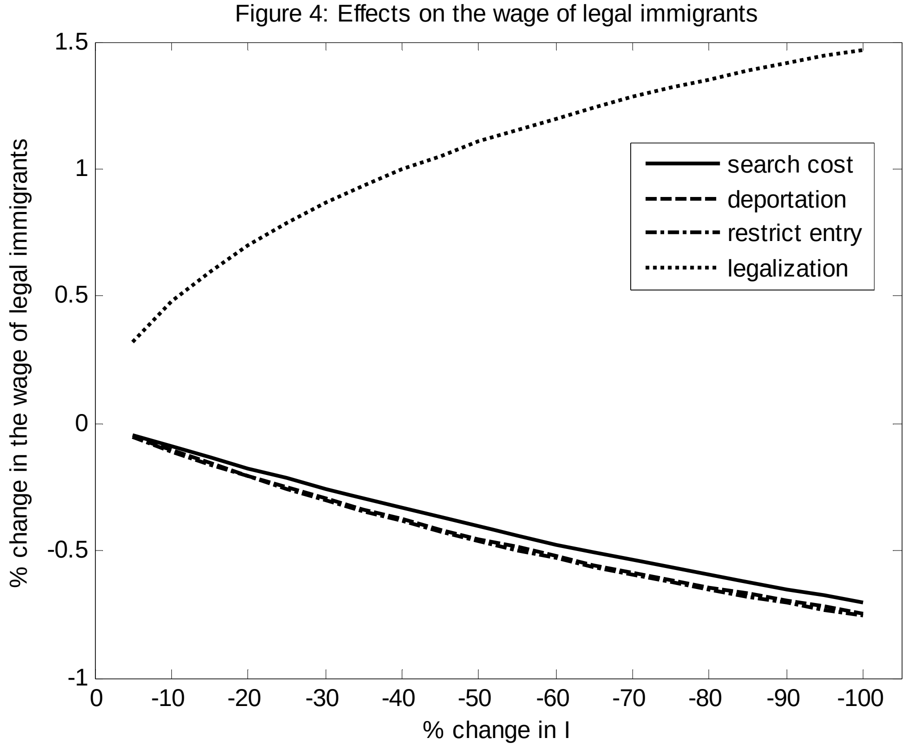


Figure 5: Effects on the wage of illegal immigrants

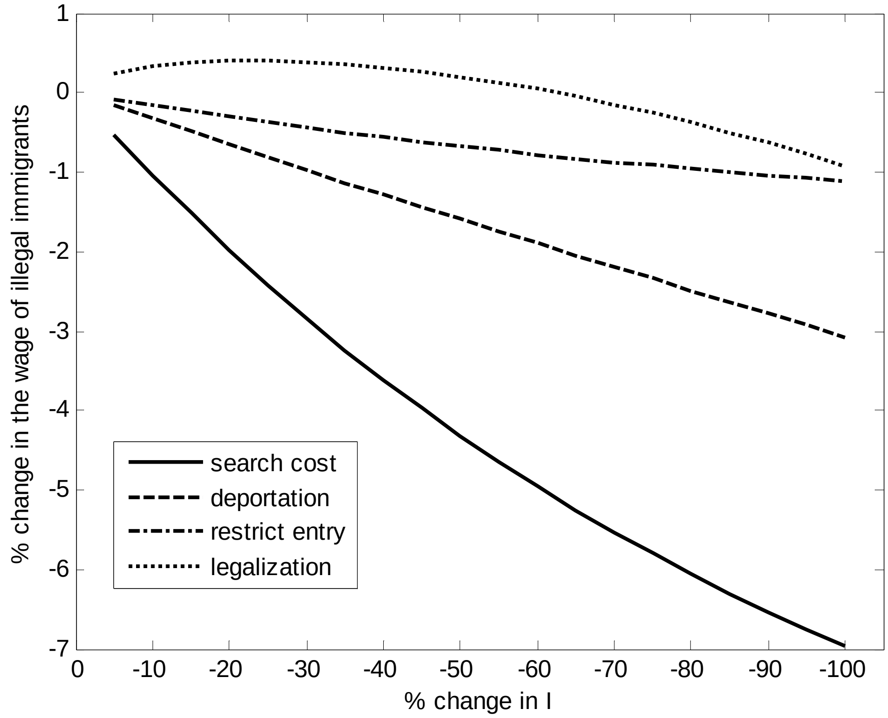


