THE ECONOMIC EFFECT OF IMMIGRATION POLICIES: ANALYZING AND SIMULATING THE U.S. CASE

Andri Chassamboulli
Giovanni Peri

WORKING PAPER 25074

NBER WORKING PAPER SERIES

THE ECONOMIC EFFECT OF IMMIGRATION POLICIES: ANALYZING AND SIMULATING THE U.S. CASE

Andri Chassamboulli
Giovanni Peri

Working Paper 25074
http://www.nber.org/papers/w25074

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2018

The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2018 by Andri Chassamboulli and Giovanni Peri. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

The Economic Effect of Immigration Policies: Analyzing and Simulating the U.S. Case
Andri Chassamboulli and Giovanni Peri
NBER Working Paper No. 25074
September 2018
JEL No. E24,F22,J64

ABSTRACT

In this paper we analyze the economic effects of changing immigration policies in a realistic institutional set-up, using a search model calibrated to the migrant flows between the US and the rest of the world. We explicitly differentiate among the most relevant channels of entry of immigrants to the US: family-based, employment-based and undocumented. Moreover we explicitly account for earning incentives to migrate and for the role of immigrant networks in generating job-related and family-related immigration opportunities. Hence, we can analyze the effect of policy changes in each channel, accounting for the response of immigrants in general equilibrium. We find that all types of immigrants generate higher surplus for US firms relative to natives, hence restricting their entry has a depressing effect on job creation and, in turn, on native labor markets. We also show that substituting a family-based entry with an employment-based entry system, and maintaining the total inflow of immigrants unchanged, job creation and natives' income increase.

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

How would different immigration policies impact the US economy? This is an important and much debated question. Economists have adopted, so far, very simplified models to evaluate the consequences of changing immigration policies on the national economy and labor markets. Usually they have analyzed the consequences of a change in the number and composition of foreign-born as a shift in supply within a neoclassical model (e.g. Ottaviano and Peri 2012, or Llull 2017). Actual policies, however, are provisions changing the conditions of entry of specific immigration channels and the degree of enforcement of those conditions. The number of immigrants and their composition are themselves equilibrium outcomes of these policies. To evaluate the effect of a policy change on immigration flows, and in turn of these flows on the economy, one has to account for the impact of policies on current and future incentives and potential for immigration. Models that produce quantitative assessments of the impact of immigration on labor markets and other economic outcomes, have usually neglected the analysis of specific policies and the general equilibrium effects accounting for networks and incentives. To do this one has to model networks of job referrals and family unification opportunities, which may create the conditions for the so called "chain migration effects". Analyzing and simulating how specific policies, affect each channel of entry in the US and, in turn, long-run immigration flows and native labor markets and welfare is the goal of this paper.

Sometimes small changes in immigration laws have had large long-run equilibrium effects. Through networks and family linkage effects they may increase substantially the immigration opportunities in the future. For instance, the Immigration and Naturalization act of 1965, supposed to be a small change that could preserve immigrant composition while abolishing quotas, ushered a family-based immigration system in the US, and over time, through family ties, allowed the largest increase in immigrants in the US as immigration networks increased the probability of foreigners to move to the US for family and work related reasons. Similarly the high tolerance for undocumented immigrants in the 1990's which allowed in the US a large number of undocumented foreign workers, may have deeply affected the economy of entire sectors also affecting subsequent immigration opportunities.

The U.S. federal Government does not control directly the number of immigrants entering or staying in the country. Instead, it sets rules about their entry and their opportunities to remain and it decide the intensity of enforcement of these rules. Immigration policies are not usually quotas, but rather they specify different tracks of entry and different conditions for staying in the country. These rules, together with the incentives of immigrants and the effectiveness of their enforcement, generate the observed number of immigrants. While it will be impossible to mirror the intricacy and complexities of the US immigration system, our model aims at capturing with some degree of quantitative accuracy, the main avenues of entry and stay in the US. Very few economic studies have incorporated the important interplay between realistic immigration policies, immigrants' economic incentives and the role of immigrant networks in analyzing the inflow of immigrants and their labor market effects as equilibrium outcomes. This paper begins to fill that gap.

We develop a two-country economy that represents the US and the rest of the World, and we model in detail each of three main ways of entry: Family, Employment and Undocumented immigration. The opportunities for legal entry through each specific channel, are affected by policies and by the existing networks (of family or of potential co-workers). Similarly illegal entry is affected by the degree of enforcement. A change in one policy will change entry through that channel but also the size of the immigrant network with consequences on the opportunity for entry of others. Importantly, in order to capture key features of the labor market composition, we separate high (college-educated) and low (non college educated) skilled immigrants as participating in different labor markets, and we consider their different opportunities for entry.

To reflect the current immigration system in the US we assume that the employment route for legal entry is only available to highly skilled, the family route is available to skilled and unskilled, in proportion of the existing family ties, and the illegal route is pursued only by less skilled. We represent the labor market with a search and matching model, which implies that firms post vacancies for skilled and unskilled workers and workers search for jobs. Native and immigrants fill those vacancies and, as they have different outside options this reflects on their bargaining power and they are paid different wages. Finally, we model the incentives to migrate so that changes in the wage and unemployment conditions in the US will affect the incentives to move: higher wages and lower unemployment conditions would attract more immigrants. To mirror the US experience in 1990-2015 we choose parameters that reflect the fact that during that period Mexico was the most relevant country supplying low skilled immigrants and Asia (especially China and India) was the most relevant source region for high skilled immigrants.

We solve the model accounting for a rich structure of the labor markets which includes the following type of agents: high and low skilled natives, high and low skilled immigrants who enter through one of three different routes (family, employment and illegal). We then calibrate the model to the aggregate labor market- and policy statistics for the US and its relevant migration partners for the average of 1990-2015. We use such an equilibrium as starting point to simulate alternative policy scenarios. By capturing these important aspects of the labor market and of immigrant entry, this model allows us three insights into the effect of different policies that would not be present in models based on the canonical labor demand and supply and policy-controlled inflow of immigrants. First, as immigrants, especially temporary (skilled) and undocumented (unskilled), have worse outside job options than natives, they will earn lower wages in equilibrium. Hence a higher number of them increases the expected firm surplus from a match. This, in turn, generates more job creation in the relevant skill market, and tighter labor markets. This will benefit employment of natives, so that an increase in undocumented and of "employment channel" immigrants, generally produces lower unemployment for skilled and unskilled native workers. This job creation channel may attenuate or even reverse the prediction from a pure supply/demand model. Second, while the family route allows unskilled workers it also generates family opportunities for high skilled immigrants who come to the US to be employed. High-skilled have larger incentives to migrate and also generate "network" opportuntities for other high skilled through on the job referrals. Hence, in the long run, family reunification policies in the US have only a marginally smaller effect in increasing skilled/unskilled ratio vis-a-vis employment-based policies. Third, the job creation effect of immigrants from any entry route (family, employment and illegal) are beneficial to natives. Undocumented and family immigrants produce large surplus to firms because they are paid a lower wage than natives. High skilled immigrants because they are more productive. Both effects encourage job creation. If the overall immigration policies are balanced, allowing workers to enter from each channel so as to have a balanced entry of skilled and unskilled then natives, skilled and unskilled, will be better off in terms of unemployment (lower) and wages (higher). The corollary to this is that restrictive immigration policies will have depressing effects on native labor market conditions.

An appealing innovation of this paper is that we can illustrate the impact on native wages and unemployment from changing one channel of entry at the time. For instance we can modify the approval rate of family admissions, so as to increase the number of family immigrants by 10% or 50%, leaving the other policies (relative to other channels of entry) unchanged. We can then analyze what would happen in equilibrium to the inflow of other groups of immigrants (also indirectly affected by incentives and networks) and to wages and unemployment of natives. We will also use the model to evaluate the labor market effects of some actual policy proposals of the last decade. One is the plan to reduce by 50% the family reunification immigrants (which captures the main provision of the RAISE act proposed in 2017 in the U.S. Senate). Another is the substantial increase in deportation rates to reduce (by 10 or 50%) the population of undocumented immigrants (this reflects the end of the DACA program and the explicit goal of the Trump administration to increased intensity of deportations of undocumented). We can also analyze the plan to reduce the most prominent temporary visa program, the H1B, (which is under scrutiny and several bill proposed in the House in 2017, aimed at making more restrictive). This would imply a smaller number of temporary (and then in equilibrium permanent) high skilled employment immigrants. Our model will provide estimates of the potential effects of these measures on US labor markets, specifically on wage and unemployment rates of natives and immigrants.

The rest of the paper proceeds as follows. Section 2 reviews the relevant papers in the literature and details the innovative content of this paper relative to those. Section 3 describes the main components of the model, describes its working and the equilibrium conditions and provide an intuition of its key mechanisms, with a focus on incentive to immigration and to the working of the labor market. Section 4 describes the calibration and parameterization of the Model, targeting the US as home country and Mexico/Asia as foreign country, using as steady state the years 2010-2015. Section 5 describes some specific simulations of policies that change the tightness of each entry mechanisms and allow us to discuss the channels at work. Then we also simulate the effects of combining changes in more than one channel to shift the composition of immigrants and keep the total number of immigrants constant. Section 7 provides some concluding remarks.

2 Literature Review

This paper contributes to the literature that analyzes the effects of changes in immigration policies on Labor Market outcomes of natives in the US. The novelty of the paper is that we develop a labor market model that allows for the analysis of different channels of entry of immigrants and that we account for the incentive and network effects on immigrants.The basic structure of the model builds on Chassamboulli and Peri (2017), and Chassamboulli and Palivos (2015), but it enriches those models, significantly, by featuring a fully developed 2-country equilibrium model and a much richer set of channels of immigration. We also add jobs that can be filled directly with referrals from existing workers, on top of jobs that are filled through the usual search process after opening a vacancy.

There are several papers analyzing the economic effect of immigrants in the US (see Lewis and Peri 2015 and Peri 2016 for overview of the literature). These papers are, however, mostly empirically focussed and they identify a portion of the total inflow of immigrants to the US as exogenous and they track and analyze its effects on the US labor markets. Recently, some papers have analyzed in a general equilibrium framework the impact of high skilled immigrants, admitted through the H1B program, on growth and labor markets in the US. Notably Bound et al. 2017 and Jaimovich and Siu 2017 focus on the fact that highly skilled immigrants have a high propensity to specialize in science and technology and this has a strong impact on innovation and economic growth in the long run. Basso et al. (2017) develop an equilibrium model that analyzes the interaction of technological change and immigration, incorporating the endogeneity of immigrants inflows to technological growth. Battisti et al. (2017) use a search model to examine the effect of changes in high skilled and low skilled immigrants on labor market and fiscal transfers in European countries.

Relative to those papers this study is the first to account for the response of immigrants to earning incentives, the role of networks in facilitating future immigration flows via family and job referrals and the existence of several types of entry avenues (family permits, employment permits and undocumented entry) when evaluating the economic effects of immigration. Empirical papers on the determinants of international migrations have studied the impact of wage and unemployment differentials on migration flows across countries (e.g. Grogger and Hanson 2011). However, paper focussing on the impact of immigration on the receiving country economy have usually neglected this "feedback channel" as less relevant. In our analysis we account for the indirect effect of migration policies on immigration incentives, through labor market variables. Similarly, several studies have emphasized the importance of networks in producing persistence in immigration flows (e.g. Munshi 2003; Hanson et al. 2017). None of them, however, has separately analyzed the role of family reunification and jobs referrals as channels contributing to such persistence. Recently, the labor literature has recognized the role of referrals in hiring and its implication for labor markets (e.g. Calvo-Armengol and Zenou, 2005, Fontaine, 2008, Galenianos, 2013, 2014, Horvath, 2014). We are the first to explicitly incorporate the "referral" channel of hiring in the immigration literature.

One of the contributions of this paper is to explicitly consider the differences in immigrant skills, associated to each channel of entry. Due to legal restrictions immigrants entering through different channels are quite different in skills. This affects their impact on labor markets. We are only aware of few studies (e.g. Hunt 2011) relating the economic performance of immigrants to their channel of entry. However, from a policy perspective this is a very relevant question: changing the costs and opportunities of entry for each channel affects immigrants' composition and hence their labor markets effects. While there is an extensive literature on selection and sorting of migrants across skills (e.g. Grogger and Hanson 2013; Ortega and Peri 2012) and some papers specifically analyze the sorting of immigrants to the US (e.g., Huertas-Moraga 2011; Kastner and Malamoud 2017) those studies do not relate selection to the type of entry channels and hence they do not relate sorting directly to policy.

Finally, recently there have been empirical studies looking at the effect of specific immigration policies on US economic outcomes. Examples are Kerr and Lincoln (2010) and Mayda et al (2018) who look at the change in quota for the H1B visa policy, Pope (2017) who analyzes the effect of DACA (Deferred Action for Childhood Arrival) and Clemens et al (2018) analyzing the effects of the end of a temporary visa program (the Bracero program). Those papers, while careful on identification, have a very specific goal of evaluating the immediate effect of one policy and their results are therefore hard to generalize. Moreover as they are empirical papers their framework cannot be used to simulate or predict the effect of other policies. Our contribution is to provide a flexible model that can be used to gain insight and simulate a relatively large set of immigration policies.

3 Model

We describe here the main features of the model. We consider two countries: country 1 (the US) and country 2 (the rest of the world). Country 1 has higher wages and better employment opportunities relative to country 2. Hence, some workers have incentives to migrate from country 2 to country 1 to increase their income. No worker has incentives to migrate from country 1 to country 2. The size of the native labor force of country 1 (indicated as N) is normalized to 1 and it is divided into two types of workers: skilled in measure of S and unskilled in measure of $1 - S$. Individuals born in country 2 are, instead, of measure X and are also divided into skilled and unskilled workers in measure of X_s and X_u, respectively. Individuals from either country enter and exit the labor force at rate τ, so that the overall size of the labor force (native of country 1 and 2) remains constant. New individuals enter the labor force as unemployed. All agents are risk neutral and discount the future at a common rate $r > 0$, equal to the interest rate. Time is continuous.

The natives of country 2 can find opportunities to enter, reside and work legally in country 1 through two channels. First, through family reunification laws that allow lawful permanent residents of country 1 to sponsor their immediate relatives for immigration to country 1. In particular, a native of country 2 can enter into country 1 on a family visa, if one of his/her immediate family members is a legal immigrant of country 1. Second, it is possible to enter on an employment visa. To be qualified for an employment visa an individual must have a job offer in country 1. Such job offers are made available to the natives of country 2 through referrals from their network of contacts who are lawful permanent residents of country 1. Employment visas, as opposed to family visas, are targeted towards aliens with certain skills, because they are meant to fill specific skill gaps. We account for the fact that in country 1, which we take to be the US, employment visas are mainly targeted towards foreigners with high abilities and professional skills. We therefore assume that entry through employment is only available to the skilled natives of country 2, whereas, entry through family ties is available to both skilled and unskilled.

Besides legal, migration to country 1 can also be illegal/unauthorized. Opportunities for illegal migration arise as "random events" occurring at rate x_I, for the unskilled natives of country 2. Skilled individuals typically face fewer restrictions on legal entry channels and presumably relatively larger payoff, compared to unskilled individuals. It is therefore reasonable to assume that those actively looking for opportunities to migrate illegally are the unskilled individuals only[1].

[1] According to estimates reported by the Migration Policy Institute in 2012, more than 80% of undocumented immigrants in the US had at most a high school degree. See https://www.migrationpolicy.org/programs/us-immigration-policy-program-data-hub/unauthorized-immigrant-population-profiles

In any given period, some of the natives of country 2 will choose to take advantage of opportunities to migrate to country 1 either illegally or legally. Immigrants, together with natives, search for jobs, match with firms, bargain for wages and produce. Individuals admitted on family visas can stay and work in country 1 indefinitely (i.e. family visas are permanent). Employment immigrants, on the other hand, are initially admitted on temporary work permits, and may transition to permanent residence status subsequently [2]. They may obtain a permanent visa at rate x_E, or return home at rate d_T, reflecting the end of their employment contract, the expiration of their visa or other personal reasons. For workers on temporary permits, stay in country 1 is conditional on having a job in country 1. If they switch to permanent residency they can stay and work in country 1 indefinitely. Legal immigrants with either family or permanent-employment visas face zero deportation risk. They have a positive probability of returning home, however for personal idiosyncratic reasons. Illegal immigrants face the additional risk of being repatriated by deportation. Hence the return probability of illegal immigrants is higher than that of legal immigrants. Let d_L and d_I denote the instant return rate of legal and illegal immigrants, respectively. We set $d_I \geq d_L > 0$ where their difference is the deportation rate.

The total labor force of country 1 thus consists of natives (N) and immigrants, legal and illegal (denoted as L and I, respectively) and its size is $1 + I + L$, while the size of total labor force in country 2 is $X - I - L$. All illegal immigrants are unskilled and all employment immigrants, temporary or permanent (denoted as L_T and L_E, respectively), are skilled, while family immigrants can be skilled (L_{sF}) or unskilled (L_{uF}). The total number of legal immigrants in country 1 is given by $L = L_{uF} + L_s$, where $L_s = L_{sF} + L_E + L_T$ gives the number of legal immigrants who are skilled.

Since our focus is on the impact of migrations on the receiving country in what follows we give a detailed presentation of the labor market of country 1. Labor market conditions in country 2 matter only for the immigration decision and the size of immigrant inflows into country 1. We explain how conditions in country 2 affect migration to country 1 in Section 3.5. We first describe the production side of the economy in Section 3.1, the search and matching behavior of workers and firms in Section 3.2 and the optimal conditions

[2] We assume that the employment entry is constituted by a temporary-permanent visa track as most of the immigrants in the US follow such a path. The Department of State reports that in the years 2010-2017 only 10% of permanent employment permits (green cards) was given each year to people who came directly from abroad. 90% of them was given as "adjustment of status," to people already in the US with another visa. See https://travel.state.gov/content/travel/en/legal/visa-law0/visa-statistics/nonimmigrant-visa-statistics.html

determining job creation and wages in Section 3.3. We then describe in Sections 3.4 and 3.5 the arrival rate of immigration opportunities through the employment and family routes and the immigration decision. In Section 3.6, we complete the description of the model by specifying the steady-state conditions for unemployment and immigrant stocks.

3.1 Workers and firms

Firms in country 1 operate in one of two intermediate sectors, or in the final sector.[3] The two intermediate sectors produce intermediate goods Y_u and Y_s, using unskilled and skilled labor, respectively. Each of these two sectors operates a linear technology, which implies that immigrants and natives of the same skill type are perfect substitutes in the production of intermediates. These two intermediate inputs are non-storable. Once produced, they are sold in competitive markets and are assembled for the production of country 1's final good (Y), the numeraire. The production technology for the final good of country 1 is as follows:

$$Y = \left[\alpha Y_s^\sigma + (1-\alpha) Y_u^\sigma\right]^{\frac{1}{\sigma}}, \sigma \leq 1 \tag{1}$$

where α is a positive parameter that governs income shares and σ determines the elasticity of substitution between the unskilled and skilled inputs. The production technology in (1) implies diminishing marginal products and Edgeworth complementarity between the two inputs Y_s and Y_u.

