The Labor Market Effects of Immigration and Emigration in OECD Countries*

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Abstract

In this paper, we quantify the labor market effects of migration flows in OECD countries during the 1990's based on a new global database on the bilateral stock of migrants, by education level. We simulate various outcomes using an aggregate model of labor markets, parameterized by a range of estimates from the literature. We find that immigration had a positive effect on the wages of less educated natives and it increased or left unchanged the average native wages. Emigration, instead, had a negative effect on the wages of less educated native workers and increased inequality within countries.

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Immigration rates in OECD (Organization for Economic Cooperation and Development) countries are larger than in the rest of the world and have increased significantly in the last 20 years.[1] The common portrayal of this process is a massive flow of uneducated individuals from poor countries who are trying to gain access to the labour markets and welfare systems of rich countries. This view also claims that immigration depresses wages and causes job losses for less educated native workers, a group that has underperformed in the labour markets during the last 20 years.

The available data (e.g. Docquier *et al.* (2012)), however, have uncovered different international migration patterns. First, a large portion of the labour movement is from other OECD countries. Foreign-born residents comprised 7.7% of OECD countries' population in 2000 and over half of those were from other OECD countries. Second, the share of college graduates among recent immigrants exceeded the share among natives virtually in all OECD countries.[2] In some cases the share of college educated among recent immigrants is four to five times as large as their share among non-migrant natives. These patterns have clear implications for the potential labour market effects of immigration, especially on less-educated native workers.

Most importantly, emigration from OECD countries to the rest of the world is routinely missing from the overall picture. Many studies have documented and explained the widespread presence of positive selection patterns in emigration (e.g. Docquier and Marfouk (2006), Grogger and Hanson (2011)). Although positive selection on skills and education is particularly pronounced in the case of poor sending countries, it also characterizes emigration from OECD countries. In particular, the emigration rates among college-educated exceed the rates among less-educated in almost all OECD countries in 2000.[3] While there are countless number of widely cited studies on the labour market effects of immigration in individual OECD countries, there are only a few papers investigating the effects of emigration.[4] These unbalanced views might lead to

[1] According to Freeman (2006) in 2000, about 7.7% of the adult residents in OECD countries were born in another country, versus only 2.9% in the average world country). Since then, the number of foreign-born individuals has further increased. In 2009 about 10% of the OECD resident population was estimated to be foreign-born (OECD, 2011).

[2] The total stock of immigrants exhibits lower educational attainment than the national labor force in some European countries such as France, Germany, Italy and the Netherlands. On the other hand, the total stock of immigrants, not just recent arrivals, is more educated than the natives in the United Kingdom, Spain and Portugal.

[3] Emigration rates among the college educated natives were more than twice as large of those among the less-educated in 16 OECD countries. The highest ratios of college/non-college emigration rates were observed in Japan (5.0), Hungary (4.2), Poland (4.2), the Czech Republic (4.1), and the United Kingdom (3.3).

[4] The prevalence of the research focus on immigration is due to the absence of comprehensive emigration data and to the fact that countries can influence their immigration rates more easily than their emigration rates.

various misconceptions on the economic effects of overall migration patterns.

The goal of this paper is to assess the impact of both immigration and emigration in the OECD countries in the 1990s on the employment and wage levels of natives who did not migrate. We first document the above migration patterns by using a new comprehensive database that provides bilateral migrant stocks by education level for 195 origin/destination countries for 1990 and 2000. The database is constructed by combining national census data from a large number of destination countries, which provides immigrant stocks from origin countries, complementing these data with imputed values for a small percentage of migrants. The database measures migration stocks for both college-educated and non college-educated workers between every pair of the 195 countries in the world. We use it to construct net immigration and emigration flows by education level for all OECD countries in the 1990s. This is a substantial improvement over existing bilateral migration databases (such as Docquier and Marfouk (2006), and Docquier *et al.* (2009)), especially in the construction of emigration and net migration data numbers for OECD countries, because we now have data for twice the number of destination countries. This paper is the first to use this global dataset to analyze labour market implications of migration.

Using these data and aggregate models of the national labour markets, we simulate the employment and wage effects of immigration and emigration on non-migrant natives in each OECD country. We use an aggregate production-function model, which has become popular in the labour literature analyzing the effects of immigration.[5] Macroeconomic studies of growth, productivity and skill premium have also used similar models.[6] This basic framework enables us to derive labour demand by skill group. We add a simple labour supply decision that generates an aggregate supply curve for each skill group. Equipped with this model, we calculate the wage and employment effect of immigration on native workers.