Figure 6: Effects on the net income of native workers

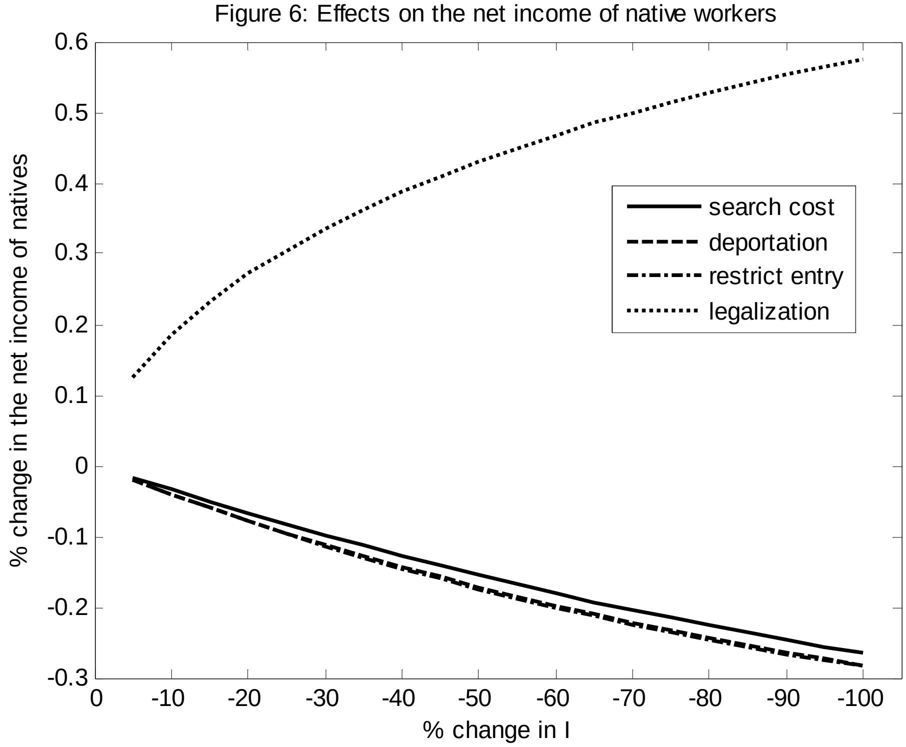


Figure 7: Effects on the net income of native workers (Y1a)