One important difference between skilled immigrants admitted on employment visas and skilled family immigrants or natives is that the former are screened for their occupational qualifications. Employment visas are targeted towards skilled foreigners with specific abilities and they require that immigrants have a job offer in the US. No such screening applies to skilled family immigrants who are, therefore, less selected on the productivity dimension. There is therefore reason to expect that employment immigrants are more productive than family immigrants and even than natives. We capture this by assuming that each skilled native or family immigrant produces one unit of the intermediate input, while each employment immigrant (either permanent or temporary) produces $\lambda \geq 1$ units. In the numerical experiments that follows we calibrate the value of λ by matching the wage difference between skilled employment-immigrants and skilled family-immigrants and this parameter turns out to be larger than one. Unskilled workers, on

[3] Our production side borrows from Acemoglu and Zilibotti (2001).

the other hand, are all equally productive. They all produce one unit of the intermediate input. Given a linear production technology for the two intermediate inputs, we can write, $Y_s = e_{sN} + e_{sF} + \lambda(e_{sE} + e_{sT})$ and $Y_u = e_{uN} + e_{uF} + e_{uI}$, where $e_{i\kappa}$ denotes the number of employed workers of skill type i and immigration/nativity status $\kappa = [N, I, F, T, E]$ (N = native, I = illegal, F = family-based, T = temporary employment-based and E = permanent employment-based).

Since the two intermediate inputs are sold in competitive markets, their prices, p_s and p_u will be equal to their marginal products, that is:

$$p_s = \alpha \left(\frac{Y}{Y_s}\right)^{1-\sigma} \quad (2)$$

$$p_u = (1-\alpha) \left(\frac{Y}{Y_u}\right)^{1-\sigma} \quad (3)$$

3.2 Search and Matching

There are two separate labor markets in country 1, one for skilled and one for unskilled labor. In each of the two labor markets unemployed workers and job vacancies are brought together via a stochastic matching technology $M(U_i, V_i)$, where U_i and V_i denote, respectively, the number of unemployed workers and vacancies of skill $i = [u, s]$. We assume that the function $M(U_i, V_i)$, exhibits standard properties. It is at least twice continuously differentiable, increasing in its arguments, it exhibits constant returns to scale and satisfies the Inada conditions. Using the property of constant returns to scale, we can write the flow rate of match per unemployed worker of skill type i as $M(U_i, V_i)/U_i = m(\theta_i)$. The flow rate of match per vacancy is $M(U_i, V_i)/V_i = q(\theta_i)$, where $\theta_i = V_i/U_i$ is the measure of tightness in market i and $m'(\theta_i) > 0$ while $q'(\theta_i) < 0$. Firms post either high-skill vacancies, which are suited for skilled workers, or low-skill vacancies, which are suited for unskilled workers. Each firm posts at most one vacancy and hires one worker. The number of firms of each type is determined endogenously by free entry. While vacancies are skill-specific, they cannot be specifically "targeted" to natives or immigrants. They are open to both native and immigrant workers with those skills. Hence, natives and immigrants of skill type i, both find jobs at rate $m(\theta_i)$.

Firms bear a recruitment cost c_i for each vacancy, which is specific to the skill type and related to the expenses of looking for a worker. An unemployed worker of type i receives a flow of income b_i, which can be considered as the opportunity cost of employment. In addition, unemployed workers pay a search cost π_{ij} per unit of time where the subscript $j = [N, I, L]$ denotes the worker's origin and legal status: native (N), illegal-immigrant (I) and legal-immigrant (L). We account for the fact that a legal immigrant worker faces a higher search cost compared to a native worker and an illegal immigrant faces even higher costs. The reason is that legal immigrants, whether on temporary visas or permanent residency, have access to significantly fewer benefits than US citizens.[4] Undocumented immigrants cannot access any welfare program/unemployment insurance at all and hence their cost of searching is even larger. We standardize the search cost of a native worker to 0 and set $\pi_{iN} = 0$, and we presume $\pi_I > \pi_{uL} > 0$, $\pi_{sL} > 0$ which will be confirmed by the calibration.

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. Matches of unskilled firms with unskilled workers (natives or immigrants) produce output p_u (given in 3). Matches of skilled firms with skilled natives or family immigrants produce output p_s (given in 2), while matches with skilled employment immigrants on temporary or permanent visas produce output $p_E = \lambda p_s$. Wages, denoted as $w_{i\kappa}$, differ by skill type (i) and migration status $\kappa = [N, I, F, T, E]$. They are determined by Nash bargaining of the produced surplus between the firm and the worker. After an agreement has been reached, production commences immediately. Matches dissolve at the rate s_i. Following a job destruction, the worker and the vacancy enter the corresponding market and search for new match.

3.3 Optimality Conditions and Free entry

At each point in time a worker is either employed (E) or unemployed (U), while a vacancy may be either filled (J) or empty (V). We use the notation $E_{i\kappa}, U_{i\kappa}, J_{i\kappa}$ and $V_{i\kappa}$ to denote the present discounted value associated with the state where a worker is employed, a worker is unemployed, a job is filled and a job is vacant, where $i = [s, u]$ indicates the worker's skill type and $\kappa = [N, I, F, T, E]$ the worker's immigration/nativity status. Note that we drop the subscript κ from $V_{i\kappa}$, since a vacancy of skill type i is open to any worker of skill type i irrespective of his/her immigration status and is therefore described by the

[4] Since the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) of 1996 many federal government benefits (Food stamps, TANF, AFDC and others) were restricted to US citizens only. Hence non-naturalized legal immigrants had a significant larger cost of being without a job. In the 2000's some but not all, states re-instated some of them.

same Bellman equation. We also drop the subscript i whenever $\kappa = [I, T, E]$, since all illegal immigrants are unskilled and all employment immigrants (on either temporary or permanent visas) are skilled. The full set of Bellman equations that describe the optimal behavior of workers and firms in country 1 is in Appendix A.

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

$$V_i = 0, \quad i = [s, u] \tag{4}$$

Wages are then determined by Nash bargain between the matched firm and the worker. The outside options of the firm and the worker are the value of a vacancy (i.e. of searching for a worker) and the value of being unemployed (i.e. of searching for job), respectively. Let $S_{i\kappa}$ denote the surplus of a match between a vacancy of skill type i and a worker of immigration status κ. With Nash-bargaining the wage is set to a level such that the worker gets a share β of the surplus, where β represents the relative bargaining power of workers, and the share $(1-\beta)$ goes to the firm. This implies seven equilibrium conditions of the following form:

$$\beta S_{i\kappa} = E_{i\kappa} - U_{i\kappa}, \quad (1-\beta)S_{i\kappa} = J_{i\kappa} - V_i, \quad i = [s, u] \quad \text{and} \quad \kappa = [N, F] \tag{5}$$

$$\beta S_E = E_E - U_E, \quad (1-\beta)S_E = J_E - V_s \tag{6}$$

$$\beta S_I = E_I - U_I, \quad (1-\beta)S_I = J_I - V_u \tag{7}$$

$$\beta S_T = E_T - U_s^2, \quad (1-\beta)S_T = J_T - V_s \tag{8}$$

Conditions 5 to 7 are relative to workers in Country 1. Only condition 8 is relative to residents of country 2. U_i^2 denotes the value of searching for a job in country 2 for an individual of skill type $i = [s, u]$ who was born in country 2. It gives the outside option of natives of country 2 who are currently employed (or seeking entry) in country 1 on temporary visas, because these workers' stay (or entry) in country 1 is conditional upon having a job in country 1. If an agreement is not reached and they are not offered a job in country 1, they will have to search for a job in country 2.

3.4 Legal Migration

We next describe the two main channels through which the natives of country 2 migrate legally to country 1. We characterize the rate at which they obtain visas for legal migration to country 1 through each of the following two channels: the family unification system and the employment system.

3.4.1 Family unification

To be eligible for a family visa, a native of country 2 must have an immediate relative who is a lawful permanent resident of country 1. Let $L_P \equiv L - L_T$ denote the number of legal immigrants of country 1 that hold permanent (employment or family) visas. An individual from country 2 is more likely to be eligible to apply for a family visa when a larger share of country-2 natives are legal (permanent) immigrants of country 1. More formally, if we assume that all families have exactly the same probability/share of legal immigrants on permanent visas in country 1, then the probability that a member of a family network is a permanent-legal immigrant of country 1 is $\frac{L_P}{X}$. Suppose that petitions for obtaining family visas are filed and approved at rate x_F. The rate at which natives of country 2 obtain visas for legal entry into country 1 through family unification is proportional to the share of legal-permanent immigrants in the total labor force native of country 2 and is given by $x_F \frac{L_P}{X}$. Evidently, as the network of incumbent legal immigrants expands (i.e. as L_P increases), entry of new immigrants through family ties becomes more plausible.

3.4.2 Employment-based Admissions

A country-2 native can apply for a permit to enter and work in country 1 only if he has already been offered a job in country 1. Such job offers are made available to potential skilled migrants from country 2 through referrals from their network of co-ethnics who are legally employed in country 1. We assume that an employer who is currently employing a skilled legal-immigrant worker may be willing to support a new skilled worker's migration by opening a new position and asking his current legal-immigrant employee to recommend an alien worker for the new position. If the referred worker is unemployed and willing to migrate for the job, then a petition for an employment visa is filed, and if approved, the worker gets the job and migrates to country 1. One way of interpreting this channel of hiring is that incumbent immigrants use their employer contacts in order to assist the migration of their friends, relatives or other members of their network. In other words, support from incumbent immigrants encourages country 1 employers to create new positions for bringing workers from country 2 lawfully into country 1. Another interpretation is that employers try to take advantage of the information provided by their current skilled immigrant employees in order to identify good quality candidates from abroad that can fill skilled positions, without having to engage in time-consuming search.

Let e_{sL} denote the number of skilled natives of country 2 that are legally employed in country 1. The employer of each of these skilled-legal immigrants is willing to offer a job to support another skilled worker's migration at rate ρ. In this event, the incumbent immigrant employee will recommend one from his network.[5] Suppose that n is the size of the network of co-ethnics of each individual from country 2. Each of the skilled natives of country 2 is therefore linked to $\rho n\left(\frac{e_{sL}}{X}\right)$ referring immigrants. Each of these referring immigrants is in turn linked to $n\left(\frac{X_s-L_s}{X}\right)$ natives of country 2 who are skilled, thus suited for the job, and are currently residing in country 2. The referring immigrant will recommend one among them at random.[6] Hence, the rate at which a skilled worker who is currently residing in country 2 is referred to an employer in country 1 who is willing to support his migration to country 1 is given by $\rho n\left(\frac{e_{sL}}{X}\right)$ divided by $n\left(\frac{X_s-L_s}{X}\right)$ which gives $\rho\left(\frac{e_{sL}}{X_s-L_s}\right)$. We assume for simplicity that being referred to the employer is the same as being offered the job in which case a petition for a temporary work permit is immediately filed. If work-permit petitions are approved at rate γ_T, the skilled natives of country 2 obtain permits to work in country 1 at rate $x_T\left(\frac{e_{sL}}{X_s-L_s}\right)$, where $x_T \equiv \rho\gamma_T$.

3.5 The Immigration Decision and Inflows

A worker will act upon an opportunity to migrate to country 1 if its benefit exceeds its cost. The migration cost, z, is heterogeneous across individuals and is distributed according to the CDF $\Phi(z)$ with support $[\underline{z}, \bar{z}]$. We assume that only the unemployed natives of country 2 are actively searching for opportunities to migrate illegally, so such opportunities arise only for the unskilled natives of country 2 who are unemployed. We also assume that only unemployed workers are willing to act upon opportunities to legally migrate through either the employment or the family route.[7] All workers deciding whether

[5] Our modeling of referrals borrows from Galenianos (2014).

[6] We assume that referrals are targeted towards non-migrants, in line with the idea that incumbent immigrants use their employer contacts to bring new immigrants into the country.

[7] In order to migrate illegally, workers need to actively look for such opportunities, and often, they need to move closer to the border. It is therefore reasonable to assume that those actively looking for

to migrate or not, through any of the three possible routes, are therefore unemployed and their benefit from migrating is the difference between their value of being immigrants of country 1 and their value of being unemployed (searching for a job) in their home country.

The value of being an immigrant of country 1 depends on the entry route (i.e. whether illegal, on a family visa or on an employment visa) and on the worker's skill level. New illegal immigrants and new immigrants admitted on family visas arrive in country 1 without a job and must search for a job in the market. Hence, for these types of immigrants the benefit from migrating to country 1 is the difference in value between searching for a job in country 1 and searching for a job in country 2. New immigrants on employment visas, by contrast, arrive with jobs. Their migration benefit is the difference between the value of being employed in country 1 (on a temporary work permit) and the value of being unemployed in country 2.

An unskilled individual whose migration cost is z, will choose to take advantage of an opportunity to enter illegally into country 1 only if $U_I - U_u^2 \geq z$ while he/she will enter on a family visa (if such an opportunity arises) if $U_{uF} - U_u^2 \geq z$. Likewise a skilled native of country 2 will migrate on a family visa only if $U_{sF} - U_s^2 \geq z$ and on a temporary employment visa only if $E_T - U_s^2 \geq z$. The threshold costs, denoted as $\tilde{z}_I$, $\tilde{z}_{iF}$, and $\tilde{z}_T$ and representing the highest cost a worker is willing to pay in order to obtain illegal, family-based or employment-based entry into country 1, are defined by the following conditions:

$$\tilde{z}_I = U_I - U_u^2 \tag{9}$$

$$\tilde{z}_{iF} = U_{iF} - U_i^2 \tag{10}$$

$$\tilde{z}_T = E_T - U_s^2 \tag{11}$$

These threshold immigration costs can then be used to determine the four rates $\Phi(\tilde{z}_I)$, $\Phi(\tilde{z}_T)$ and $\Phi(\tilde{z}_{iF})$, at which natives of country 2 take up opportunities to migrate, illegally, on a temporary work permit and on a family visa, respectively. These take up rates together with the rates at which workers obtain visas for entry through the two legal channels (described in Section 3.4) or find opportunities to enter illegally, determine the inflows of legal and illegal immigrants. Let u_i^2 denote the number of unemployed workers of skill type $i = [s, u]$ in country 2. Inflows of illegal immigrants are given by $x_I \Phi(\tilde{z}_I) u_i^2$,

opportunities to enter illegally into country 1 are not only unskilled but also unemployed. Although we cannot rule out the possibility of workers quitting their jobs in order to migrate, especially when migrations are legal, we choose not to allow for this possibility in our analysis. Allowing for this possibility would complicate the model considerably, without adding anything fundamental.

of skilled immigrants on temporary work permits by $x_T\left(\frac{e_{sL}}{X_s-L_s}\right)\Phi(\tilde{z}_T)u_i^2$, and of skilled and unskilled immigrants on family visas by $x_F\left(\frac{L_P}{X}\right)\Phi(\tilde{z}_{sF})u_s^2$ and $x_F\left(\frac{L_P}{X}\right)\Phi(\tilde{z}_{uF})u_u^2$, respectively.

Notice that all conditions of country 2 that can influence the migration decision and the flows of migrants from country 2 to country 1 can be summarized into only two values: the value of searching for a job U_i^2 and the number of unemployed individuals u_i^2. The value of searching for a job reflects all labor market conditions in the home country that may influence the decision to migrate such as wages, employment opportunities etc. The number of unemployed gives the pool of potential immigrants of country 1, given our assumption that only unemployed workers are willing to migrate or search for opportunities to migrate. Since our focus is on the impacts of migrations on the receiving country, we can skip a detailed representation of the labor market in country 2 and simply focus on only these two conditions. Further, for simplicity we take these two conditions as given. In other words, we assume for simplicity that labor market conditions in country 2 are independent of immigration and labor market conditions in country 1.

3.6 The Steady-State Conditions

The last set of equilibrium conditions are the steady-state conditions. Six of them determine the constant number of unemployed workers of each type in country 1 by equating the flows into and out of unemployment status for each type of worker: u_{sN} and u_{uN} are skilled and unskilled natives in country 1, u_{sF} and u_{uF} are skilled and unskilled family immigrants, u_E are employment immigrants and u_I are illegal immigrants. Five more conditions guarantee the stationarity of the number of family immigrants (L_{sF} and L_{uF}), illegal immigrants (I), and employment immigrants (L_E and L_T), by equating the flows into and out of the group. The eleven formal conditions defining these steady state variables are given by equations (46) to (54) in Appendix A. Writing the steady state conditions for unemployed and migrants as a function of parameters, labor market tightness in the respective markets (θ_s, θ_u) and threshold costs $\tilde{z}_{sF}$, $\tilde{z}_{uF}$, $\tilde{z}_T$, $\tilde{z}_I$ we obtain the following expressions:

$$\tilde{u}_{sN} = \frac{u_{sN}}{S} = \frac{s_s + \tau}{s_s + m(\theta_s) + \tau} \tag{12}$$

$$\tilde{u}_{uN} = \frac{u_{uN}}{1-S} = \frac{s_u + \tau}{s_u + m(\theta_u) + \tau} \tag{13}$$

$$\tilde{u}_{iF} = \frac{u_{iF}}{L_{iF}} = \frac{s_i + d_L + \tau}{s_i + d_L + m(\theta_i) + \tau} \tag{14}$$

$$\tilde{u}_{E} = \frac{u_{E}}{L_{E}} = \frac{s_s}{s_s + d_L + m(\theta_s) + \tau} \tag{15}$$

$$\tilde{u}_{I} = \frac{u_{I}}{I} = \frac{s_u + d_I + \tau}{s_u + d_I + m(\theta_u) + \tau} \tag{16}$$

$$L_{sF} = \left(\frac{x_F \tilde{u}_s^2 \Phi(\tilde{z}_{sF}) \frac{L_P}{X}}{d_L + \tau + B x_F \tilde{u}_s^2 \Phi(\tilde{z}_{sF}) \frac{L_P}{X}} \right) X_s \tag{17}$$

$$L_{uF} = \left[\frac{x_F \tilde{u}_u^2 \Phi(\tilde{z}_{uF}) \frac{L_P}{X}}{(d_L + \tau)\left(1 + \frac{x_I \tilde{u}_u^2 \Phi(\tilde{z}_I)}{d_I + \tau}\right) + x_F \tilde{u}_u^2 \Phi(\tilde{z}_{uF}) \frac{L_P}{X}} \right] X_u \tag{18}$$

$$L_E = \left[\frac{\left(\frac{x_E}{x_E + d_T + \tau}\right) x_T \tilde{u}_s^2 \Phi(\tilde{z}_T)(1 - \tilde{u}_{sF})}{d_L + \tau - \left(\frac{x_E}{x_E + d_T + \tau}\right) x_T \tilde{u}_s^2 \Phi(\tilde{z}_T)(1 - \tilde{u}_E)} \right] L_{sF} \tag{19}$$

$$L_T = \left[\frac{x_E + d_L + \tau}{x_E} \right] L_E \tag{20}$$

$$I = \left[\frac{x_I \tilde{u}_u^2 \Phi(\tilde{z}_I)}{(d_I + \tau)\left(1 + \frac{x_F \tilde{u}_u^2 \Phi(\tilde{z}_{uF}) \frac{L_P}{X}}{d_L + \tau}\right) + x_I \tilde{u}_u^2 \Phi(\tilde{z}_I)} \right] X_u \tag{21}$$

where $B = 1 + \left[\frac{\left(\frac{x_E + d_L + \tau}{x_E + d_T + \tau}\right) x_T \tilde{u}_s^2 \Phi(\tilde{z}_T)(1 - \tilde{u}_{sF})}{d_L + \tau - \left(\frac{x_E}{x_E + d_T + \tau}\right) x_T \tilde{u}_s^2 \Phi(\tilde{z}_T)(1 - \tilde{u}_E)} \right]$.