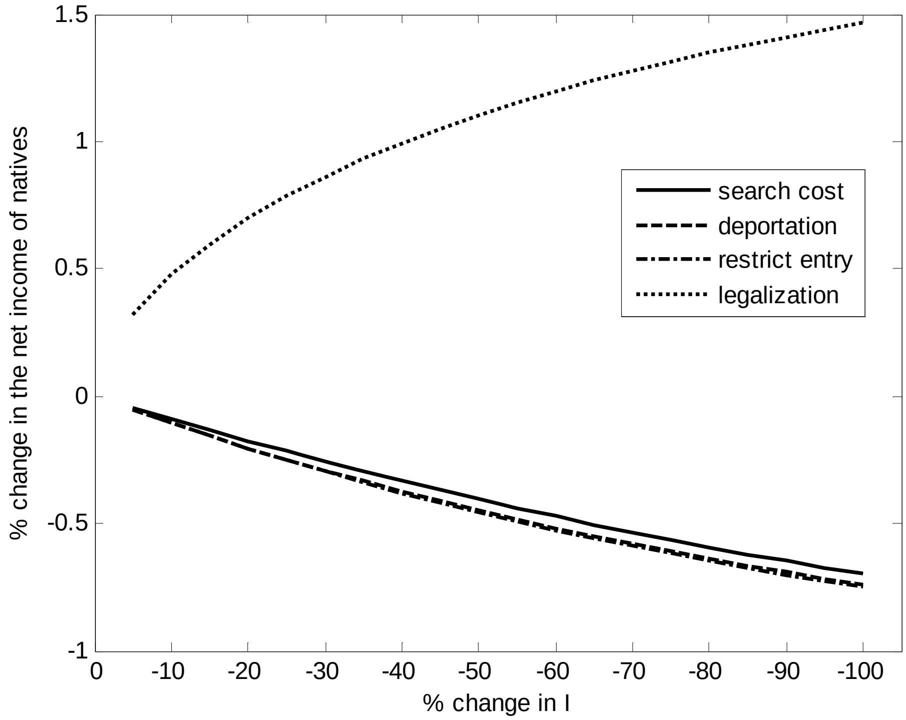


Figure 8: Effects on total immigrants as a share of population of country 1

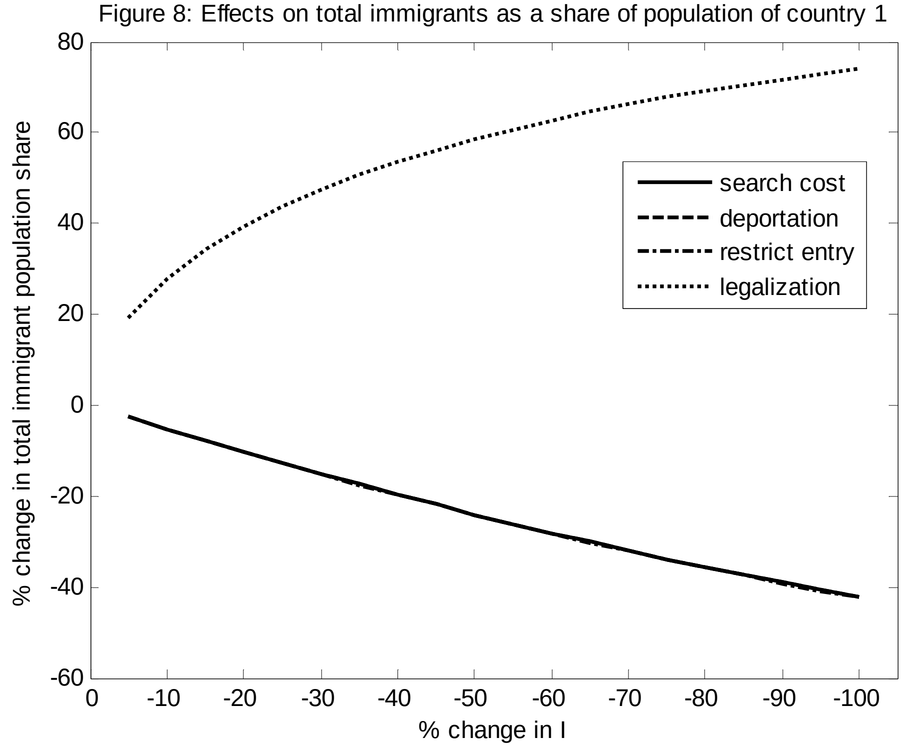
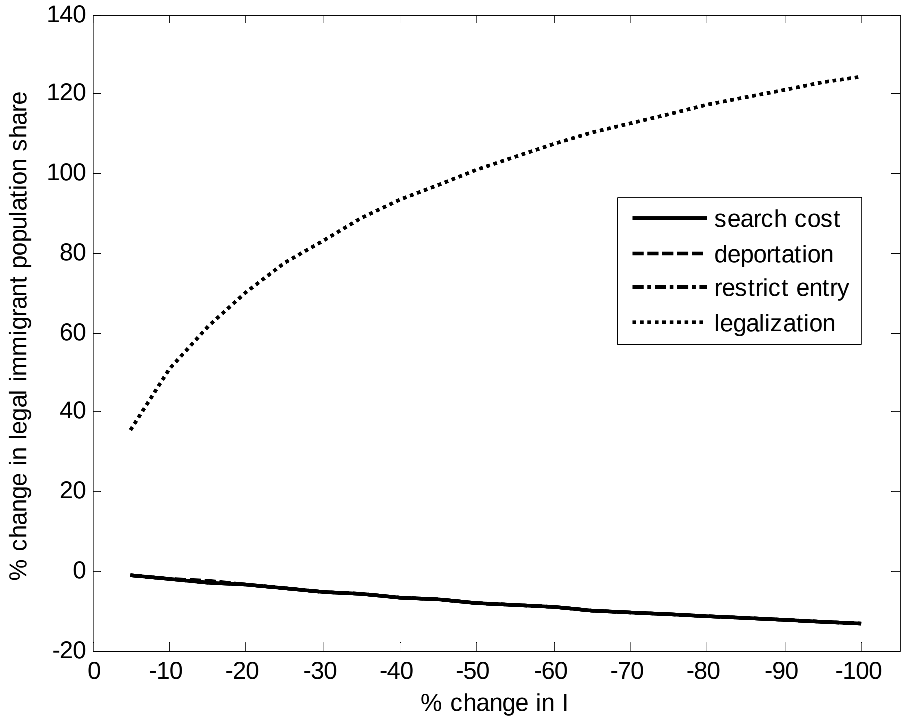


Figure 9: Effects on legal immigrants as a share of population of country 1



Appendix of Tables

Table A1: Higher search cost (increase in π_I)
(percentage changes)

I	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
π_I	1,06	2,05	2,98	3,84	4,64	5,40	6,10	6,76	7,37	7,95
Country 1										
θ_1	-0,39	-0,78	-1,16	-1,53	-1,89	-2,24	-2,58	-2,91	-3,23	-3,54
Unemployment rates										
u_{1N}	0,16	0,32	0,48	0,63	0,77	0,92	1,06	1,19	1,32	1,45
u_{1L}	0,20	0,40	0,59	0,78	0,96	1,14	1,31	1,47	1,63	1,79
u_{1I}	0,16	0,31	0,46	0,61	0,76	0,90	1,03	1,16	1,29	1,42
Wages										
w_{1N}	-0,01	-0,01	-0,02	-0,03	-0,04	-0,04	-0,05	-0,06	-0,06	-0,07
w_{1L}	-0,05	-0,09	-0,13	-0,18	-0,22	-0,26	-0,30	-0,33	-0,37	-0,41
w_{1I}	-0,53	-1,04	-1,52	-1,98	-2,42	-2,84	-3,24	-3,62	-3,98	-4,32
Net output										
Y_1	-0,02	-0,03	-0,05	-0,07	-0,08	-0,10	-0,11	-0,13	-0,14	-0,15
Y_{1a}	-0,04	-0,09	-0,13	-0,17	-0,22	-0,26	-0,29	-0,33	-0,37	-0,40
Legal immigration and composition										
$z_I^\star$	-5,13	-10,26	-15,39	-20,52	-25,65	-30,79	-35,92	-41,05	-46,18	-51,31
$z_L^\star$	-0,16	-0,33	-0,50	-0,67	-0,83	-1,00	-1,17	-1,33	-1,50	-1,66
L	-1,03	-2,03	-2,98	-3,90	-4,79	-5,64	-6,45	-7,24	-7,99	-8,71
φ	0,11	0,21	0,31	0,40	0,49	0,58	0,66	0,73	0,81	0,87
λ	1,80	3,58	5,33	7,06	8,76	10,43	12,08	13,69	15,27	16,82
Country 2										
θ_2	0,81	1,54	2,20	2,80	3,34	3,83	4,27	4,67	5,04	5,37
u_2	-0,22	-0,42	-0,61	-0,77	-0,92	-1,06	-1,18	-1,29	-1,39	-1,48
w_2	-0,05	-0,09	-0,13	-0,16	-0,20	-0,22	-0,25	-0,27	-0,30	-0,32
Y_2	0,36	0,70	1,02	1,32	1,61	1,88	2,14	2,39	2,62	2,84
Y_{2a}	0,49	0,95	1,38	1,78	2,15	2,50	2,83	3,14	3,43	3,71