Let us also define the variables $\phi_u \equiv \frac{u_{uF} + u_I}{u_{uF} + u_I + u_{uN}}$ and $\phi_s \equiv \frac{u_{sF} + u_E}{u_{sF} + u_E + u_{sN}}$ to be the share of immigrants in the pool of unemployed unskilled and skilled workers, respectively, $\eta_I \equiv \frac{u_I}{u_I + u_{uF}}$ to be the share of illegal immigrants among unemployed unskilled immigrants and $\eta_E \equiv \frac{u_E}{u_E + u_{sF}}$ to be the share of employment immigrants among unemployed skilled immigrants. In equilibrium these shares are constant.

Expressions (12)-(21) reveal some important mechanisms at work in our model. First, as customary in these models, unemployment rates decrease with the matching probability $m(\theta_i)$. The main channel through which immigration policies can influence the unemployment rate of natives that participate in the market is their impact on the labor market tightness, θ_i, and in turn, on the matching probability $m(\theta_i)$. Second, expressions (17)-(21) show the equilibrium number of migrants of each type depend negatively on the return probabilities (d_I and d_L), positively on the approval rates of visa opportunities (x_F, x_T, x_E) or illegal immigration opportunities (x_I) and positively on the threshold migration costs ($\tilde{z}_{sF}$, $\tilde{z}_{uF}$, $\tilde{z}_T$ and $\tilde{z}_I$). The latter implies any economic and policy factor that increases the value of searching for a job in country 1 relative to country 2 or the value of being employed in country 1 on a temporary visa encourages immigration and translates to larger equilibrium numbers of legal and illegal immigrants in country 1. Third, we see from expressions (17)-(19), the importance of immigrant networks in determining the size of immigrant stocks. The share of legal (permanent) immigrants in total foreign population ($\frac{L_P}{X}$) affects the probability of entry through family unification positively, thus has a positive impact on legal immigration, while it affects the number of illegal immigrants negatively. Similarly, the number of employment immigrants increases as the employment rate of legal (employment or family) skilled immigrants increases. A change in an immigration policy (affecting either entry or exit of immigrants) will therefore affect the number of immigrants through three different paths: first, it will have a direct impact on the immigrant inflow or outflow (e.g. visa quotas or deportations), second, it will affect immigrant entry thought its impact on immigration incentives (changes in threshold immigration costs $\tilde{z}_I$, $\tilde{z}_{iF}$, and $\tilde{z}_T$) and third, it will also affect the size of immigrant networks with consequences on opportunity for entry of other immigrants.

Let us notice that once the constant equilibrium values of $L_{iF}, L_E, L_T, I, u_{iF}, u_{iN}, u_E$ and u_I, $i = [s, u]$, are determined, a linear technology determines production of intermediates so that $Y_s = S + L_{sF} - u_{sN} - u_{sF} + \lambda(L_E + L_T - u_E)$ and $Y_u = S + L_{uF} + I - u_{uN} - u_{uF} - u_I$.

3.7 Equilibrium

A steady state equilibrium consists of a set of threshold immigration costs, $\tilde{z}_{sF}, \tilde{z}_{uF}, \tilde{z}_T, \tilde{z}_I$, tightnesses θ_s, θ_u, number of unemployed $u_{sN}, u_{uN}, u_{sF}, u_{uF}, u_E, u_I$, and number of immigrants L_{sF}, L_{uF}, L_E, L_T and I such that the following apply

1. Natives of country 2 decide optimally whether to migrate or not (equations 9-11 are satisfied)
2. The two free-entry conditions in (4) are satisfied
3. Flows into and out of each group of unemployed workers are equal (equations 50-54 in Appendix A)[8]

[8] Apparently, due to the network dependence of legal immigration pathways, the steady-state numbers

4. The outflows of immigrants of each type equal their inflows (equations 46-48 in Appendix A)

The two linear production functions described above can determine the steady-state production of intermediates, Y_s, Y_u, and in turn, aggregate production of country 1 (using equation 1). The two marginal productivity conditions (2, 3), can be used to determine the set of marginal productivities p_u, p_s and $p_E = \lambda p_s$. Finally, equations (55)-(60) in Appendix A determine the seven wages $w_{sN}, w_{uN}, w_{sF}, w_{uF}, w_E, w_T, w_I$, given that wages are the outcome of Nash bargaining. As mentioned above, we take the values of searching for jobs in country 2 to skilled and unskilled workers, U_s^2 and U_u^2, and the unemployment rates in country 2, $\tilde{u}_s^2$ and $\tilde{u}_u^2$, as given. In Appendix A we show how to derive some intermediate results and provide a description for how to solve the model in blocks. Given the fact, however, that some of the expressions are cumbersome we omit those from the text. We will explain, instead, before calibrating and simulating the full model, the intuition behind some key mechanisms.

3.8 Key conditions and mechanisms

Before moving to simulations of specific policies it is useful to provide some intuition for how altering each type of immigration channel – family-based, employment-based or undocumented-tolerant – can have different consequences.

3.9 Job Surplus and Job Creation

First, we discuss firm incentives to open vacancies and create new jobs. Given that free entry drives the value of a vacancy to zero, using (29)-(30) we get:

$$\frac{c_u}{q(\theta_u)} = \phi_u \left[\eta_I J_I + (1-\eta_I) J_{uF}\right] + (1-\phi_u) J_{uN} \tag{22}$$

$$\frac{c_s}{q(\theta_s)} = \phi_s \left[\eta_E J_E + (1-\eta_E) J_{sF}\right] + (1-\phi_s) J_{sN} \tag{23}$$

where ϕ_i is the share of of immigrants in the pool of unemployed individuals of skill type i, η_I is the share of illegal immigrants among unemployed unskilled immigrants and

of legal immigrants, given in equations (17)-(19) depend on the share of total immigrants $\frac{L_P}{X}$. By adding up (17)-(19) we can get the steady-state condition that determines $\frac{L_P}{X}$. That condition is quadratic with two roots. One of the two roots is negative and thus can be ruled out. Hence, we get a unique solution for $\frac{L_P}{X}$ in terms of tightnesses θ_s, θ_u and immigration thresholds $\tilde{z}_{sF}, \tilde{z}_{uF}, \tilde{z}_T, \tilde{z}_I$, which can be used to determine the steady-state solutions of L_{sF}, L_{uF}, L_E and L_T.

η_E the share of employment immigrants among unemployed skilled immigrants. These expressions give the job creation conditions in unskilled and skilled markets, respectively. They set the expected costs of creating a vacancy (left-hand-side) equal to the expected value of a new job (right-hand-side) and can be used to determine the equilibrium market tightness θ_u and θ_s, and in turn, the rates at which workers find jobs, $m(\theta_u)$ and $m(\theta_s)$.

We see, from these expressions, that if the value to the firm from creating a new job differs depending on the type of worker hired (i.e. if $J_I \neq J_{uF} \neq J_{uN}$ and $J_E \neq J_{sF} \neq J_{sN}$) then changes in the size and composition of immigrant stock (i.e. changes in ϕ_s, ϕ_u, η_E and η_I) can change the expected gains from creating new jobs and in turn affect market tightness and job finding rates. A proportional increase in all types of immigrants that leaves their composition unchanged, but increases their share in the unemployment pool (increases ϕ_s and ϕ_u) will increase the expected value of a new job, and induce firms to open more vacancies per unemployed worker (increase θ_u and θ_s) as long as immigrants generate on average larger surplus and hence have higher value for firms than natives: $\eta_I J_I + (1-\eta_I)J_{uF} > J_{uN}$ or $\eta_E J_E + (1-\eta_E)J_{sF} > J_{sN}$. The reasons why the inequality is likely to hold are discussed below. Changes in the composition of unemployed immigrants will also alter job creation incentives if different types of immigrants generate different surplus to firms. For instance, an increase in η_I or η_E will encourage job creation if $J_I > J_{uF}$ or $J_E > J_{sF}$. Any positive impact that immigrants may have on job creation and job finding rates will translate into higher wages and lower unemployment rates for native workers, as can be verified from equations (12)-(13) and (55) in Appendix A.

The value to the firm from hiring a worker may differ depending on the worker's immigration status and entry channel for three reasons. The first is productivity. Since employment-based immigrants are selected for their skills (through referral and visa requirements) they are likely more productive than other skilled immigrants and natives. In our notation this means that $\lambda > 1$ so that $p_E > p_s$. Manipulating the Bellman equations for jobs filled by employment- and skilled-family-based immigrants (equations 63 and 64 in Appendix A) we get:

$$J_E - J_{sF} = \frac{(1-\beta)(p_E - p_s)}{r + s_s + \tau + d_L + \beta m(\theta_s)} \tag{24}$$

Clearly, if $p_E > p_s$, then $J_E > J_{sF}$ and an increase in η_E increases the expected gain from creating a skilled job, inducing firms to open more vacancies per unemployed worker (increase θ_s).

The second and third reasons are search costs and return probabilities, which as discussed above, differ between natives and immigrants and may also differ across different types of immigrants. In general, firms employing immigrants face a higher probability of separation, because immigrants return home either voluntarily, for personal reasons, or due to expiring visa. The likelihood of a separation is even higher when immigrants are illegal, due to the risk of deportations. A higher probability of match break up implies a lower value to the firm. On the other hand, immigrants, especially illegal ones, face higher search costs relative to natives. This pushes them to accept lower wages and thus generate higher profits to the firms. As can be verified from the equilibrium wage expressions in (55)-(60) the higher a worker's search costs the lower his wage, since search costs worsen a worker's outside option. By comparing J_{iF} to J_{iN} and J_I to J_{uF} (equations 61-63 and 65 in Appendix A) we can see more clearly how immigrants' search costs and return probabilities affect the firm's value from hiring them.

$$J_{iF} - J_{iN} = \frac{(1-\beta)\pi_{iL} - d_L J_{iN}}{r + s_i + \tau + d_L + \beta m(\theta_i)} \tag{25}$$

$$J_I - J_{uF} = \frac{(1-\beta)(\pi_I - \pi_{uL}) - (d_I - d_L)J_{uF}}{r + s_u + \tau + d_I + \beta m(\theta_u)} \tag{26}$$

Expression (25) reveals that if family immigrants have higher search cost than natives, that is, if $\pi_{iL} > 0$, then $J_{iF} - J_{iN} > 0$ as long as d_L is small. The higher the search cost of immigrants the smaller the wage they will accept. Hence, the value of a legal immigrant to the firm is higher than that of a native, even given equal productivity, as long as the immigrant's search cost is high enough to compensate for the larger probability of separation. Likewise, condition (26) reveals that if illegal immigrants have worse outside options than legal ones ($\pi_I - \pi_{uL} > 0$), then $J_I - J_{uF} > 0$ as long as the difference between the return probabilities, $d_I - d_L$ - representing the deportation rate - is not too large. Hence, low deportation rates and high search cost for illegal immigrants make them particularly valuable to the firm.

Summing up, positive values of expressions (26)-(25) imply that both legal immigrants admitted on family visas and illegal immigrants may stimulate job creation, because they are willing to accept lower wages, thus by hiring them firms can save on labor costs. A positive value of expression (24) implies that immigrants screened for skills at entry can be more beneficial in terms of job creation compared to skilled family reunification immigrants, because they are more productive.

3.10 Skill composition and price effects

An additional channel through which changes in the size and composition of the immigrant population can affect the labor market outcomes of natives, operates through the marginal product of each of the two skill types, p_s and p_u. This is the standard channel of the canonical model: immigrants of a certain skill type substitute for natives of the same skill type, and complement natives of different skill types. So increasing their supply decreases the marginal productivity of natives of the same skill type and increases the marginal productivity of natives of the different skill. This channel operates only when immigrant inflows alter the relative skill composition of the labor force. A proportional increase in skilled and unskilled due to immigrants will have no impact through this channel. Changes in immigration policy that decrease the relative supply of unskilled labor, such as tighter border control (smaller x_I) or deportations (larger d_I), will put upward pressure on marginal productivity of unskilled workers, and downward pressure on marginal productivity of skilled ones. Effects go in the opposite direction when changes in immigration policies decrease the relative supply of skilled labor.

The overall impact of changes in immigration policies on job creation combines the effects on marginal products and the effects on the expected value of a job (discussed in the previous section) brought by changes in the composition of labor force (due to changes in ϕ_u, ϕ_s, η_I and η_E).[9] The impact of these two effects can be in opposite direction, hence the prediction of this model may be opposite from that of the canonical model. Consider for example the enforcement of deportations of illegal immigrants. It will increase marginal productivity of unskilled, p_u, by reducing their relative supply, but it will also decrease the value of filling an unskilled job for the firm, if illegal immigrants are paid significantly less compared to other unskilled workers. The overall impact on the number of vacancies per unemployed worker, may go either way, and need not be negative, as predicted by the price effect only.

Finally, despite being separated by skill level, job creation in the two labor markets

[9] If $d_L = d_I = 0$, $\pi_{iL} = \pi_I = 0$, $\lambda = 1$ then immigrants and natives belonging to the same skill group are identical and generate equal profits to firms so that changes in the composition of labor force in terms of nativity and immigrant status no longer affect job creation. All effects, in this case, work through the prices of intermediate inputs, p_u and p_s. If, in addition, skilled and unskilled labor are perfect substitutes in production, i.e. $\sigma = 1$, then as can be verified from (2) and (3), prices are constant ($p_s = \alpha$, $p_u = 1 - \alpha$) and immigration does not affect prices either. In this case immigration has no impact on the labor market. In the general case, where different types of immigrants and natives differ, and the two labor inputs are imperfect substitutes ($\sigma < 1$) the effects of immigration work through both of these channels.

is linked by production complementarity. Immigration-induced changes in one market will carry over to the other through complementarities in production. For instance, any policy hurting the creation of unskilled jobs, will also hurt the creation of skilled jobs, by lowering the marginal productivity of the skilled labor.

3.11 Immigrant Networks

The legal entry routes of employment and family reunification, depend strongly on networks, which means past immigrants. Inflows through the family unification channel are larger when the stock of legal immigrants (on permanent visas) is larger. Also (19) and (20) show that the stock of employment-based immigrants is proportional to the stock of skilled-family immigrants. This means that immigrant entry through the family- and the employment-based channels are linked. A policy affecting one entry route will also affect the other entry route in the long run equilibrium. The strong network dependence of the legal entry routes may amplify any impacts of migrations on job creation. This is what is sometimes called "chain migration" especially in reference to immigration of people linked by family ties, however employment immigrants also depend on the network for referrals and opportunities.

Two interesting facts should be noted about the role of networks. First, the network of past immigrants from family or employment channel affects new entry in both. This implies that a change in either channel will produce similar long run changes in the stock and skill composition of total legal immigrants. The network attenuates the long-run differences in the effects of acting on family or employment visa in the short run. Second, and differently, undocumented will not create large network effects, because undocumented can neither sponsor a family member nor create a referral for an employment-entry[10]. Intensity of this channel of entry (enforcement) will mainly affect the number of unskilled workers in the labor market.

[10]We are not analyzing here long run effects in an overlapping generation framework, but long run effects within the first generation. Considering U.S.-born children of immigrants as immigrants would generate a channel through which undocumented can affect the stock of legal immigrants in the next generation. U.S. born children of immigrants, however, have natives' skills, education and legal status and we do not see reasons to differentiate them from natives in the labor market

4 Parameterization of the model

The model is complex and rich. We devote substantial attention in choosing parameters and robustness checks for some of them. Still, one should think of our simulations as providing a reasonable, rather than exact, illustration of the importance and magnitude of labor market effects of different policies. We combine three types of parameters. Some are taken from estimates in the literature. Others are summary statistics taken directly from the data. A third group is chosen to match some moments of the data through calibration. The parameter choice is summarized in Table 1. We describe here the sources and the methods used to calculate these parameters.

We use a Cobb-Douglas matching function, $M_i = \xi(U_i)^{\epsilon}(V_i)^{1-\epsilon}$, $i = [s, u]$. Following common practice in these models, we set the unemployment elasticity of the matching function to $\epsilon = 0.5$, which is within the range of estimates reported in Petrongolo and Pissarides (2001). We postulate the worker's bargaining power to be $\beta = 0.5$, so that the Hosios condition ($\beta = \epsilon$) is met (see Hosios, 1990). We use the monthly interest rate $r = 0.4\%$ which implies a yearly real rate of about 5%.[11] This is calculated as the 30-year treasury constant maturity bond rate minus the average GDP deflator over the period 1980-2010 for the US. We define as skilled a worker who has at least some college education and unskilled workers are those with no college education. Based on existing estimates (see Goldin and Katz (2008) and Ottaviano and Peri (2012)) the elasticity of substitution between those two types of workers is around 2. We therefore set $\sigma = 0.5$. We assume that the distribution of migration costs is uniform over the interval $[0, \bar{z}]$ where we have standardized the lower bound to 0. In order to measure x_F, the rate at which family reunification opportunities occur, we use the fact that it takes about 5 to 6 years (we set it at about 67 months) for a family visa to be approved[12]. Hence we set the rate at $x_F = 0.015$ (i.e. $\frac{1}{x_F} = 66.67$).

As mentioned above, we match the US data in 1990-2010 and consider Mexicans as the main country supplying low skilled immigrants and Chinese and Indians as the most relevant foreign group supplying high skilled immigrants. Our measures of X_u and X_s represents the population of foreign skilled and unskilled who can migrate to the US include the unskilled Mexican labor force and the skilled Indian and Chinese labor force,

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

[12] We use the waiting time of the Family 2nd preference Visas, which allow entry to spouses and children of green card holders, as measured now in the US, see https://www.legalmatch.com/law-library/article/waiting-periods-and-quotas-for-family-based-visas.html

respectively. Those values are equal to 0.323 and 0.562, respectively, when standardized by the US native population between 18 and 65 years, which is set to 1 and are obtained from Barro and Lee (2010).

The share of native skilled workers in the US is set to $S = 0.604$. This is the share of US native workers with some college education or more in the total native population in working age (18-65) from the 2014 US ACS Public Use Microdata Sample (PUMS)[13]. Using Census data over the period 1980 to 2010 we find the annual growth rate of US native labor force to be 0.86% per year implying a monthly growth rate of 0.072% and hence we set $\tau = 0.00072$. Using matched data from the ORG Current Population Survey (CPS) we estimated the average skilled and unskilled monthly job-separation rates in the US (s^s and s^u, respectively) to be 0.024 and 0.032, respectively.[14] To calculate the unemployment rate of foreign unskilled workers in their country of origin we use estimates of unemployment rates by education in year 2015 for Mexico and find $\tilde{u}_u^2 = 0.036$. We set the unemployment rate of skilled foreign workers in their country to $\tilde{u}_s^2 = 0.067$. This was calculated using estimates of unemployment rates for highly skilled in India averaged over years 2013-2014 and China for year 2012.[15]

The return probabilities of legal and illegal immigrants in the US, are taken from Chassamboulli and Peri (2015) who calculate these probabilities for Mexican immigrants and find that they are $d_L = 0.0023$, $d_I = 0.0039$. They use estimates for the total

[13] obtained at https://usa.ipums.org/usa/

[14] These measures calculate the employment to unemployment and employment to inactivity transitions relative to employment and non-employment stocks.

[15] Estimates of unemployment rates in Mexico were taken from OECD (2017), Unemployment rates by education level (indicator). doi: 10.1787/6183d527-en (Accessed on 04 May 2017). Estimates are reported for three education groups: below upper secondary, upper secondary non-tertiary and tertiary. To calculate the unemployment rate of unskilled workers, which we assume to be workers with no college education, we take the average unemployment rate of the first two education groups. Estimates for India are from the Ministry of Labour and Employment/Labour Bureau, Fourth Annual Employment and Unemployment Survey Report (2013-14). Chandigarh: Government of India. Estimates for China are from (n.d.). Unemployment rate in China between 2011 and 2012, by education level. In Statista - The Statistics Portal. Retrieved May 4, 2017, from https://www.statista.com/statistics/304678/china-unemployment-rate-trend-by-education-level/. We take the average unemployment rate across workers with Diploma, Graduate degree and workers with a post-graduate degree in India in order to get an estimate of the unemployment rate of skilled workers in India. We then multiply with the skilled working age population in India to get an estimate of the number of unemployed-skilled workers in India. To get an estimate of the number of skilled unemployed in China we take the average unemployment rate of workers that have completed Junior college and those that have a Bachelor's degree and above and multiply it with the skilled working age population in China. As mentioned above, the numbers of skilled working age populations in China and India were taken from Barro and Lee (2015) and are relative to year 2010. We then add up the total number of skilled unemployed in the two countries and divide by the total skilled population in working age in the two countries to get an estimate of the average skilled unemployment rate of the two countries.

number of returnees to Mexico (excluding deportations) and deportations (of non-criminal Mexicans) each year (averaged over the available period 2001-2005) from Masferrer and Roberts (2009). They consider returns other than deportations to be the "basic" returns of legal immigrants and calculate the return migration rate for legal Mexican migrants as the ratio of returnees to Mexican-born unskilled population in the US. In order to compute the yearly return rate of illegal Mexican immigrants they add to the basic rate the deportation rate of non-criminal Mexicans. More specifically, by applying the same basic return rate to the illegal Mexican population in the US (taken from Passel and Capps, 2004), they calculate the number of illegal Mexicans returning to Mexico each year for reasons other than deportations. They then add the number of deportations per year of non-criminal Mexicans to that number (for the period 2001-2005) and divide by the number of illegal Mexicans in the US to get the return+deportation rate of the illegal Mexicans. Given the limited evidence on these parameters we also conduct robustness checks allowing values for the return rates twice as large (see section 6).

We jointly calibrate the remaining 17 parameters of the model (c_s, c_u, b_s, b_u, $\bar{z}$, ξ, π_{sL}, π_{uL}, π_I, α, d_T, λ, U_s^2, U_u^2, x_T, x_E, x_I) to match as many targets. We target the ratio of employment/population in working age (18 to 65) for workers with some college education or more (skilled workers) and for high-school graduates or less (unskilled workers) in the US using ACS data in 2014 and we obtain values equal to 84% and 67%, respectively.[16] We target the percent wage premium for US-born workers who have at least some college education. Using 2014 ACS PUMS we find it to be equal to 78%.[17] We use the Conference Board's Help-Wanted Index (HWI) to calculate the vacancy to unemployment ratioas of 2014 which was equal to 0.62 in the US. We then calculate the wage differences between immigrants legal or illegal and natives by education we use weekly wages for full time (male) workers from the a dataset produced by the Center for Migration Studies (CMS) that hincludes an indicator for "undocumented" to the basic microdata from the American Community Survey, for year 2014[18]. The ratio of wage of skilled natives relative to skilled legal immigrants in the US was 0.92 and the ratio of wages of unskilled natives relative to unskilled legal immigrants was 1.173.[19] The ratio of wages of illegal (unskilled)

[16] As there are very large flows between employment and non-employment for individuals in working age we match the value of u to non-employment rather than to unemployment.

[17] To measure the wage premium we use weekly wages for adults full time employed and US born individuals, ages 16-65.

[18] see http://data.cmsny.org/about.html for a description of data and methodology

[19] Notice that in line with our assumptions, skilled natives earn on average less than skilled immigrants,

immigrants to the wages of unskilled natives is set at 0.8.[20] From the New Immigrant Survey (NIS) which is a survey on immigrants who have obtained their permanent resident status, we calculate the wage at first employment of labor immigrants and of those with family reunification permits. We restrict to employed people in prime age (25-50 years old) males. There are 4 categories of immigrants in the NIS: those who have family reunification permits 55%, those who have employment green card 10%, refugees 10% and others 25%. If we consider those belonging in the last group "others" as labor immigrants we find the ratio of wages of employment to family immigrants to be 1.6, but if we exclude them and take only employment relative to family the ratio is 2.5, quite larger. In our benchmark calibration we choose the most conservative wage ratio of 1.6, but we also show results using the alternative estimate of 2.5 in Appendix B (see Table 18). We use Hall and Milgrom's (2008) estimate for the ratio of unemployment to employment income of 0.71 to pin down values for the unemployment incomes; we set $b_s = 0.71w_s$, $b_u = 0.71w_u$ where w_s and w_u are the average wages of skilled and unskilled workers, respectively.

We set the ratio of immigrants on family unification visas, temporary work permits, permanent employment visas and of illegal immigrants to the US native labor force to $L_{sF} + L_{uF} = 0.116$, $L_T = 0.0092$, $L_E = 0.02$ and $I = 0.007$, respectively. To get these numbers we first use the CMS database to calculate the number of all immigrants in working age that are illegal and the number that are legal (year 2014). We then use the estimates of the number of temporary visas in 2013 from Costa and Rosenbaum (2017).[21] We subtract the number of temporary visas from the total number of legal immigrants in working age to get an estimate of the total number of legal immigrants in working age that are on a permanent visa. We then use the NIS to calculate the share of family unification and employment permits among the permanent legal immigrants.

Based on the fact that the average duration of a temporary skilled worker visa (H1B visa) is 3 years we set $\frac{1}{x_E+d_T} = 36$. Finally, we assume that the value of searching for

since a portion of skilled immigrants are admitted into the US on employment visas and thus are screened for their skills. A recent study of H1B visa workers by Lofstrom and Hayes(2011) calculates that H1B workers, the largest skilled visa program, earn between 8 and 20% more than natives confirming the high productivity of this group of workers.

[20]Notice that our targeted wage difference between unskilled natives and immigrants is not far from the immigrant-native wage gap of about 20% estimated in Borjas and Friedberg (2009) for year 2000, after controlling for observed abilities such as education and age. Several other papers (e.g. LaLonde and Topel 1991, Kerr and Kerr 2011) show that immigrants are paid less than natives even after controlling for other observable productivity determinants such as education and language. A negative immigrant premium of about 20% is also within the range found in the survey by Kerr and Kerr (2011).

[21]Report form Economic Policy Institute, available at http://www.epi.org/publication/temporary-foreign-workers-by-the-numbers-new-estimates-by-visa-classification/.

a job in the US to a legal and permanent immigrant is at least four times the value of searching for a job at home. Specifically we set $U_{sF} = 4U_s^2$ and $U_{uF} = 4U_u^2$. This value is similar to the ratio of income per person in the US relative to Mexico, which provides an order of magnitude for the real wage gains expected from migrating form that country.

The values of the parameters matching the above targets are as follows: $c_s = 0.0170$, $c_u = 0.0445$, $b_s = 0.44$, $b_u = 0.23$, $\bar{z} = 14.04$, $\xi = 0.125$, $\pi_{sL} = 0.002$, $\pi_{uL} = 0.183$, $\pi_I = 0.390$, $\alpha = 0.703$, $d_T = 0.0212$, $\lambda = 1.626$, $U_s^2 = 22.36$, $U_u^2 = 7.85$, $x_T = 0.0206$, $x_E = 0.0066$, $x_I = 0.0908$ and they are shown in Table 1.

As discussed above, the values of J_E,J_{sF}, relative to J_{sN} and of J_I,J_{uF} relative to J_{uN} are important in determining the impact of changes in immigration policies on the creation of jobs in country 1. With our targeted wage differences and remaining parameters as described above, we get $J_E = 2.97J_{sF}$, $J_{sF} = 0.98J_{sN}$, $J_I = 1.58J_{uF}$, $J_{uF} = 2.14J_{uN}$. This implies that employment immigrants generate significantly larger profits to firms than other skilled immigrants or natives because they are significantly more productive. Although skilled family immigrants accept lower wages than skilled natives firms expect to generate slightly lower profits from hiring them than from hiring their native-born counterparts, because firms anticipate that matches with family immigrants will have lower duration, due to the possibility of them returning to their home country. This implies that in the skilled sector, a shift away from family and towards employment immigration may generate a significant increase in the expected surplus to the firm and, in turn, a job-creating effect on the economy of country 1. In the unskilled sector, on the other hand, both types of immigrants (family and illegal), but especially illegal immigrants, generate significantly larger profits to firms than natives. This means that a higher share of immigrants may generate a significant job-creating effect. It also implies that in the unskilled sector, a policy that replaces illegal immigrants with legal ones is less harmful in terms of job creation compared to a purely restrictive immigration policy that does not replace undocumented immigrants.

5 Policy Experiments

The rich structure of our model allows us to simulate the labor market implications of different policies. We consider five of them: (i) reduced opportunities of illegal entry, captured by a decline in x_I and representing an increase in border control (ii) an increase in the intensity of deportations, captured by an increase in d_I (iii) a decrease (slowdown) in the approval rate of petitions for family visas captured by a decrease in x_F (iv) a decrease in the approval rate of petitions for temporary work permits captured by a decrease in x_T and (vi) a decrease in the approval rate of petitions for permanent employment visas captured by a decrease in x_E[22].

We perform two sets of experiments. In the first one, we use each of the five policy instruments listed above to reduce the number of immigrants in the group by 10% (a small change) or by 50% (a more significant change). By targeting reductions in specific immigrant groups (while keeping the other entry channels unchanged) we are able to illustrate the effects that different types of immigration policies may have on the labor market. In the second set of experiments we consider policy combinations that restrict one entry channel, reducing the relative immigrant group by 10% and 50%, and relax another channel so that the size of overall immigrant population remains constant and only its composition changes.

We focus on the effects of those policies on the labor market outcomes of natives, skilled and unskilled, and on the total income of natives, $\tilde{Y}$, which is given by the following expression:

$$\tilde{Y} = Y + b_s u_{sN} + b_u u_{uN} - c_s v_s - c_u v_u - w_{sF} e_{sF} - w_{uF} e_{uF} - w_E e_E - w_I e_I - w_T L_T \quad (27)$$

where $e_{iF} = L_{iF} - u_{iF}$, $i = [s, u]$, $e_E = L_E - u_E$, and $e_I = I - u_I$. The expression above assumes that employers are natives and it shows that total income to natives includes total wage income to natives plus unemployment income to native workers minus the cost of keeping vacancies open. An alternative definition can be obtained by omitting the natives' unemployment income (which is reasonable if one think that such income is generated by transfers rather than by additional home-production)

$$\tilde{Y}_1 = \tilde{Y} - b_s u_{sN} - b_u u_{uN} \quad (28)$$

5.1 Purely restrictive immigration policies

The effects on natives' outcome of each of the five purely restrictive policies listed above are summarized in Table 2. Columns 1-2 and columns 3-4 show the impact of reducing illegal immigrants by 10% and 50% using increased border controls (lower x_I) or

[22]The decrease/increase in approval rates lead to a decline/increase in the yearly number of entries, which is the usual variable people have in mind in immigration policies, but is an equilibrium outcome in our approach

increased enforcement of deportations (higher d_I) respectively. Columns 5-6 show the impact of decreasing the approval rate of family permits x_F to achieve a 10% or 50% decrease in family immigrants. Finally, columns 7-8 and 9-10 show the effects of decreasing employment-based admissions (lower x_T) or the rate of transition from a temporary to a permanent employment visa (lower x_E) to achieve 10% and 50% decrease, respectively, in the number of temporary and permanent employment immigrants. The entries in Table 2 represent the percentage effect on market tightness (top 2 rows), natives' unemployment rates, wages and net income (next 6 rows) and the percentage effect on immigrant stocks and composition (last 8 rows).

All these five policies, which imply a decline of immigrants, decrease the labor market tightness for skilled and unskilled native workers. They all decrease the job finding rates of both types of native workers, thereby increasing their unemployment rates and decreasing their net income. Key to understating the negative effects of these policies on job creation is their impact on the expected values of new jobs, which, in all cases, is negative and dominates over the relative price effects. Decreasing the number of illegal immigrants, through either border enforcement or deportations, reduces the relative supply of unskilled labor and thus increases p_u, but also increases the expected labor costs of firms seeking to hire unskilled workers, since illegal immigrants accept lower wages. The second effect dominates leading firms in the unskilled market to open fewer vacancies per unemployed.[23] This depressing effect on labor markets produced by a decline of undocumented (via deportation or tightening of the border) was already pointed out in Chassamboulli and Peri (2015). The large surplus that a match with an undocumented provides to employers, drives a strong job creation effect, and their decline reduces labor market tightness. Consistent with this result are also the findings of Lee, Peri and Yasenov (2017), who find negative employment effects on natives from an episode of large deportation of Mexicans in the 1929-1934 period.

The second experiment consists in a decrease in the number of employment immigrants, achieved through a lower approval rate for permanent or temporary employment applications (a decrease in x_E, shown in columns 7 and 8 of Table 2 or in x_T, shown in

[23]The effects seem to be similar when the decrease in illegal immigration is achieved through increased deportations (increase in d_I) or stronger border enforcement (decrease in x_I). The only difference between the two policies perhaps worth mentioning is that with increased deportations, the negative effect on incentives to migrate via illegal channels is stronger. The decrease in illegal immigration, in this case, is to a larger degree endogenously driven: individuals choose not to migrate illegally since the increased deportation risk makes the benefit of illegal migrations much smaller.

column 9 and 10 of Table 2). This tightening of entry of skilled employment immigrants increases the value of p_s, on the one hand, because it lowers the relative supply of skilled labor. On the other hand, however, it lowers the expected productivity of skilled jobs, because employment immigrants, selected specifically for high skilled jobs, are significantly more productive than native workers. For the calibrated choice of parameters, the second effect dominates and market tightness for skilled workers decreases, as a consequence of the lower job posting by employers.[24] The direct impact of the decrease in illegal immigration is on the unskilled market while that of the decrease in employment immigration is on the skilled market. Nevertheless, in both of these cases the negative job creation effects carry over to the other market through complimentarities in production. The reduced supply of unskilled labor, due to the decrease in the number of illegal immigrants, lowers p_s. This hurts the profit of skilled jobs and lowers market tightness for skilled workers as well. Similarly, the decrease in the number of employment immigrants, lowers market tightness for unskilled workers by lowering p_u. Network effects are also at work in the case of employment immigrants: with fewer of them there are also fewer entries through family ties. Hence the proportion of (family) immigrants in the pool of potential hires for unskilled jobs decreases. Because unskilled immigrants accept lower wages than natives, due to their high search costs and worse outside options, this hurts the profits from unskilled jobs adding to the decrease in market tightness for unskilled workers due to the decrease in p_u.

The two legal entry routes (employment and family) are linked strongly by networks so that a policy affecting one entry route will also affect the other. The effects of the third type of policy, namely a decrease in the inflow of family immigrants, through a decrease in x_F, are represented in Column 5 and 6. The effects of decreasing x_F resemble those of decreasing x_E (or x_T). Both policies reduce the size of legal immigrant network, and in equilibrium decrease entry of immigrants through both the employment and the family channel, as they reduce the size of the network. Our calibration gives $J_{sF} = 0.98 J_{sN}$, meaning a smaller share of family immigrants in the pool of those searching for skilled jobs does not necessarily alter incentives to create skilled jobs, since firms are almost indifferent between hiring skilled family immigrants or skilled natives. Nevertheless, we

[24] In our model having a temporary work permit is the necessary first step to obtaining a permanent employment visa. Hence, a decrease in the number of immigrants on temporary work permits implies, in steady state, an equal percentage decrease in the number of immigrants on permanent employment visas (see equation 20). Thus, the effects of a decreasing x_T are quite similar to those of a decreasing x_E.

see that even in this case market tightness decreases not only for the unskilled but also for the skilled workers. Incentives to create skilled jobs decrease mainly due to the decrease in the number of employment immigrants, indirectly affected through the lower number of referrals on the job. This pushes the average productivity of skilled jobs down. As in the case of decreasing employment-based admissions, the decrease in x_F hurts firms in the unskilled sector and induces them to open fewer vacancies for unskilled workers for two reasons. First, with fewer family immigrants firms expect to pay higher wages on average and second, the price of the unskilled labor input, p_u, decreases as the relative supply of skilled labor, which is complementary to unskilled, decreases. In the working of our model, reducing family unification admissions, leads to a significant decrease in the ratio of skilled to unskilled immigrant workers for two reasons. First, a larger share of family immigrants are skilled, as skilled individuals have larger incentives to migrate. Second, reducing family admissions reduces the referrals for employment entry and leads to a significant decrease in the entry of highly skilled individuals.

The impact of each policy on wages, shown in the fourth and fifth row of Table 2, follows that on prices (p_s and p_u). Although all policies restricting immigration to the US through any of the three possible channels hurt job creation for both skilled and unskilled workers, in all cases, one of the two types of workers benefits in terms of wages, while the other is hurt. Decreasing illegal migration increases the wage of unskilled and reduces that of skilled natives, because the relative supply of skilled labor increases. All other policies, which reduce the size of legal immigrant population, lead to a decrease in the supply of skilled labor. In those cases, the wages of skilled workers increase while those of unskilled workers decrease. All measures restricting legal immigration, in our simulations, hurt low skilled natives by generating higher unemployment and lower wages for this group. Moreover all policies, including the reduction of illegal immigrants, reduce the net income of natives in our simulations, (see seventh and eight row of the Table) because they reduce job creation and employment of both skilled and unskilled native workers. The positive wage effect on one group is not enough to compensate the loss in income due to these employment losses.

In quantitative terms the largest effect on employment of a native group, for a 50% decline in immigrants from any channel, is on unskilled natives when illegal immigrants are reduced. Their unemployment rate increases by 2.85% . However also their wages increase by 2.38%. At the same time the unemployment of skilled increases and their wages decrease. Combining all these effects gives an decrease in natives' net income by by 1.16%. Undocumented play an important role in keeping the labor markets tight for natives too as they provide less expensive labor and better employment opportuntities for natives. On the other hand changes in family immigration have also significant effects, especially on the less skilled natives. A 50% decline in family immigrants has significant effects on unemployment rates (3.83 %) and wage of low skilled (-1.85%), and depresses significantly the net average income of natives (-2.03%). The reason is that the group of family-immigrants is the largest and a decline in their size (by 50%) represent a large direct reduction of immigrants. Moreover via the network effect employment immigration is also reduced, and, through the weaker labor market for unskilled, it also produces lower undocumented immigration. A decline in this group has the largest effect on aggregate stock of immigrants that declines by 7.61 percent (third to last row in the Table) for a 10% decline of this group.

A final general feature is worth noting in the simulated results. Looking at the impact of policies on immigration across all channels, we see that there is a "complementarity" in legal channels of entry, in the sense that a restrictive policy in one of them reduces entry in the others. This is mainly due to the linkages generated by networks. On the other hand there is independence between legal and illegal immigration, as affecting one of the two channels changes only marginally (mainly through labor market feedback) the inflow of immigrants through the other channel.