Table A2: Increased rates of deportation (increase in δ_I)
(percentage changes)

I	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
δ_I	2,74	5,45	8,12	10,76	13,37	15,95	18,49	21,01	23,49	25,95
Country 1										
θ_1	-0,47	-0,93	-1,36	-1,78	-2,18	-2,56	-2,93	-3,28	-3,61	-3,93
Unemployment rates										
u_{1N}	0,19	0,38	0,56	0,73	0,89	1,05	1,20	1,34	1,48	1,61
u_{1L}	0,23	0,46	0,67	0,88	1,08	1,27	1,45	1,63	1,79	1,95
u_{1I}	0,41	0,82	1,23	1,63	2,02	2,41	2,79	3,17	3,55	3,92
Wages										
w_{1N}	-0,01	-0,02	-0,03	-0,03	-0,04	-0,05	-0,06	-0,06	-0,07	-0,08
w_{1L}	-0,05	-0,11	-0,16	-0,20	-0,25	-0,29	-0,34	-0,38	-0,42	-0,45
w_{1I}	-0,17	-0,33	-0,49	-0,65	-0,81	-0,97	-1,13	-1,29	-1,44	-1,59
Net output										
Y_1	-0,02	-0,04	-0,06	-0,08	-0,10	-0,11	-0,13	-0,14	-0,16	-0,17
Y_{1a}	-0,05	-0,11	-0,16	-0,20	-0,25	-0,29	-0,33	-0,37	-0,41	-0,45
Legal immigration and composition										
$z_I^\star$	-2,83	-5,68	-8,53	-11,40	-14,28	-17,17	-20,07	-22,99	-25,92	-28,86
$z_L^\star$	-0,24	-0,48	-0,70	-0,92	-1,13	-1,33	-1,52	-1,71	-1,89	-2,06
L	-1,03	-2,02	-2,97	-3,89	-4,77	-5,62	-6,44	-7,23	-7,98	-8,70
φ	0,10	0,20	0,30	0,39	0,47	0,56	0,63	0,71	0,78	0,85
λ	1,70	3,39	5,05	6,69	8,30	9,89	11,46	12,99	14,50	15,98
Country 2										
θ_2	0,49	0,96	1,40	1,82	2,21	2,58	2,94	3,27	3,59	3,89
u_2	-0,14	-0,26	-0,39	-0,50	-0,61	-0,71	-0,81	-0,90	-0,99	-1,07
w_2	-0,03	-0,06	-0,08	-0,11	-0,13	-0,15	-0,17	-0,19	-0,21	-0,23
Y_2	0,35	0,69	1,01	1,31	1,60	1,87	2,13	2,37	2,60	2,83
Y_{2a}	0,43	0,85	1,24	1,61	1,96	2,29	2,61	2,90	3,19	3,46

Table A3: Increased border control (entry restrictions) (decrease in μ_I)
(percentage changes)