5.2 Policy combinations

We now consider two alternative policy combinations that do not decrease the size of total immigrant population but, rather, change its composition. In the first policy package we target 10% and 50% decreases in the number of illegal immigrants by decreasing x_I (e.g. through border enforcement). In the second, we target a 10% and 50% decreases in the number of family immigrants by decreasing x_F (lower approval rate for family-visa petitions). In both cases we simultaneously allow for a higher approval rate of petitions for permanent or temporary employment visas (we increase either x_E or x_T), so that the total number of immigrants remains the same. Results for these two policy experiments are reported in Tables 3 and 4. As above, the tables report the percentage effects on market tightness (first two rows), native unemployment rates (rows 3 and 4), wages (rows 5 and 6), net income (rows 7 and 8), and immigrant stocks (rows 9-15).

The first policy combination, of decreasing x_I and increasing x_E or x_T (in Table 3), delivers a replacement of illegal immigrants with legal immigrants in the population. This policy has smaller adverse effects on native labor market outcomes than the corresponding restrictive policy that simply reduced the number of undocumented. The simulation results in this case show that for a reduction of illegal immigrants by 50% and no increase in total immigrants this policy delivers an increase of unskilled natives unemployment of 1.29% of its initial value and an increase of skilled natives unemployment by 0.64% of its initial value, as opposed to increases by 2.85% and 1.45%, respectively, when the restrictive-only policy was used (as shown in Table 2). While the purely restrictive policy generates an income loss to natives, this policy combination delivers an increase in their net income by $0.18\% - 0.28\%$. The increase in natives' net income is even larger $(0.53\% - 0.58\%)$ when the increase in employment-based immigrants is achieved through a higher rate of a temporary work-permit admissions (higher x_T). What this mixed policy essentially does is to replace some of the illegal immigrants with employment immigrants and, in equilibrium, with family immigrants, since with more employment immigrants there is also more entry through family ties and we get a significant increase in the number of family immigrants as well. By increasing admissions on temporary work permits instead of giving permanent residency to temporary workers the increase in employment immigrants $(L_T + L_E)$, who are significantly more productive than family immigrants and have worse outside options, is larger. Hence, natives' net income increases by more. Because of the higher number of employment immigrants skilled firms benefit from higher productivity on average which partially offsets the depressing effect of reduced supply of unskilled labor (due to fewer illegal immigrants) on p_s. In the unskilled sector, we see a smaller decrease in job creation for two reasons. First, with the entry of employment and family immigrants the increase in the relative supply of skilled labor is larger, meaning that the increase in p_u is also larger through canonical complementarity. Second, the increase in expected labor costs of firms seeking to hire unskilled workers is smaller, since some of the illegal immigrants are replaced by unskilled family immigrants whose wage is larger, but still smaller than that of natives. Notice that this policy would bring a mix of immigrants which is more skilled, and hence would imply higher average wages for immigrants too.

The second policy combination, of decreasing x_F and increasing x_E or x_T (in Table 4), delivers even more positive results on natives. In fact, in this case we get a positive effect on job creation for both skilled and unskilled workers. While decreasing family immigrants alone generates income losses to native workers and increases their unemployment rates, this mixed policy has the opposite effects. The simulation results show that for a reduction of family immigrants by 50% and no increase in total immigrants a policy combination of decreasing x_F and increasing x_E delivers decreases in unskilled and skilled natives unemployment rates of -1.91% and -5.20%, respectively. This policy combination replaces family immigrants mainly by employment immigrants, but increases also the number of illegal immigrants. Entry of illegal immigrants increases due to stronger migration incentives, since, as a consequence of the policies implemented, job creation and wages for unskilled workers in country 1 increase. Evidently, replacing skilled family immigrants by employment immigrants, who are highly productive, generates significant gains to skilled firms and spurs the creation of skilled jobs. Firms in the unskilled market also benefit since some of the unskilled family immigrants are replaced by employment immigrants, who are skilled and thus complement the production of the unskilled labor input (increase p_u), and illegal immigrants, who are paid less.

The overall takeaway from these policy experiments is that given the productivity of high skilled immigrants and the surplus generated by low skilled immigrants for native firms, restrictive policies by themselves, reduce labor market tightness. On the other hand policies that change the composition of immigrants are most stimulating of the labor market for natives when they increase the component of employment immigrants. Our analysis, however, represents also an assessment of the fact that family immigration policies, as long as one accounts for network effects and immigrant economic incentives, may also have a stimulating effect on native labor markets.

6 Robustness Checks and Extensions

While our baseline parameterization is based on the best data available, in some cases there is a range of reasonable uncertainty about some of the statistics and parameter values. For some important parameters we show the simulated effects of policies in a range indicated by the relevant literature and empirical evidence. These checks are performed in Tables 5-10 that reproduce the simulations reported in Tables 2-4, with each table devoted to one specific policy. In each table, we show the effects of a policy that produces a 10% decrease in the relevant immigrant group. Table 5 shows the effects of tighter border controls (increase in d_I). Table 6 of a lower approval rate of family petitions (decrease in x_I).

Table 7 of a lower approval rate of petitions for permanent employment visas (decrease in x_E). Table 8 of a lower approval rate of temporary work permit petitions (decrease in x_T). Finally, Tables 9 and 10 show the effects of the two policy combinations considered above, which target decrease in illegal and family immigration, respectively, and offset the decline with increased employment immigration. These tables, which are described in more detail below, follow the same structure. In the first column we show results in the baseline (benchmark) case. In the rest of the columns we show robustness checks on four parameters. For other parameters that are less relevant we perform robustness checks in the Appendix B (see Tables 11-16, which mirror the structure of Tables 5-10).

A first key parameter is λ, which measures the productivity gap between employment-based immigrants and skilled immigrants on family visas or skilled natives. The significant job-creation effect from employment immigrants derives from their higher productivity which is reflected in their higher wages. In order to check the robustness of our main results, in columns (2) and (3) in Tables 5-10 we decrease λ so that the productivity of employment immigrants decreases by 10% and 20% of the value we used in our baseline parameterization, and the wage ratio between employment and skilled family immigrants drops from 1.55 in our baseline case to 1.41 and 1.26, respectively.

The degree of skilled-unskilled complementarity in production is also important in determining how the immigration-induced changes in the skill-mix of labor force translate into the change in their marginal productivity p_u and p_s. In columns (4) to (6) we change σ, the parameter that governs the elasticity of substitution between the skilled and unskilled labor inputs. We keep all other targets and parameter vales the same. We consider $\sigma = -0.5$ and $\sigma = 0$, which are lower than our benchmark value of $\sigma = 0.5$, implying stronger complimentarity between the two labor inputs, and $\sigma = 1$, which means that the two types of labor inputs are perfect substitutes to each other.

The return rate of immigrants is an important determinant of their value to a firm and of their job-creating effect. In column (7) we double the return rate of illegal immigrants, d_I, while in column (8) we check that our results are robust to a much higher exogenous natural return rate of legal immigrants, and we double d_L. In both cases, we re calibrate the model and adjust the values of π_{sL}, π_{uL} and π_I so that we keep matching our baseline targeted wage differences (given in Table 1). By doubling d_L we essentially decrease the values of π_{sL} and π_{uL} that match our targeted wage differences, i.e., we decrease the search costs of legal immigrants and make firms' value from hiring them, and especially family immigrants, smaller. Likewise, by doubling d_I we reduce firms' value from hiring illegal immigrants, by increasing their match break up probability and lowering their search cost π_I.

In our final check, shown in column (9), we examine how the effects of policies change when we eliminate chain immigration through family ties. As shown above the two legal entry routes (family and employment), are closely connected since entry through employment generates opportunities for chain migration through the family unification system. We eliminate chain migration through family ties by assuming that expanding the size of legal immigrant population, can only create opportunities for entry through the employment route by creating employment referrals for skilled foreigners. We assume that family ties no-longer generate immigration opportunities meaning that changes in the entry rate of other (non-employment) immigrants reflect only changes in immigration incentives or changes in visa approval rates.

Let us first discuss Tables 7 and 8, which show the effects of decreasing employment immigration through fewer permanent employment visas, and fewer (temporary) employment-based admissions, respectively. While they produce, a relatively small decrease in immigrants, about 3 percent of the total stock of immigrants (See Table 2) , under the baseline parameter configuration, those two policies generate the largest decrease in native income and the strongest depressive effect, on job opportunities, for both types of native workers. These effects are not sensitive to doubling the return rate of either legal or illegal immigrants (column 7 and 8). On the other hand, as the productivity of employment immigrants decreases (column 2 and 3), the negative impact of reducing their presence on job opportunities, especially for skilled workers, becomes smaller. Still, it remains negative and the overall impact on natives, in terms of net income, remains close to -0.2%. By shutting down chain immigration, we prevent further reductions in the size of legal immigrant population, which is predominately skilled. This implies a smaller decrease in the relative supply of skilled labor, which explains why closing the family unification route, somewhat attenuates and increases, respectively, the negative effects of these policies on unskilled and skilled native workers.

The robustness checks for the effects of tightening border controls are shown in Table 5. Results are almost unchanged when decreasing the productivity of employment immigrants, doubling the return rates of immigrants or eliminating chain immigration. This is also true when considering the policy combination of tightening border control together with a higher approval rate of permanent employment visas, shown in Table 9. In the latter case, eliminating chain immigration through the family unification system would attenuate the negative job-creating effect on unskilled workers, would actually generate a significant job creating effect on skilled workers and enhance the positive income effects on natives overall.[25] This is not surprising since in the absence of chain immigration keeping the size of total immigrant population constant implies a large inflow of employment immigrants who are highly productive.

Confirming our previous conclusion that fewer family-based admissions hurt incentives to create skilled jobs mainly by decreasing referrals for other highly productive immigrant workers, we see, in Table 6 that in specifications (2) and (8), which essentially decrease the benefit from hiring immigrants through referrals (by reducing the productivity and increasing the return probability of employment immigrants, respectively), the impact of fewer family admissions on job opportunities (and unemployment rate) for skilled workers turns positive (negative). It remains, however, very small, while the effects on all other labor market variables remain robust to these changes. Hence, in all specifications, reducing family immigration gives a similar percentage decrease in net income.[26]

Finally, changes in the elasticity of substitution (columns 4-6) alter mainly the distributional effects of policies and have very little impact on net income changes. As the degree of skilled-unskilled complementarity decreases (σ increases) the impact of policies that tend to increase (decrease) the relative supply of skilled labor, such as decreasing x_I (such as decreasing x_F, x_T or x_E) becomes more positive (negative) on skilled workers and more negative (positive) on unskilled workers, while in all cases the net income effects remain almost unchanged. This occurs because as the degree of complementarity decreases the effects of changes in relative supply of skills on the marginal products of the two labor types diminish. In the extreme case of perfect substitutability ($\sigma = 1$), those effects become zero.

[25] While in the baseline case the unemployment rate of skilled natives increases by 0.15%, when we eliminate chain immigration it actually decreases by −0.40%. The unemployment rate of unskilled natives increases by 0.23% in the baseline case and by only 0.04% without chain immigration. The effect on net income is positive in all specifications, but much larger when chain immigration is shut down. It ranges between 0.02% and 0.05% in the baseline specification and 0.30% to 0.39% without the family unification route.

[26] Note that, as expected, the effects of fewer family admissions remain intact when we shut down network dependence in column (9). In that case we need a larger decrease in x_F in order to achieve the 10% decrease in the number of legal (family) immigrants, but other than this, all other effects remain exactly the same.

7 Conclusions

In this paper we develop a two-country search and matching model that represents the US and the rest of the World, and we model in detail each of the three channels of immigrant entry to the US: Family reunification, Employment and Illegal. Importantly, we model the opportunities for legal entry through each specific channel, as determined by policies and by the existing networks of family or potential co-workers. In our model immigration policies together with the effectiveness of their enforcement, the incentives of immigrants and the networks size, determine the observed number of immigrants, their conditions for staying in the country, and their composition in terms of skills and productivity. Models of immigration and quantitative assessment of its impact on labor markets and other economic outcomes, have typically treated immigration as an exogenous policy variable, and have neglected the analysis of incentives and network effects. We include these effects in our analysis and we evaluate how immigration policies, affecting each one of those three main channels of entry, affect long-run immigration and its consequences on native labor markets and welfare.

We then use the model to evaluate the labor market effects of some policy proposals, that mirror some existing bills that have been discussed in the Senate and the House in the recent past. For instance the plan to reduce by 50% the family reunification is similar to the RAISE act which has been proposed in the Senate in 2017. Also a drastic increase in deportation rates, in order to reduce (by 10 or 50%) the population of undocumented immigrants is often considered as a more or less explicit goal of the current presidential administration. Moreover a plan to reduce the most prominent temporary visa program (the H1B program) by 10 or 50%, implying a smaller share of temporary and then possibly permanent high skilled employment immigrants, is also reminiscent of bills proposed in the House in 2017. We simulate the effects of these policies, and of alternative, more balanced proposals that do not reduce overall immigration but redistribute it across channels of entry. By changing one entry channel at a time (while leaving other entry channels untouched) we illustrate their labor market impact on native wages and unemployment. The real novelty of our model is that our simulations account for what happens in equilibrium to the inflow of other groups of immigrants, to incentives to migrate and to native unemployment and wages accounting for all these general equilibrium effects.

By capturing important aspects of the labor market and of the immigrant entry, our model allows insights into the effect of different policies that would not be present in a model based on classical labor demand and supply and on the idea that policy controls the total number of immigrants. First, undocumented and unskilled family immigrants as they will have lower pay for same productivity (lower value while unemployed) encourage job creation and may have positive employment effects on natives. Highly skilled employment immigrants, on the other hand, receive higher wages, because they are more productive. Their productivity per unit of wage is also higher than that of natives and their presence generates also a significant job creating effect. Given this job creating effect, we show that a decrease in the inflow of immigrants from any entry route has a depressing effect on the labor market for both skilled and unskilled natives via complementarity in production and job creation.

Second, the two channels of legal entry, family unification and employment, are connected. Family reunification increases opportunities for future employment immigration via networks/referrals and vice versa. The family reunification channels amplifies the negative effects of a decrease in employment immigrants, as fewer employment immigrants generate fewer opportunities for new immigrant entries through family ties. Likewise, to a large extent the negative effects of decreasing family-based admissions come from the consequent decrease in employment immigration. For this reason, a policy combination that reduces entry through one channel but facilitates entry through the other helps attenuate the negative effects and may have positive effects on job creation and total income of natives. We show, in particular, that, unlike a purely restrictive policy, restricting family-based admissions, while increasing employment-based admissions leads to an increase in job creation total income of natives. These are only few of the policy experiments that one can perform using the model. We hope that future research will follow, extending and applying the model to evaluate the the economic effects of a large array of possible immigration policies.

Table 1: Parameterization and matched moments

	From the literature:
$\epsilon = 0.5$	Petrongolo and Pissarides (2001)
$\beta = 0.5$	Satisfies the Hosios(1990)condition
$\sigma = 0.5$	Implies elasticity skilledunskilled equal 2 (Ottaviano and Peri, 2012)
$\underline{z} = 0$	normalization
$d_L = 0.0023$	The ratio of returnees to US residents is 0.027 per year
$d_I = 0.0039$	For Mexican immigrants – Chassamboulli and Peri (2015)
$s_s = 0.032$	The US monthly skilled separation rates – Chassamboulli and Peri (2015)
$s_u = 0.024$	The US monthly unskilled separation rates – Chassamboulli and Peri (2015)
	Measured from the data:
$r = 0.004$	The monthly interest rate
$\tau = 0.00072$	The growth rate of the population 18-65 years of age – Census data
$S = 0.604$	The share of skilled labor force in the US, 18-65 years of age – 2014 ACS
$\tilde{u}_s^2 = 0.067$	Average skilled unemployment rate in China and India – Barro Lee 2010
$\tilde{u}_u^2 = 0.037$	Unskilled unemployment rate in Mexico – Barro Lee 2010
$X_s = 0.562$	Skilled labor force of India+China standardized by US native LF – Barro Lee 2010
$X_u = 0.323$	Unskilled labor force of Mexico standardized by US native LF – Barro Lee 2010
$x_F = 0.015$	It takes about 67 months for a family visa to be issued
	Jointly calibrated to match moments of the data:
$\alpha = 0.703$	The skilled wage premium in the US of 1.78
$\xi = 0.125$	The vacancy to unemployment ratio in the US of 0.62
$b_s = 0.440$	The ratio of unemployment to employment income of 0.71
$b_u = 0.232$	for both skill types (Hall and Milgrom, 2008)
$\pi_{sL} = 0.002$	The wage ratio between: 1. skilled natives and immigrants of the US of 0.92
$\pi_{uL} = 0.183$	2. unskilled natives and legal-unskilled immigrants of the US, of 1.173
$\pi_I = 0.390$	3. illegal (unskilled) immigrants and unskilled natives of the US, of 0.8
$\lambda = 1.626$	4. employment immigrants and family immigrants of the US, of 1.6
$c_s = 0.0170$	The employment rates of skilled and unskilled native workers
$c_u = 0.0445$	in the US: 0.84 and 0.67
$x_T = 0.0206$	The ratio of temporary workers to the US native labor force of 0.0092
$x_E = 0.0066$	The ratio of employment immigrants to the US native labor force of 0.02
$x_I = 0.0908$	The ratio of illegal immigrants to the US native labor force of 0.07
$\bar{z} = 14.04$	The ratio of family immigrants to the US native labor force of 0.116
$d_T = 0.0212$	Average duration of a temporary worker visa is 36 months
$U_s^2 = 22.36$	$U_s^2 = \frac{1}{4} U_{sF}$
$U_u^2 = 7.85$	$U_u^2 = \frac{1}{4} U_{uF}$.