I	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
μ_I	-4,47	-8,96	-13,47	-17,98	-22,51	-27,06	-31,62	-36,20	-40,79	-45,39
Country 1										
θ_1	-0,48	-0,95	-1,39	-1,81	-2,22	-2,61	-2,98	-3,33	-3,67	-4,00
Unemployment rates										
u_{1N}	0,20	0,39	0,57	0,74	0,91	1,07	1,22	1,37	1,50	1,64
u_{1L}	0,24	0,46	0,68	0,89	1,09	1,28	1,47	1,64	1,81	1,97
u_{1I}	0,19	0,38	0,56	0,73	0,89	1,04	1,19	1,33	1,47	1,60
Wages										
w_{1N}	-0,01	-0,02	-0,03	-0,03	-0,04	-0,05	-0,06	-0,06	-0,07	-0,08
w_{1L}	-0,06	-0,11	-0,16	-0,21	-0,25	-0,30	-0,34	-0,38	-0,42	-0,46
w_{1I}	-0,08	-0,16	-0,23	-0,31	-0,37	-0,44	-0,50	-0,56	-0,62	-0,68
Net output										
Y_1	-0,02	-0,04	-0,06	-0,08	-0,10	-0,11	-0,13	-0,14	-0,16	-0,17
Y_{1a}	-0,05	-0,11	-0,16	-0,21	-0,25	-0,30	-0,34	-0,38	-0,42	-0,46
Legal immigration and composition										
$z_I^{\star}$	-0,73	-1,44	-2,13	-2,80	-3,44	-4,06	-4,66	-5,23	-5,79	-6,32
$z_L^{\star}$	-0,25	-0,48	-0,71	-0,94	-1,15	-1,35	-1,55	-1,74	-1,92	-2,09
L	-1,04	-2,03	-2,99	-3,91	-4,80	-5,65	-6,47	-7,26	-8,02	-8,74
φ	0,11	0,21	0,31	0,40	0,49	0,58	0,66	0,73	0,81	0,88
λ	1,80	3,58	5,33	7,06	8,76	10,43	12,07	13,68	15,26	16,81
Country 2										
θ_2	0,51	0,99	1,45	1,87	2,26	2,64	2,98	3,31	3,62	3,91
u_2	-0,14	-0,27	-0,40	-0,51	-0,62	-0,73	-0,82	-0,91	-1,00	-1,08
w_2	-0,03	-0,06	-0,08	-0,11	-0,13	-0,15	-0,17	-0,19	-0,21	-0,23
Y_2	0,35	0,69	1,01	1,31	1,60	1,87	2,13	2,37	2,61	2,83
Y_{2a}	0,44	0,85	1,25	1,62	1,97	2,30	2,62	2,91	3,20	3,46

Table A4: Legalization (increase in n)
(percentage changes)

I	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
n	119,11	156,69	182,16	202,13	218,88	233,52	246,65	258,64	269,75	280,15
	Country 1									
θ_1	2,82	4,21	5,28	6,17	6,95	7,63	8,25	8,81	9,32	9,79
Unemployment rates										
u_{1N}	-1,16	-1,73	-2,17	-2,54	-2,86	-3,14	-3,39	-3,63	-3,84	-4,03
u_{1L}	-2,38	-3,37	-4,05	-4,60	-5,04	-5,42	-5,76	-6,05	-6,31	-6,54
u_{1I}	1,68	2,90	4,08	5,27	6,49	7,74	9,03	10,36	11,73	13,15
Wages										
w_{1N}	0,05	0,08	0,10	0,12	0,13	0,15	0,16	0,17	0,18	0,19
w_{1L}	0,32	0,48	0,60	0,70	0,79	0,86	0,93	1,00	1,05	1,11
w_{1I}	0,24	0,33	0,38	0,40	0,40	0,38	0,35	0,31	0,26	0,20
Net output										
Y_1	0,12	0,18	0,23	0,27	0,31	0,34	0,36	0,39	0,41	0,43
Y_{1a}	0,32	0,48	0,60	0,70	0,79	0,86	0,93	0,99	1,05	1,10
Legal immigration and composition										
$z_I^\star$	23,16	33,16	40,31	45,98	50,70	54,75	58,29	61,42	64,23	66,76
$z_L^\star$	1,23	1,78	2,17	2,48	2,74	2,95	3,13	3,29	3,43	3,55
L	36,07	51,88	63,17	72,06	79,43	85,71	91,16	95,97	100,26	104,11
φ	-0,85	-1,29	-1,64	-1,94	-2,20	-2,44	-2,66	-2,86	-3,04	-3,21
λ	15,15	21,54	25,98	29,38	32,14	34,44	36,41	38,11	39,60	40,92
Country 2										
θ_2	-5,07	-8,15	-10,80	-13,22	-15,50	-17,65	-19,71	-21,69	-23,59	-25,42
u_2	1,39	2,22	2,93	3,58	4,19	4,76	5,30	5,82	6,31	6,79
w_2	0,29	0,46	0,61	0,74	0,86	0,98	1,08	1,19	1,28	1,38
Y_2	-2,95	-4,55	-5,85	-6,97	-7,98	-8,90	-9,75	-10,54	-11,28	-11,98
Y_{2a}	-3,79	-5,90	-7,65	-9,18	-10,58	-11,87	-13,09	-14,22	-15,30	-16,33