Table 2: Purely restrictive immigration policies (in % changes)

Decrease in immigrants:	**illegal**($\downarrow x_I$) **10%**	**50%**	**illegal** ($\uparrow d_I$) **10%**	**50%**	**family** ($\downarrow x_F$) **10%**	**50%**	**employment** ($\downarrow x_E$) **10%**	**50%**	**temporary** ($\downarrow x_T$) **10%**	**50%**
Tightness:										
θ_s	-0.66	-3.37	-0.68	-3.44	-0.03	-0.32	-0.33	-1.62	-0.31	-1.53
θ_u	-1.53	-8.09	-1.54	-8.15	-1.99	-10.72	-0.93	-5.22	-1.04	-5.71
Unempl. Rates:										
$\tilde{u}_{sN}$	0.28	1.45	0.29	1.48	0.01	0.13	0.14	0.69	0.13	0.65
$\tilde{u}_{uN}$	0.52	2.85	0.52	2.87	0.67	3.83	0.31	1.80	0.35	1.98
Wages:										
w_{sN}	-0.17	-0.87	-0.18	-0.89	0.10	0.50	0.04	0.23	0.05	0.26
w_{uN}	0.46	2.38	0.47	2.43	-0.36	-1.84	-0.17	-0.95	-0.20	-1.04
Net Income										
$\tilde{Y}$	-0.14	-0.71	-0.14	-0.71	-0.29	-1.50	-0.17	-0.93	-0.23	-1.17
$\tilde{Y}_1$	-0.22	-1.16	-0.23	-1.17	-0.39	-2.03	-0.24	-1.27	-0.30	-1.56
Immigrants:										
Family-skilled	0.16	0.76	0.15	0.70	-9.77	-49.41	-2.61	-15.85	-2.26	-14.16
Employment	-0.16	-0.87	-0.18	-0.96	-9.64	-49.06	-10.00	-50.00	-10.00	-50.00
Temporary	-0.16	-0.87	-0.18	-0.96	-9.64	-49.06	-3.86	-22.12	-10.00	-50.00
Family-unskilled	3.40	17.24	3.39	17.23	-12.11	-55.40	-3.64	-20.62	-3.36	-19.23
Illegal	-10.00	-50.00	-10.00	-50.00	-2.79	-16.42	-1.38	-7.95	-1.57	-8.86
Total	-3.02	-15.10	-3.03	-15.14	-7.61	-38.95	-3.00	-16.98	-3.14	-17.57
Total legal	0.35	1.73	0.34	1.67	-9.93	-49.81	-3.79	-21.33	-3.90	-21.77
Skilled/Unskilled	8.93	68.90	8.92	68.80	-5.88	-35.13	-2.14	-12.92	-2.17	-13.01

Table 3: Policy Combination: Border Controls and Increased Employment-Based Admissions (in % changes)

	Increase in x_E		Increase in x_T	
Size of decrease in I:	**10%**	**50%**	**10%**	**50%**
Tightness:				
θ_s	-0.35	-1.51	-0.40	-1.81
θ_u	-0.68	-3.78	-0.62	-3.41
Unemployment Rates:				
$\tilde{u}_{sN}$	0.15	0.64	0.17	0.77
$\tilde{u}_{uN}$	0.23	1.29	0.21	1.17
Wages:				
w_{sN}	-0.25	-1.20	-0.25	-1.25
w_{uN}	0.73	3.75	0.76	3.91
Net Income:				
$\tilde{Y}$	0.05	0.28	0.10	0.58
$\tilde{Y}_1$	0.02	0.18	0.09	0.53
Immigrants:				
Family-skilled	3.11	14.21	2.59	11.46
Family-unskilled	8.34	45.29	7.90	42.53
Employment	12.04	65.45	11.58	62.16
Temporary	4.26	20.28	11.58	62.16
Illegal	-10.00	-50.00	-10.00	-50.00
Total legal	4.82	24.10	4.82	24.10
Ratio skilled to unskilled	12.90	92.93	13.02	94.49

Table 4: Policy Combination: Reduced Family and
Increased Employment Admissions
(in % changes)

	Increase in x_E		Increase in x_T	
Size of decrease in L_F:	**10%**	**50%**	**10%**	**50%**
Tightness:				
θ_s	2.60	13.48	1.70	8.80
θ_u	1.19	5.89	1.24	6.15
Unemployment Rates:				
$\tilde{u}_{sN}$	-1.07	-5.20	-0.71	-3.49
$\tilde{u}_{uN}$	-0.40	-1.91	-0.41	-1.99
Wages:				
w_{sN}	-0.02	-0.13	-0.04	-0.21
w_{uN}	0.25	1.25	0.26	1.30
Net Income				
$\tilde{Y}$	0.47	2.30	0.60	3.01
$\tilde{Y}_1$	0.68	3.31	0.80	3.98
Immigrants:				
Family-skilled	**-10.02**	**-50.05**	**-10.02**	**-50.06**
Family-unskilled	-9.85	-49.54	-9.82	-49.48
Employment	50.03	256.14	33.88	169.88
Temporary	-0.66	-14.60	33.88	169.88
Illegal	2.36	11.59	2.44	11.99
Total legal	-1.14	-5.59	-1.17	-5.78
Ratio skilled to unskilled	-1.04	-4.69	-1.14	-5.23

Table 5: Tighter border controls, robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	bench.	-10% in p_E	-20% in p_E	$\sigma = -0.5$	$\sigma = 0$	$\sigma = 1$	double d_I	double d_L	no chain
θ_s	-0.66	-0.67	-0.68	-1.42	-1.11	0.03	-0.63	-0.67	-0.66
θ_u	-1.53	-1.56	-1.59	0.11	-0.56	-3.02	-1.37	-1.53	-1.58
$\tilde{u}_{sN}$	0.28	0.28	0.29	0.60	0.47	-0.01	0.27	0.28	0.28
$\tilde{u}_{uN}$	0.52	0.53	0.54	-0.04	0.19	1.03	0.46	0.52	0.53
w_{sN}	-0.17	-0.17	-0.18	-0.36	-0.28	0.00	-0.16	-0.17	-0.17
w_{uN}	0.46	0.46	0.46	1.05	0.80	-0.08	0.44	0.46	0.44
$\tilde{Y}$	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.13	-0.14	-0.15
$\tilde{Y}_1$	-0.22	-0.23	-0.23	-0.22	-0.22	-0.23	-0.21	-0.23	-0.23
L_{sF}	0.16	0.16	0.16	-0.31	-0.12	0.59	0.20	0.19	0.16
L_E	-0.16	-0.16	-0.15	-0.98	-0.64	0.59	-0.11	-0.13	-0.16
L_T	-0.16	-0.16	-0.15	-0.98	-0.64	0.59	-0.11	-0.13	-0.16
L_{uF}	3.40	3.39	3.40	4.08	3.80	2.76	3.45	3.41	3.40
I	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00

Table 6: Decrease in family-based admissions, robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	bench.	-10% in p_E	-20% in p_E	$\sigma = -0.5$	$\sigma = 0$	$\sigma = 1$	double d_I	double d_L	no chain
θ_s	-0.03	0.10	0.20	0.20	0.13	-0.45	-0.02	0.08	-0.03
θ_u	-1.99	-1.90	-1.81	-3.05	-2.69	-0.12	-1.96	-1.88	-1.99
$\tilde{u}_{sN}$	0.01	-0.04	-0.08	-0.09	-0.05	0.19	0.01	-0.03	0.01
$\tilde{u}_{uN}$	0.67	0.64	0.61	1.04	0.92	0.04	0.66	0.64	0.67
w_{sN}	0.10	0.09	0.09	0.16	0.14	-0.01	0.10	0.11	0.10
w_{uN}	-0.36	-0.33	-0.31	-0.56	-0.50	0.00	-0.37	-0.38	-0.36
$\tilde{Y}$	-0.29	-0.25	-0.21	-0.32	-0.31	-0.24	-0.29	-0.31	-0.29
$\tilde{Y}_1$	-0.39	-0.33	-0.28	-0.44	-0.42	-0.30	-0.38	-0.40	-0.39
L_{sF}	-9.77	-9.78	-9.79	-9.76	-9.77	-9.78	-9.76	-9.76	-9.77
L_E	-9.64	-9.65	-9.66	-9.54	-9.58	-9.83	-9.63	-9.62	-9.64
L_T	-9.64	-9.65	-9.66	-9.54	-9.58	-9.83	-9.63	-9.62	-9.64
L_{uF}	-12.11	-12.04	-11.96	-12.15	-12.14	-12.04	-12.15	-12.17	-12.11
I	-2.79	-2.72	-2.65	-4.58	-3.97	0.31	-2.62	-2.29	-2.79

Table 7: The effects of fewer permanent employment visas, robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	bench.	-10% in p_E	-20% in p_E	$\sigma=-0.5$	$\sigma=0$	$\sigma=1$	double d_I	double d_L	no chain
θ_s	-0.33	-0.21	-0.09	-0.22	-0.26	-0.53	-0.33	-0.29	-0.45
θ_u	-0.93	-0.87	-0.81	-1.43	-1.26	-0.04	-0.91	-0.85	-0.48
$\tilde{u}_{sN}$	0.14	0.09	0.04	0.09	0.11	0.22	0.14	0.12	0.19
$\tilde{u}_{uN}$	0.31	0.29	0.27	0.48	0.43	0.01	0.31	0.29	0.16
w_{sN}	0.04	0.04	0.04	0.07	0.06	-0.01	0.04	0.04	0.02
w_{uN}	-0.17	-0.16	-0.15	-0.27	-0.24	0.00	-0.18	-0.18	-0.09
$\tilde{Y}$	-0.17	-0.15	-0.13	-0.19	-0.18	-0.15	-0.17	-0.18	-0.12
$\tilde{Y}_1$	-0.24	-0.21	-0.18	-0.26	-0.25	-0.20	-0.24	-0.24	-0.17
L_{sF}	-2.61	-2.61	-2.61	-2.53	-2.55	-2.75	-49.39	-2.72	0.40
L_E	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-49.03	-10.00	-10.00
L_T	-3.86	-3.80	-3.72	-3.75	-3.79	-4.05	-49.03	-1.89	-1.42
L_{uF}	-3.64	-3.64	-3.63	-3.58	-3.60	-3.76	-55.54	-3.77	0.00
I	-1.38	-1.30	-1.22	-2.22	-1.93	0.10	-15.35	-1.10	-0.79

Table 8: The effects of fewer employment-based admissions, robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	bench.	-10% in p_E	-20% in p_E	$\sigma = -0.5$	$\sigma = 0$	$\sigma = 1$	double d_I	double d_L	no chain
θ_s	-0.31	-0.19	-0.07	-0.19	-0.23	-0.53	-0.30	-0.26	-0.41
θ_u	-1.04	-0.97	-0.90	-1.61	-1.41	-0.04	-1.02	-0.99	-0.67
$\tilde{u}_{sN}$	0.13	0.08	0.03	0.08	0.10	0.22	0.13	0.11	0.17
$\tilde{u}_{uN}$	0.35	0.33	0.30	0.54	0.48	0.01	0.34	0.33	0.23
w_{sN}	0.05	0.05	0.04	0.08	0.07	-0.01	0.05	0.05	0.03
w_{uN}	-0.20	-0.18	-0.16	-0.31	-0.27	0.00	-0.20	-0.21	-0.13
$\tilde{Y}$	-0.23	-0.20	-0.18	-0.24	-0.24	-0.20	-0.23	-0.25	-0.20
$\tilde{Y}_1$	-0.30	-0.27	-0.23	-0.33	-0.32	-0.25	-0.30	-0.32	-0.27
L_{sF}	-2.26	-2.26	-2.26	-2.17	-2.20	-2.43	-2.26	-2.26	0.56
L_E	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
L_T	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
L_{uF}	-3.36	-3.36	-3.36	-3.28	-3.31	-3.51	-3.39	-3.40	0.00
I	-1.57	-1.48	-1.38	-2.52	-2.19	0.09	-1.48	-1.32	-1.11

Table 9: The effects of decreasing illegal and increasing employment immigration, robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	bench.	-10% in p_E	-20% in p_E	$\sigma = -0.5$	$\sigma = 0$	$\sigma = 1$	double d_I	double d_L	no chain
θ_s	-0.35	-0.49	-0.64	-1.51	-1.02	0.60	-0.32	-0.39	0.96
θ_u	-0.68	-0.75	-0.82	2.08	0.90	-2.95	-0.51	-0.72	-0.13
$\tilde{u}_{sN}$	0.15	0.21	0.27	0.64	0.43	-0.25	0.14	0.16	-0.40
$\tilde{u}_{uN}$	0.23	0.25	0.27	-0.69	-0.30	1.00	0.17	0.24	0.04
w_{sN}	-0.25	-0.24	-0.24	-0.56	-0.42	0.01	-0.24	-0.24	-0.29
w_{uN}	0.73	0.71	0.69	1.72	1.30	-0.08	0.71	0.72	0.96
$\tilde{Y}$	0.05	0.02	0.00	0.07	0.06	0.03	0.05	0.05	0.30
$\tilde{Y}_1$	0.02	-0.01	-0.04	0.07	0.05	-0.01	0.04	0.03	0.39
L_{sF}	3.11	3.10	3.10	2.83	2.95	3.33	3.12	3.29	-1.80
L_E	12.04	12.07	12.11	12.63	12.37	11.56	11.97	12.14	40.05
L_T	4.26	4.18	4.08	3.62	3.89	4.77	4.27	1.83	4.52
L_{uF}	8.34	8.30	8.26	10.31	9.47	6.72	8.35	8.42	3.96
I	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00

Table 10: The effects of decreasing family and increasing employment immigration, robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	bench.	-10% in p_E	-20% in p_E	$\sigma = -0.5$	$\sigma = 0$	$\sigma = 1$	double d_I	double d_L	no chain
θ_s	2.60	1.98	1.31	2.32	2.41	3.26	2.60	2.97	2.60
θ_u	1.19	0.97	0.73	1.72	1.55	-0.10	1.17	1.20	1.19
$\tilde{u}_{sN}$	-1.07	-0.82	-0.54	-0.96	-1.00	-1.34	-1.07	-1.22	-1.07
$\tilde{u}_{uN}$	-0.40	-0.32	-0.24	-0.57	-0.52	0.03	-0.39	-0.40	-0.40
w_{sN}	-0.02	-0.02	-0.02	-0.06	-0.05	0.06	-0.03	-0.02	-0.02
w_{uN}	0.25	0.20	0.16	0.36	0.32	0.00	0.26	0.27	0.25
$\tilde{Y}$	0.47	0.41	0.35	0.45	0.46	0.51	0.47	0.54	0.47
$\tilde{Y}_1$	0.68	0.58	0.47	0.66	0.67	0.72	0.68	0.78	0.68
L_{sF}	-10.02	-10.02	-10.03	-10.01	-10.01	-10.04	-10.02	-10.02	-10.02
L_E	50.03	47.61	45.47	47.20	48.11	56.92	50.33	58.94	50.03
L_T	-0.66	-1.33	-2.30	-1.11	-0.97	0.45	-0.62	-18.39	-0.65
L_{uF}	-9.85	-9.79	-9.72	-9.93	-9.90	-9.65	-9.81	-9.79	-9.85
I	2.36	2.02	1.65	3.23	2.95	0.25	2.27	2.15	2.36

References

[1] Acemoglu Daron and Fabrizio Zilibotti, 2001. "Productivity Differences," The Quarterly Journal of Economics, Oxford University Press, vol. 116(2), pages 563-606.

[2] Barro Robert and Jong-wha Lee (2015) "Data Set on Long-term Educational Attainment by Country" available at http://barrolee.com/data/oup$_download_b.htm$.

[3] Basso Gaetano , Giovanni Peri and Ahmed Rahman, 2017. "Computerization and Immigration: Theory and Evidence from the United States," NBER Working Papers 23935, National Bureau of Economic Research, Inc.

[4] Battisti Michele, Gabriel Felbermayr, Giovanni Peri and Panu Poutvaara, (forthcoming) "Immigration, Search, and Redistribution: A Quantitative Assessment of Native Welfare," (forthcoming) *Journal of the European Economic Association*.

[5] Borjas, George J. (2016) "The Labor Supply of Undocumented Immigrants," NBER Working Papers 22102, National Bureau of Economic Research, Inc.

[6] Bound, J., G. Khanna and N. Morales, 2017. Understanding the Economic Impact of the X-1B Program on the US," in High-Skilled Migration to the United States and its Economic Consequences, G.X. Hanson, W.R. Kerr and S. Turner (Eds.). University of Chicago Press, forthcoming.

[7] Calvo-Armengol Antoni and Yves Zenou, 2005. "Job matching, social networking and word-of-mouth communication," Journal of Urban Economics, 57, 500522.

[8] Chassamboulli Andri and Theodore Palivos, (2014) "A Search-Equilibrium Approach To The Effects Of Immigration On Labor Market Outcomes," *International Economic Review*, vol. 55, 111-129, 02.

[9] Chassambouli Andri and Giovanni Peri, (2015). "The Labor Market Effects of Reducing the Number of Illegal Immigrants," Review of Economic Dynamics, Elsevier for the Society for Economic Dynamics, vol. 18(4), pages 792-821, October.

[10] Clemens Michael, Ethan Lewis, Hannah Postel, 2017. "Immigration Restrictions as Active Labor Market Policy: Evidence from the Mexican Bracero Exclusion - Working Paper 451," Working Papers 451, Center for Global Development.

[11] Fernndez-Huertas Moraga, Jess , 2011. "New Evidence on Emigrant Selection," The Review of Economics and Statistics, MIT Press, vol. 93(1), pages 72-96, February.

[12] Francois Fontaine, 2008. "Why are similar workers paid differently? The role of social networks." Journal of Economic Dynamics and Control, 32 39603977.

[13] Galenianos M. 2013. "Learning about match quality and the use of referrals." Review of Economic Dynamics, Volume 16, Issue 4, pp. 668-690.

[14] Galenianos M. 2014. "Hiring through Referrals." Journal of Economic Theory, vol. 152, 304-323

[15] Goldin Claudia and Larry Katz (2008) "The Race between education and Technology", Harvard University press, Boston Mass, 2008.

[16] Grogger, Jeffrey and Hanson, Gordon X., 2011. Income maximization and the selection and sorting of international migrants," Journal of Development Economics, 95(1): 42- 57.

[17] Hanson Gordon & Chen Liu & Craig McIntosh, 2017." The Rise and Fall of U.S. Low-Skilled Immigration," NBER Working Papers 23753, National Bureau of Economic Research, Inc.

[18] Horvath, G. 2014. Occupational mismatch and social networks, Journal of Economic Behavior and Organization, 106(C), 442468.

[19] Hunt, Jennifer 2011. "Which Immigrants Are Most Innovative and Entrepreneurial? Distinctions by Entry Visa," Journal of Labor Economics, University of Chicago Press, vol. 29(3), pages 417-457.

[20] Jaimovich, N. and X.E. Siu. (2017). "High-Skilled Immigration, STEM Employment,and Non-Routine-Biased Technical Change," in High-Skilled Migration to the United States and its Economic Consequences, G.X. Hanson, W.R. Kerr and S. Turner (Eds.).University of Chicago Press, forthcoming.

[21] Kaestner Robert and Ofer Malamud (2014) "Self-selection and International migration New Evidence from Mexico" Review of Economics and Statistics Volume 96, Issue 1, March 2014 p.78-91.

[22] Kerr William R. and William F. Lincoln, 2010. "The Supply Side of Innovation: X-1B Visa Reforms and U.S. Ethnic Invention," Journal of Labor Economics, University of Chicago Press, vol. 28(3), pages 473-508, July.

[23] Lewis, Ethan & Peri, Giovanni, (2015). "Immigration and the Economy of Cities and Regions," Handbook of Regional and Urban Economics, Elsevier.

[24] Lofstrom, Magnus and Hayes, Joseph, 2011. "X-1Bs: How Do They Stack Up to US Born Workers?," IZA Discussion Papers 6259, Institute for the Study of Labor (IZA).

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

[26] Mayda Anna Maria, Francesc Ortega, Giovanni Peri, Kevin Shih and Chad Sparber, 2017. "The Effect of the X-1B Quota on Employment and Selection of Foreign-Born Labor," NBER Working Papers 23902, National Bureau of Economic Research, Inc.

[27] Munshi, Kaivan 2003. "Networks in the Modern Economy: Mexican Migrants in the U. S. Labor Market," The Quarterly Journal of Economics, Oxford University Press, vol. 118(2), pages 549-599.

(2017)

[28] Ottaviano, G. I., and Peri, G. (2012). Rethinking the Effect of Immigration on Wages. *Journal of the European Economic Association*, 10(1), 152-197.

[29] Ortega Francesc and Giovanni Peri, 2015. "Migration Policies: Recent Advances on Measurement, Determinants and Outcomes," CESifo Economic Studies, CESifo, vol. 61(3-4), pages 521-526.

[30] Peri, Giovanni 2016. "Immigrants, Productivity, and Labor Markets," Journal of Economic Perspectives, American Economic Association, vol. 30(4), pages 3-30, Fall.

[31] Pope, Nolan 2016 The Effects of DACAmentation: The Impact of Deferred Action for Childhood Arrivals on Unauthorized Immigrants, Journal of Public Economics 143: 98-114, 2016

A Model Details

A.1 Bellman Equations

The Bellman equations describing the values of job vacancies for unskilled and skilled workers in country 1 are as follows:

$$rV_u = -c_u + q(\theta_u)\left[\phi_u\left(\eta_I J_I + (1-\eta_I)J_{uF}\right) + (1-\phi_u)J_{uN} - V_u\right] \quad (29)$$

$$rV_s = -c_s + q(\theta_s)\left[\phi_s\left(\eta_E J_E + (1-\eta_E)J_{sF}\right) + (1-\phi_s)J_{sN} - V_s\right] \quad (30)$$

where ϕ_i is the proportion of unemployed workers of skill type i that are immigrants, η_I is the proportion of unemployed unskilled immigrants that are illegal and η_E is the proportion of unemployed skilled immigrants that have employment visas.

The value of a job in country 1 depends on the origin and immigrant status of the worker filling the job and is expressed by the following equations:

$$rJ_T = p_E - w_T + x_E\left[J_E - J_T\right] + (d_T + \tau)\left[V_s - J_T\right] \quad (31)$$

$$rJ_{iN} = p_i - w_{iN} + (s_i + \tau)\left[V_i - J_{iN}\right] \quad i = [s, u] \quad (32)$$

$$rJ_I = p_u - w_I + (s_u + d_I + \tau)\left[V_u - J_I\right] \quad (33)$$

$$rJ_{uF} = p_u - w_{uF} + (s_u + d_L + \tau)\left[V_u - J_{uF}\right] \quad (34)$$

$$rJ_{sF} = p_s + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) J_T - w_{sF} + (s_s + d_L + \tau)\left[V_s - J_{sF}\right] \quad (35)$$

$$rJ_E = p_E + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) J_T - w_E + (s_s + d_L + \tau)\left[V_s - J_E\right] \quad (36)$$

When a job is filled by a native worker its value (J_{iN}) takes the standard form: it is equal to the flow surplus that the job generates (productivity minus the wage) plus the expected capital loss in case the job is destroyed (match breaks up), which occurs at rate $s_i + \tau$. The effective rate of destruction of jobs filled by immigrants is larger; it is given by $s_s + d_L + \tau$ if the immigrant is legal, $s_u + d_I + \tau$ if illegal and $d_T + \tau$ if the immigrant is on a temporary work permit. Notice that matches with immigrants on temporary work permits break up at rate $d_T + \tau$, due to labor force exits or returns, there are no separations to unemployment in this case, since stay in country 1 on a temporary work permit is conditional on having a job. The use of referrals to hire skilled workers from country 2 can generate an expected flow of surplus equal to $x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) J_T$: the probability that an employment visa is approved (given that the employer is willing to sponsor a skilled worker's migration), x_T, times the probability that a match with a foreign skilled worker is created, $\tilde{u}_s^2 \Phi(\tilde{z}_T)$, times the firm's value of such a match, J_T. A match with a foreign worker will be created if the contacted worker is unemployed, the probability of which is $\tilde{u}_s^2$ and willing to immigrate (i.e. his immigration cost is sufficiently low) the probability of which is $\Phi(\tilde{z}_T)$. We assume that the use of referrals can increase the value of a job filled by a skilled immigrant by a fraction $\delta \in [0, 1]$ of this expected surplus.[27] If $\delta = 1$ the employer fully internalizes the flow surplus that the use of referrals from his current skilled immigrant employee can generate, while in the other extreme, where

[27] Galenianos (2014) adopts an alternative assumption; that new jobs created through the use of referrals are immediately sold off to keep a firm's employment at one. The firm receives a share $\delta \in [0, 1]$ of the surplus of the job from selling it and the remaining goes to the buyer.

$\delta = 0$ the employer does not internalize that surplus and the flow value of a match with a skilled immigrant worker is only his/her productivity (p_s or p_E). In our benchmark model, analyzed and the main text, we set $\delta = 0$ so that the use of referrals to hire skilled foreign workers does not generates any rents to the firm and does not affect job creation incentives. In Appendix B, in Table 17 we also present results with $\delta > 0$. Finally, workers on temporary employment visas may transfer to a permanent status with probability x_E and thereby generate a flow surplus equal to $J_E - J_T$.

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

$$
\begin{aligned}
(r+\tau)U_{iN} &= b_i + m(\theta_s)\left[E_{iN} - U_{iN}\right] && (37)\\
(r+\tau)U_{iF} &= b_i - \pi_{iL} + m(\theta_s)\left[E_{iF} - U_{iF}\right] + d_L\left[U_i^2 - U_{iF}\right] && (38)\\
(r+\tau)U_{I} &= b_u - \pi_{I} + m(\theta_u)\left[E_{I} - U_{I}\right] + d_I\left[U_u^2 - U_{I}\right] && (39)\\
(r+\tau)U_{E} &= b_s - \pi_{iL} + m(\theta_s)\left[E_{E} - U_{E}\right] + d_L\left[U_s^2 - U_{E}\right] && (40)
\end{aligned}
$$

There is no value of being unemployed in country 1 for an immigrant on temporary work permit, since, as already mentioned, stay in country 1 on a temporary work permit is conditional on being employed. All immigrants on temporary work permits are employed, otherwise they return home.

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

$$
\begin{aligned}
(r+\tau)E_{iN} &= w_{iN} + s_i\left[U_{iN} - E_{iN}\right] && (41)\\
(r+\tau)E_{iF} &= w_{iF} + s_i\left[U_{iF} - E_{iF}\right] + d_L\left[U_i^2 - E_{iF}\right] && (42)\\
(r+\tau)E_{I} &= w_{I} + s_u\left[U_{I} - E_{I}\right] + d_I\left[U_u^2 - E_{I}\right] && (43)\\
(r+\tau)E_{E} &= w_{E} + s_s\left[U_{E} - E_{E}\right] + d_L\left[U_s^2 - E_{E}\right] && (44)\\
(r+\tau)E_{T} &= w_{T} + x_E\left[E_{E} - E_{T}\right] + d_T\left[U_s^2 - E_{T}\right] && (45)
\end{aligned}
$$

A.2 Steady-State Conditions

By equating the outflow of immigrants of each type, which includes returns to the home country and labor force exits, to the inflow of new immigrants into each group we obtain the steady-state conditions for the number of immigrants that hold permanent family or employment visas, L_{iF} and L_E, respectively, the number of immigrants on temporary work permits, L_T and the number of illegal immigrants, I:

$$
\begin{aligned}
(d_L+\tau)L_{iF} &= x_F \frac{L_P}{X} u_i^2 \Phi(\tilde{z}_{iF}) && (46)\\
(d_L+\tau)L_{E} &= x_E L_T && (47)\\
(d_T + x_E + \tau)L_T &= x_T \left(\frac{L_s - u_{sL}}{X_s - L_s}\right) u_s^2 \Phi(\tilde{z}_T) && (48)\\
(d_I+\tau)I &= x_I u_u^2 \Phi(\tilde{z}_I) && (49)
\end{aligned}
$$

where $L_s - u_{sL} = e_{sL}$ and $u_{sL} = u_{sF} + u_E$ gives the total number of skilled-legal immigrants that are unemployed. It includes both those holding employment visas (u_E) and those holding family visas (u_{sF}). Notice that besides repatriation and labor force exits, outflows from the group of immigrants on temporary work permits include also transitions to permanent residency (at rate x_E). In addition, entry into each group of immigrants comes from country 2, but for the group of permanent employment-based immigrants. Those are previously temporary employment immigrants that transition to permanent residency.

The conditions for steady-state unemployment of natives (u_{sN} and u_{uN}), immigrants on family visas (u_{sF} and u_{uF}), immigrants on employment visas (u_E) and illegal immigrants (u_I) are as follows

$$\tau S + s_s(S - u_{sN}) = (m(\theta_s) + \tau)u_{sN} \quad (50)$$

$$\tau(1 - S) + s_u(1 - S - u_{uN}) = (m(\theta_u) + \tau)u_{uN} \quad (51)$$

$$s_i(L_{iF} - u_{iF}) + x_F \frac{L_P}{X}\Phi(\tilde{z}_{iF})u_i^2 = (m(\theta_i) + d_L + \tau)\, u_{iF} \quad (52)$$

$$s_s(L_E - u_E) = (m(\theta_s) + d_L + \tau)\, u_E \quad (53)$$

$$s_u(I - u_I) + x_I\Phi(\tilde{z}_I)u_u^2 = (m(\theta_u) + d_I + \tau)\, u_I \quad (54)$$

Equations (50) and (51) show that flows into the pools of unemployed skilled and unskilled natives of country 1 include new labor force entrants and those who separate from their jobs (at the exogenous rate s_s and s_u, respectively), while flows out of these pools consist of those who find jobs (at the job finding rate $m(\theta_s)$ and $m(\theta_u)$, respectively) and those who exit the labor force. The rate at which workers find skilled and unskilled jobs depend on the labor market tightness that prevails in the skilled and unskilled labor market (θ_s and θ_u, respectively). Since new family-based and illegal immigrants arrive in country 1 without a job, flows into these two pools (left-hand-sides of 52 and 54) come partly from the inflow of new immigrants ($x_F \frac{L_P}{X}\Phi(\tilde{z}_{iF})u_i^2$ and $x_I\Phi(\tilde{z}_I)u_u^2$, respectively) and partly from the job separations of incumbent immigrants. Flows out of these pools (right-hand-sides of 52 and 54) can be either due to job finding, exogenous returns to country 2 and labor-force exits. Similarly, flows of employment immigrants out of unemployment (right-hand-side of 53) come from job finding, returns and labor-force exits. However, inflows of (permanent) employment-based immigrants into unemployment (left-hand-side of 53) come only from job separations and do not include new immigrants, since new employment-based immigrants, i.e. those who switch from temporary to permanent employment visas, already have jobs.

A.3 Wages

Using the Bellman equations (29) to (45), the free-entry conditions (4) the Nash bargaining conditions (5) to (8) and the immigration conditions in (9) to (11), we can solve for the equilibrium wage rates. Their expressions are as follows:

$$
\begin{aligned}
w_{iN} &= \beta p_i + (1-\beta)\left[b_i + \beta m(\theta_i) S_{iN}\right], \quad i = [s,u] && (55)\\
w_{uF} &= \beta p_u + (1-\beta)\left[b_u - \pi_L + \beta m(\theta_u) S_{uF}\right] && (56)\\
w_{I} &= \beta p_u + (1-\beta)\left[b_u - \pi_I + \beta m(\theta_u) S_{I}\right] && (57)\\
w_{sF} &= \beta\left[p_s + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) J_T\right] + (1-\beta)\left[b_s - \pi_L + \beta m(\theta_s) S_{sF}\right] && (58)\\
w_{E} &= \beta\left[p_E + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) J_T\right] + (1-\beta)\left[b_s - \pi_L + \beta m(\theta_s) S_{E}\right] && (59)\\
w_{T} &= \beta p_E + (1-\beta)\left[(r+\tau)U_s^2 - x_E(U_E - U_s^2)\right] && (60)
\end{aligned}
$$

A workers wage is a weighted average of the flow value that he generates to the firm and the outside option available to him. The weight put on the flow value by the Nash-bargaining formula is the parameter expressing the workers bargaining power (β). The outside options depend on not only the workers' skill type but also on their nativity and immigration status and they are equal to the unemployment flow income (net of search cost) plus the expected gain from search. Notice that the outside option of those working in country 1 on temporary employment visas is not the value of searching for a job in country 1, but instead, the value of searching for a job in country 2 ($(r+\tau)U_s^2$), since as explained above, these workers' stay (or entry) in country 1 is conditional on them having a job in country 1. Finally, notice that workers on temporary visas are willing to accept a wage cut in exchange of the possibility of switching from a temporary to a permanent employment visa. This is captured by the last term in (60): the wage of temporary visa holders (w_T) is smaller the higher the probability that they will transition from temporary to permanent residency, x_E, and the larger the expected gain from this transition. The expected gain from this transition is the difference between the value of searching for a job in country 1 as a permanent employment-based immigrant and the value of searching for a job in country 2 as a native.

A.4 Value of a Filled Vacancy

Setting $V_i = 0$ in (31) to (36) we get:

$$
\begin{aligned}
J_{iN} &= = \frac{p_i - w_{iN}}{r + s_i + \tau}, \quad t = [s,u] && (61)\\
J_{uF} &= \frac{p_u - w_{uF}}{r + s_u + d_L + \tau} && (62)\\
J_{sF} &= \frac{p_s - w_{sF} + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) J_T}{r + s_s + d_L + \tau} && (63)\\
J_{E} &= \frac{p_E - w_E + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) J_T}{r + s_s + d_L + \tau} && (64)\\
J_{I} &= \frac{p_u - w_I}{r + s_u + d_I + \tau} && (65)\\
J_{T} &= \frac{p_E - w_T + x_E J_E}{r + d_T + \tau + x_E} && (66)
\end{aligned}
$$

Apparently the values of jobs to the firms increase with the worker's productivity and decease with the worker's break up probability and wage, while the use of referrals to hire workers on temporary visas may also increase the value of jobs filled by skilled immigrants given $\delta \geq 0$. Notice also that the value to the firm from employing a temporary worker J_T increases with J_E, since with probability x_E the worker may become a permanent immigrant.

Substituting the equilibrium wages (given in equations 55 to 60) into the equations above and using the Nash bargaining conditions in (5) to (8) we can write:

$$J_{iN} = (1-\beta)S_{iN} = \frac{(1-\beta)(p_i - b_i)}{r + s_i + \tau + \beta m(\theta_i)}, \quad i = [s,u] \tag{67}$$

$$J_{uF} = (1-\beta)S_{uF} = \frac{(1-\beta)(p_u - b_u + \pi_L)}{r + s_u + d_L + \tau + \beta m(\theta_u)} \tag{68}$$

$$J_{sF} = (1-\beta)S_{sF} = \frac{(1-\beta)(p_s - b_s + \pi_L + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) S_T)}{r + s_s + d_L + \tau + \beta m(\theta_s)} \tag{69}$$

$$J_E = (1-\beta)S_E = \frac{(1-\beta)(p_E - b_s + \pi_L + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) S_T)}{r + s_s + d_L + \tau + \beta m(\theta_s)} \tag{70}$$

$$J_I = (1-\beta)S_I = \frac{(1-\beta)(p_u - b_u + \pi_I)}{r + s_u + d_I + \tau + \beta m(\theta_u)} \tag{71}$$

$$J_T = (1-\beta)S_T = \frac{(1-\beta)(p_E + x_E S_E - (r+\tau)U_s^2 + x_E(U_E - U_s^2))}{r + d_T + \tau + x_E} \tag{72}$$

where

$$U_E - U_s^2 = \frac{b_s - \pi_L + \beta m(\theta_s) S_E - (r+\tau)U_s^2}{r + \tau + d_L} \tag{73}$$

Notice also that the marginal products p_s, p_u and $p_E = \lambda p_s$, can be expressed using (2) and (3) and the steady-state conditions in (12)-(21) and (48) in terms of market tightness and the thresholds costs. The above equations therefore give the values of the surpluses S_{iN}, S_{iF}, S_E and S_T, $i = [s,u]$, in terms of the endogenous variables: θ_u, θ_s, $\tilde{z}_I, \tilde{z}_{sF}, \tilde{z}_{uF}, \tilde{z}_T$.

A.5 The Threshold Immigration Costs

Applying the Nash bargaining conditions in (5) to (8) to equations (38), (39) and (45) and using the threshold conditions in (9)-(11) we get:

$$\tilde{z}_I = \frac{b_u - \pi_I + \beta m(\theta_u) S_I - (r+\tau)U_u^2}{r + \tau + d_I} \tag{74}$$

$$\tilde{z}_{iF} = \frac{b_i - \pi_L + \beta m(\theta_i) S_{iF} - (r+\tau)U_i^2}{r + \tau + d_L}, \quad i = [s,u] \tag{75}$$

$$\tilde{z}_T = \frac{\beta\,(p_E - (r+\tau)U_s^2) + x_E\,(U_E - U_s^2 + S_E)}{r + \tau + d_T + x_E} \tag{76}$$

where $U_E - U_s^2$ is given by expression (73). Inspecting the above equations shows that all threshold immigration costs increase when the relevant job finding rate is higher, the corresponding job surplus larger, and the return probability smaller. In other words, a worker has stronger incentive to migrate through each of the three channels when the wage he expects to earn as an immigrant is larger or his duration of stay in country 1 is expected to be longer. This can be seen more clearly when we use (56)-(60) to express the thresholds in terms of wages:

$$\tilde{z}_I = \frac{\frac{w_I - \beta p_u}{1-\beta} - (r+\tau)U_u^2}{r+\tau+d_L} \tag{77}$$

$$\tilde{z}_{iF} = \frac{\frac{w_{iF} - \beta p_i}{1-\beta} - (r+\tau)U_i^2}{r+\tau+d_L}, \quad i = [s,u] \tag{78}$$

$$\tilde{z}_T = \frac{Cw_T + (1-C)W_P - (r+\tau)U_s^2}{r+\tau+d_L} \tag{79}$$

where

$$W_P \equiv \left[Dw_E + (1-D)\left(\frac{w_E - \beta(p_i + \delta x_T \tilde{u}_s^2 \Phi(\tilde{z}_T) S_T))}{1-\beta} \right) \right]$$

$$C \equiv \frac{r+\tau+d_L}{r+\tau+d_L+x_E}$$

$$D \equiv \frac{r+\tau+d_L}{r+\tau+d_L+s_s}$$

The first terms in (77) and (78) represent the values of searching for jobs in country 1 for an illegal immigrant and a family immigrant, respectively. These values are higher the higher the corresponding wage (w_I and w_{iF}). In the case of a temporary work permit, where entry is with a job, the first term (in 79), represents the value of being employed on a temporary work permit given that there is a possibility of transition to permanent residency. It is the weighted average of the wage he can earn as temporary immigrant (w_T) and the value of switching to permanent residency (W_P). The latter is the weighted average of the wage he can earn as a permanent employment immigrant (w_E) and the value of searching for a new job in country 1, in the event of separation with he current employer. Because of the possibility of transferring to a permanent visa, the benefit of entry on a temporary work permit increases with both w_T and w_E.

A.6 Solving the Model

By substituting the equations (67) to (73) into the two job creation conditions (22)-(23) and the four threshold conditions in (74)-(76) we get six equations in six unknowns which can be used to solve for the two market tightnesses, θ_u and θ_s, and the four thresholds, $\tilde{z}_I, \tilde{z}_{sF}, \tilde{z}_{uF}, \tilde{z}_T$, in terms of model parameters. The equilibrium values of tightnesses and thresholds can then be substituted in (2) and (3) to determine the equilibrium productivities, and then in (55)-(60) to determine wages, and in the steady-state conditions in (12)-(21) to determine immigrant stocks and unemployment rates.