Table A5: Legalization and increased border control (increase in n and decrease in μ_I) (percentage changes)

I	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100
n	41,44	73,27	99,60	122,38	142,67	161,15	178,24	194,24	209,38	223,81
μ_I	-8,46	-16,64	-24,51	-32,06	-39,28	-46,17	-52,72	-58,94	-64,82	-70,37
Country 1										
θ_1	-0,22	-0,43	-0,61	-0,78	-0,93	-1,07	-1,19	-1,31	-1,41	-1,50
Unemployment rates										
u_{1N}	0,09	0,18	0,25	0,32	0,38	0,44	0,49	0,54	0,58	0,62
u_{1L}	-0,20	-0,34	-0,44	-0,52	-0,58	-0,63	-0,66	-0,68	-0,70	-0,71
u_{1I}	0,73	1,51	2,34	3,24	4,21	5,25	6,37	7,58	8,89	10,29
Wages										
w_{1N}	0,00	-0,01	-0,01	-0,01	-0,02	-0,02	-0,02	-0,03	-0,03	-0,03
w_{1L}	-0,03	-0,05	-0,07	-0,09	-0,11	-0,12	-0,14	-0,15	-0,16	-0,17
w_{1I}	-0,09	-0,18	-0,27	-0,37	-0,47	-0,58	-0,69	-0,81	-0,94	-1,07
Net output										
Y_1	-0,01	-0,02	-0,03	-0,03	-0,04	-0,04	-0,05	-0,05	-0,06	-0,06
Y_{1a}	-0,03	-0,05	-0,07	-0,09	-0,10	-0,12	-0,13	-0,15	-0,16	-0,17
Legal immigration and composition										
$z_I^\star$	5,06	10,04	14,92	19,68	24,31	28,78	33,09	37,22	41,18	44,95
$z_L^\star$	-0,15	-0,28	-0,41	-0,53	-0,64	-0,74	-0,83	-0,92	-1,00	-1,08
L	7,21	13,32	18,54	23,03	26,94	30,34	33,33	35,95	38,27	40,32
φ	0,01	0,01	0,02	0,02	0,02	0,03	0,03	0,03	0,04	0,04
λ	7,07	13,09	18,25	22,71	26,59	29,99	32,97	35,60	37,93	40,00
L/(L+I+1)	7,21	13,32	18,54	23,03	26,94	30,34	33,33	35,95	38,27	40,32
(L+I) /(L+I+1)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Country 2										
θ_2	-0,10	-0,22	-0,34	-0,49	-0,64	-0,80	-0,96	-1,14	-1,31	-1,49
u_2	0,03	0,06	0,09	0,13	0,18	0,22	0,26	0,31	0,36	0,41
w_2	0,01	0,01	0,02	0,03	0,04	0,05	0,06	0,07	0,08	0,09
Y_2	0,00	0,00	0,00	0,00	-0,01	-0,01	-0,01	-0,01	-0,01	-0,02
Y_{2a}	-0,02	-0,04	-0,06	-0,08	-0,11	-0,14	-0,17	-0,20	-0,23	-0,26