B Additional robustness checks and extensions

The structure of Tables 11-16 that follow mirrors that of Tables 5-10 in the text. Each table is devoted to one policy producing a 10% decrease in the relevant immigrant group. It shows results in the baseline case in the first column while the rest of the columns are devoted to robustness checks on six parameters. In columns (2) and (3) we change the bargaining power parameter. In particular we set $\beta = 0.4$ and $\beta = 0.3$. In columns (4) and (5) we set $\epsilon = 0.6$ and $\epsilon = 0.4$; a higher and lower value for the matching function elasticity. In column (6) we lower the targeted replacement ratio to 0.5 implying a lower value for the flow unemployment income b_i. In columns (7) and (8) we increase the value of searching for a job as an immigrant in the US relative to the value of searching for a job at home and set $U_{iF} = 5U_i^2$ and $U_{iF} = 6U_i^2$, respectively. And finally, in columns (9) and (10) we double the separation rates (s_s and s_u) for skilled and unskilled workers, respectively. The Tables show that our main results are not sensitive to these changes.

Next we analyze the case where the employer of skilled immigrants internalizes the surplus that the use of referrals generates. In Table 17 we examine how the effects of the policies considered above change when the use of referrals to hire skilled workers from abroad on temporary worker visas increases the employers surplus (i.e. $\delta > 0$). While in the benchmark calibration we set $\delta = 0$ in the table we also show results for $\delta = 0.5$. As above, the policies implemented produce a 10% decrease in the relevant immigrant group. When the employer internalizes the benefit from the use of referrals, employing skilled immigrants becomes more valuable to him. As a result, the impact of policies that discourage legal entry either directly or through their impact on networks and incentives for legal entry, such as fewer family-based or employment-based admissions becomes more negative on skilled job creation, while the impact of the two policy combinations that discourage illegal-unskilled or family immigration and favor skilled immigration, becomes more positive on the skilled job creation.

Finally, in Table 18, which mirrors the structure of Table 17 we show results when the wage ratio of employment to family immigrants is set to 2.5. As mentioned in Section 4 this is the ratio obtained from NIS when we consider as employment immigrants those belonging to the group "others". By increasing the wage ratio of employment to family immigrants we essentially make employment immigrants more productive and therefore more valuable to employers. Thus, results are similar to those reported in Table 17 for the case of $\delta = 0.5$. The effects of policies discouraging legal entry are more negative in terms of job creation, while those of policies shifting immigrant composition towards employment immigration are more positive, in terms of job creation, especially for skilled workers.

Table 11: The effects of tighter border controls, additional robustness checks

	(1) benchmark	(2) $\beta = 0.4$	(3) $\beta = 0.3$	(4) $\epsilon = 0.6$	(5) $\epsilon = 0.4$	(6) 0.5 repl. ratio	(7) $U_{iF} = 5U_i^2$	(8) $U_{iF} = 6U_i^2$	(9) double s_s	(10) double s_u
θ_s	-0.66	-0.61	-0.57	-0.71	-0.62	-0.39	-0.66	-0.66	-0.66	-0.68
θ_u	-1.53	-0.78	-0.18	-1.61	-1.45	-1.01	-1.52	-1.52	-1.53	-1.66
$\tilde{u}_{sN}$	0.28	0.26	0.24	0.36	0.21	0.16	0.28	0.28	0.28	0.29
$\tilde{u}_{uN}$	0.52	0.26	0.06	0.65	0.39	0.34	0.52	0.51	0.52	0.56
w_{sN}	-0.17	-0.16	-0.15	-0.18	-0.16	-0.17	-0.17	-0.17	-0.17	-0.17
w_{uN}	0.46	0.40	0.35	0.46	0.45	0.46	0.46	0.46	0.45	0.47
$\tilde{Y}$	-0.14	-0.14	-0.14	-0.15	-0.13	-0.16	-0.14	-0.14	-0.13	-0.14
$\tilde{Y}_1$	-0.22	-0.20	-0.19	-0.25	-0.20	-0.20	-0.22	-0.22	-0.22	-0.23
L_{sF}	0.16	0.30	0.41	0.08	0.23	0.10	0.19	0.20	0.15	0.15
L_E	-0.16	0.00	0.12	-0.26	-0.06	-0.18	-0.12	-0.11	-0.17	-0.18
L_T	-0.16	0.00	0.12	-0.26	-0.06	-0.18	-0.12	-0.11	-0.17	-0.18
L_{uF}	3.40	3.66	3.80	3.22	3.55	3.45	3.41	3.42	3.38	3.38
I	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00

Table 12: The effects of fewer family-based admissions, additional robustness checks

	(1) benchmark	(2) $\beta = 0.4$	(3) $\beta = 0.3$	(4) $\epsilon = 0.6$	(5) $\epsilon = 0.4$	(6) 0.5 repl. ratio	(7) $U_{iF} = 5U_i^2$	(8) $U_{iF} = 6U_i^2$	(9) double s_s	(10) double s_u
θ_s	-0.03	0.10	0.13	-0.10	0.03	-0.03	0.00	0.02	-0.08	-0.03
θ_u	-1.99	-1.66	-1.55	-2.15	-1.85	-1.68	-1.92	-1.88	-2.00	-2.01
$\tilde{u}_{sN}$	0.01	-0.04	-0.05	0.05	-0.01	0.01	0.00	-0.01	0.03	0.01
$\tilde{u}_{uN}$	0.67	0.56	0.53	0.87	0.50	0.57	0.65	0.64	0.68	0.68
w_{sN}	0.10	0.12	0.13	0.08	0.11	0.08	0.11	0.11	0.10	0.10
w_{uN}	-0.36	-0.42	-0.42	-0.33	-0.39	-0.34	-0.38	-0.39	-0.36	-0.36
$\tilde{Y}$	-0.29	-0.33	-0.41	-0.30	-0.28	-0.38	-0.29	-0.29	-0.28	-0.29
$\tilde{Y}_1$	-0.39	-0.42	-0.50	-0.42	-0.36	-0.45	-0.38	-0.38	-0.37	-0.38
L_{sF}	-9.77	-9.73	-9.71	-9.77	-9.76	-9.82	-9.76	-9.76	-9.77	-9.77
L_E	-9.64	-9.55	-9.52	-9.68	-9.61	-9.71	-9.63	-9.62	-9.65	-9.65
L_T	-9.64	-9.55	-9.52	-9.68	-9.61	-9.71	-9.63	-9.62	-9.65	-9.65
L_{uF}	-12.11	-12.32	-12.32	-12.06	-12.16	-11.81	-12.19	-12.23	-12.12	-12.10
I	-2.79	-1.11	-0.56	-3.28	-2.38	-4.79	-2.32	-2.09	-2.81	-2.87

Table 13: The effects of fewer permanent employment visas, additional robustness checks

	(1) benchmark	(2) $\beta = 0.4$	(3) $\beta = 0.3$	(4) $\epsilon = 0.6$	(5) $\epsilon = 0.4$	(6) 0.5 repl. ratio	(7) $U_{iF} = 5U_i^2$	(8) $U_{iF} = 6U_i^2$	(9) double s_s	(10) double s_u
θ_s	-0.33	-0.28	-0.28	-0.37	-0.30	-0.20	-0.32	-0.31	-0.36	-0.33
θ_u	-0.93	-0.79	-0.76	-1.01	-0.86	-0.76	-0.90	-0.88	-0.93	-0.94
$\tilde{u}_{sN}$	0.14	0.12	0.12	0.19	0.10	0.09	0.13	0.13	0.15	0.14
$\tilde{u}_{uN}$	0.31	0.27	0.26	0.41	0.23	0.25	0.30	0.30	0.31	0.32
w_{sN}	0.04	0.05	0.05	0.03	0.05	0.03	0.05	0.05	0.04	0.04
w_{uN}	-0.17	-0.20	-0.21	-0.16	-0.19	-0.16	-0.18	-0.19	-0.17	-0.17
$\tilde{Y}$	-0.17	-0.20	-0.25	-0.18	-0.17	-0.21	-0.17	-0.17	-0.17	-0.17
$\tilde{Y}_1$	-0.24	-0.26	-0.31	-0.26	-0.22	-0.25	-0.24	-0.24	-0.23	-0.24
L_{sF}	-2.61	-2.65	-2.68	-2.63	-2.59	-2.56	-2.61	-2.61	-2.60	-2.61
L_E	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
L_T	-3.86	-3.83	-3.77	-3.90	-3.83	-3.75	-3.87	-3.87	-3.84	-3.87
L_{uF}	-3.64	-3.84	-3.89	-3.64	-3.65	-3.40	-3.69	-3.72	-3.64	-3.65
I	-1.38	-0.62	-0.37	-1.62	-1.18	-2.23	-1.16	-1.05	-1.38	-1.42

Table 14: The effects of fewer employment-based admissions, additional robustness checks

	(1) benchmark	(2) $\beta = 0.4$	(3) $\beta = 0.3$	(4) $\epsilon = 0.6$	(5) $\epsilon = 0.4$	(6) 0.5 repl. ratio	(7) $U_{iF} = 5U_i^2$	(8) $U_{iF} = 6U_i^2$	(9) double s_s	(10) double s_u
θ_s	-0.31	-0.25	-0.25	-0.36	-0.27	-0.20	-0.30	-0.29	-0.34	-0.31
θ_u	-1.04	-0.89	-0.86	-1.13	-0.96	-0.85	-1.00	-0.98	-1.04	-1.05
$\tilde{u}_{sN}$	0.13	0.11	0.10	0.18	0.09	0.08	0.12	0.12	0.14	0.13
$\tilde{u}_{uN}$	0.35	0.30	0.29	0.46	0.26	0.29	0.34	0.33	0.35	0.35
w_{sN}	0.05	0.06	0.06	0.04	0.06	0.04	0.05	0.05	0.05	0.05
w_{uN}	-0.20	-0.23	-0.23	-0.18	-0.21	-0.18	-0.21	-0.21	-0.20	-0.19
$\tilde{Y}$	-0.23	-0.26	-0.32	-0.24	-0.22	-0.27	-0.23	-0.23	-0.22	-0.23
$\tilde{Y}_1$	-0.30	-0.34	-0.39	-0.32	-0.28	-0.31	-0.30	-0.30	-0.29	-0.30
L_{sF}	-2.26	-2.30	-2.33	-2.29	-2.24	-2.20	-2.27	-2.27	-2.26	-2.27
L_E	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
L_T	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
L_{uF}	-3.36	-3.57	-3.63	-3.36	-3.37	-3.08	-3.42	-3.45	-3.36	-3.37
I	-1.57	-0.72	-0.44	-1.83	-1.35	-2.52	-1.33	-1.20	-1.57	-1.61

Table 15: The effects of decreasing illegal and increasing employment immigration, additional robustness checks

	(1) benchmark	(2) $\beta = 0.4$	(3) $\beta = 0.3$	(4) $\epsilon = 0.6$	(5) $\epsilon = 0.4$	(6) 0.5 repl. ratio	(7) $U_{iF} = 5U_i^2$	(8) $U_{iF} = 6U_i^2$	(9) double s_s	(10) double s_u
θ_s	-0.35	-0.31	-0.27	-0.37	-0.33	-0.23	-0.35	-0.35	-0.32	-0.37
θ_u	-0.68	0.05	0.64	-0.71	-0.65	-0.37	-0.68	-0.68	-0.68	-0.82
$\tilde{u}_{sN}$	0.15	0.13	0.11	0.19	0.11	0.10	0.15	0.15	0.13	0.16
$\tilde{u}_{uN}$	0.23	-0.02	-0.21	0.29	0.18	0.12	0.23	0.23	0.23	0.28
w_{sN}	-0.25	-0.23	-0.21	-0.25	-0.24	-0.26	-0.25	-0.25	-0.25	-0.25
w_{uN}	0.73	0.65	0.59	0.73	0.73	0.77	0.73	0.73	0.73	0.74
$\tilde{Y}$	0.05	0.08	0.12	0.04	0.05	0.05	0.05	0.05	0.05	0.04
$\tilde{Y}_1$	0.02	0.08	0.15	0.01	0.03	0.05	0.03	0.03	0.03	0.02
L_{sF}	3.11	3.15	3.19	3.10	3.11	3.07	3.12	3.12	3.10	3.10
L_E	12.04	11.64	11.37	12.10	11.98	12.32	12.00	11.97	12.08	12.03
L_T	4.26	4.19	4.10	4.25	4.26	4.19	4.27	4.28	4.23	4.25
L_{uF}	8.34	8.31	8.27	8.31	8.37	8.59	8.30	8.28	8.34	8.35
I	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00

Table 16: The effects of decreasing family and increasing employment immigration, additional robustness checks

	(1) benchmark	(2) $\beta = 0.4$	(3) $\beta = 0.3$	(4) $\epsilon = 0.6$	(5) $\epsilon = 0.4$	(6) 0.5 repl. ratio	(7) $U_{iF} = 5U_i^2$	(8) $U_{iF} = 6U_i^2$	(9) double s_s	(10) double s_u
θ_s	2.60	2.70	2.82	2.68	2.52	1.52	2.61	2.61	2.66	2.59
θ_u	1.19	1.20	1.28	1.28	1.11	0.81	1.18	1.18	1.17	1.19
$\tilde{u}_{sN}$	-1.07	-1.10	-1.14	-1.31	-0.82	-0.62	-1.06	-1.06	-1.10	-1.07
$\tilde{u}_{uN}$	-0.40	-0.39	-0.41	-0.50	-0.29	-0.26	-0.39	-0.38	-0.39	-0.40
w_{sN}	-0.02	-0.03	-0.01	0.00	-0.04	0.00	-0.03	-0.03	-0.03	-0.02
w_{uN}	0.25	0.42	0.45	0.33	0.34	0.25	0.36	0.37	0.25	0.25
$\tilde{Y}$	0.47	0.81	0.95	0.72	0.64	0.56	0.70	0.71	0.46	0.47
$\tilde{Y}_1$	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.68
L_{sF}	-10.02	-10.06	-10.07	-10.01	-10.03	-9.98	-10.03	-10.03	-10.02	-10.02
L_E	50.03	52.79	53.99	49.07	50.88	48.38	50.77	51.16	50.22	49.89
L_T	-0.66	-0.65	-1.09	-0.70	-0.62	-1.45	-0.52	-0.44	-0.82	-0.67
L_{uF}	-9.85	-9.53	-9.44	-9.94	-9.77	-10.16	-9.76	-9.72	-9.84	-9.85
I	2.36	1.57	1.29	2.64	2.12	2.94	2.13	2.01	2.33	2.40

Table 17: Effects of policies – Employer gets half of the surplus generated from the use of referrals ($\delta = 0.5$)

	↓ illegal im.		↓ family im.		↓ perm. empl. im.		↓ temp. empl. im.		↓ ill. ↑ empl.		↓ fam. ↑ empl.	
	bench.	$\delta = 0.5$	bench.	$\delta = 0.5$	bench.	$\delta = 0.5$	bench.	$\delta = 0.5$	bench.	$\delta = 0.5$	bench.	$\delta = 0.5$
θ_s	-0.66	-0.58	-0.03	-1.91	-0.33	-1.21	-0.31	-1.37	-0.35	0.58	2.60	3.10
θ_u	-1.53	-1.56	-1.99	-2.15	-0.93	-1.14	-1.04	-1.35	-0.68	-0.65	1.19	1.06
$\tilde{u}_{sN}$	0.28	0.24	0.01	0.81	0.14	0.51	0.13	0.58	0.15	-0.24	-1.07	-1.27
$\tilde{u}_{uN}$	0.52	0.53	0.67	0.73	0.31	0.38	0.35	0.45	0.23	0.22	-0.40	-0.35
w_{sN}	-0.17	-0.17	0.10	0.07	0.04	0.04	0.05	0.05	-0.25	-0.23	-0.02	0.00
w_{uN}	0.46	0.44	-0.36	-0.39	-0.17	-0.21	-0.20	-0.25	0.73	0.74	0.25	0.21
$\tilde{Y}$	-0.14	-0.14	-0.29	-0.31	-0.17	-0.18	-0.23	-0.21	0.05	0.02	0.47	0.30
$\tilde{Y}_1$	-0.22	-0.22	-0.39	-0.49	-0.24	-0.28	-0.30	-0.34	0.02	0.03	0.68	0.50
L_{sF}	0.16	-0.08	-9.77	-9.78	-2.61	-3.51	-2.26	-3.91	3.11	3.40	-10.02	-11.06
L_E	-0.16	-0.40	-9.64	-9.90	-10.00	-10.00	-10.00	-10.00	12.04	10.34	50.03	52.47
L_T	-0.16	-0.40	-9.64	-9.90	-3.86	-4.65	-10.00	-10.00	4.26	4.28	-0.66	-1.36
L_{uF}	3.40	3.15	-12.11	-11.92	-3.64	-4.36	-3.36	-4.69	8.34	8.34	-9.85	-0.79
I	-10.00	-10.00	-2.79	-3.05	-1.38	-1.69	-1.57	-2.02	-10.00	-10.00	2.36	1.76

Table 18: Effects of policies – Wage ratio between employment and family immigrants is set to 2.5

	↓ illegal im.		↓ family im.		↓ perm. empl. im.		↓ temp. empl. im.		↓ ill. ↑ empl.		↓ fam. ↑ empl.	
	bench.	w.r 2.5	bench.	w.r 2.5	bench.	w.r 2.5	bench.	w.r 2.5	bench.	w.r 2.5	bench.	w.r 2.5
θ_s	-0.66	-0.47	-0.03	-2.75	-0.33	-1.66	-0.31	-1.56	-0.35	1.11	2.60	3.40
θ_u	-1.53	-1.51	-1.99	-2.44	-0.93	-1.36	-1.04	-1.50	-0.68	-0.45	1.19	1.99
$\tilde{u}_{sN}$	0.28	0.20	0.01	1.18	0.14	0.70	0.13	0.66	0.15	-0.46	-1.07	-1.40
$\tilde{u}_{uN}$	0.52	0.51	0.67	0.83	0.31	0.46	0.35	0.51	0.23	0.15	-0.40	-0.66
w_{sN}	-0.17	-0.16	0.10	0.07	0.04	0.04	0.05	0.05	-0.25	-0.23	-0.02	-0.06
w_{uN}	0.46	0.45	-0.36	-0.45	-0.17	-0.26	-0.20	-0.29	0.73	0.79	0.25	0.42
$\tilde{Y}$	-0.14	-0.13	-0.29	-0.54	-0.17	-0.32	-0.23	-0.39	0.05	0.17	0.47	0.61
$\tilde{Y}_1$	-0.22	-0.21	-0.39	-0.79	-0.24	-0.47	-0.30	-0.55	0.02	0.22	0.68	0.88
L_{sF}	0.16	0.08	-9.77	-9.78	-2.61	-3.34	-2.26	-2.97	3.11	3.32	-10.02	-9.97
L_E	-0.16	-0.21	-9.64	-10.03	-10.00	-10.00	-10.00	-10.00	12.04	10.21	50.03	45.72
L_T	-0.16	-0.21	-9.64	-10.03	-3.86	-4.46	-10.00	-10.00	4.26	4.16	-0.66	-2.15
L_{uF}	3.40	3.38	-12.11	-11.57	-3.64	-4.20	-3.36	-3.91	8.34	8.41	-9.85	-10.23
I	-10.00	-10.00	-2.79	-3.46	-1.38	-2.02	-1.57	-2.28	-10.00	-10.00	2.36	3.79