The existing estimates of the labour market effects of immigration sometimes conflict with each other.[7] Most of the disagreement, however, is based on evidence from US labour markets and limited to moderate differences on the wage impact of immigration on less educated workers. We take a different approach here and try to capture the extent of the disagreement within the literature by using different estimates of the

[5] Recent examples are Borjas (2003), D'Amuri *et al.* (2010), Ottaviano and Peri (2012), Manacorda *et al.* (2012).

[6] Prominent examples are Acemoglu and Zilibotti (2001), Card and Lemieux (2001), Caselli and Coleman (2006), Goldin and Katz (2008).

[7] The estimates in Card (2001), Borjas (2003) and Card (2009) are considered as spanning the range between the more pessimistic and more optimistic views of the labor market effects of immigration.

fundamental parameters of the labour market. In particular, we produce different scenarios using different values for (i) the elasticity of relative demand between college and non-college educated, (ii) the elasticity of relative demand between native and immigrant workers, (iii) the elasticity of human capital externalities, (iv) the elasticity of aggregate labour supply.

Different scenarios in our analysis span what can be interpreted as pessimistic or optimistic views on the labour market effects of migration as they emerged in the literature. Without taking any stand on the current debate, we present the range of resulting effects by varying the relevant parameter values within a reasonable spectrum established in the literature. Moreover, we do not aim to explain the determinants of immigration and emigration flows; we simply focus on the extent of the wage and employment response to these flows. On one hand, our exercise is somewhat limited as it simulates only the effect of immigration operating through the skill-complementarity, the labour demand-supply and the human capital externality channels. On the other hand, we are assured that other confounding factors that would co-vary in the data (and affect the empirical estimates) are absent in this exercise. Our exercise captures the difference in wages and employment of natives during the 1990's between the scenario with actual migration flows and a counter-factual scenario with zero net migration flows. The difference between the two scenarios is what we refer to as the effect of migration on native wage and employment.

Some general patterns emerge in our analysis, irrespective of the parameter choices. First, in general, *immigration had a small positive or no effect* on the average wages of non-migrant natives in all of the OECD countries over the period 1990-2000. These effects, ranging from 0 to +4%, were usually positively correlated with the immigration rate of the country (the size of immigrant flow relative to the population). Canada, Australia and New Zealand (which implemented immigration policies with education-based preferences), had significant positive wage gains from immigration. Additionally, countries which did not explicitly select their immigrants based on education, such as Luxembourg, Malta, Cyprus, the United Kingdom, and Switzerland, also experienced positive average wage effects between 1 and 3%. Second, *immigration had higher beneficial effects on wages of non-college educated workers in OECD countries.* These effects range between 0 and +6%. For some countries, such as Ireland, Canada, Australia, United Kingdom, and Switzerland, the effects are in the 2-4% range. Only Austria, Denmark, Italy, Japan and Greece show estimated effects on the wages

of less educated (in the most pessimistic scenarios) that are close to 0. A corollary of this result is that *immigration reduced the wage differential between more and less educated natives.* Third, *emigration, to the contrary, had a negative and significant effect on the wages of less educated natives* ranging between 0 and -7%. In countries like Cyprus, Ireland and New Zealand, less educated workers suffered a wage decline between 3 and 6% due to emigration of the highly skilled. Even in Portugal, the United Kingdom, South Korea, Latvia, and Slovenia, the less educated suffered losses between 1 and 2% because of emigration.

All of these results logically proceed from the nature of measured migrant flows. During the decade 1990-2000, OECD countries have experienced both immigration and emigration flows of workers that were more "tertiary–education-intensive" than the corresponding non-migrant native labour force. Under these conditions, immigration was associated with average wage gains for less educated workers. Emigration, to the contrary, induces average wage losses for the same group of non-migrants.

The educational composition of migrants is crucial in determining our relative and average wage results, and thus we attempt to correct for the "effective" skill content of immigrants in a series of checks. First, we use estimates of the extent of illegal immigration (from recent studies performed in several European countries) to correct for the inflows of low-skilled migrants as undocumented immigrants tends to be less educated. Second, we account for the potential "downgrading" of immigrants' skills in the host countries' labour market, by using data on their occupational choices as of 2000. Third, we consider the full range of parameter estimates, including the standard error of those estimates. All of these corrections reduce the share of "effective" highly educated among all immigrants in OECD countries. However, those corrections do not reverse the general picture described above. Finally, we repeat the exercises for a subset of countries for which we have provisional net immigration data for the period 2000-2007. These include some European countries that received large immigration flows (including Luxembourg, Spain and Greece), and the United States. The data are from the EU labour Force Survey and the American Community Survey, respectively. They are based on smaller samples relative to the censuses and, hence are subject to larger measurement errors. Even in this case, we find that the wage effects of the more recent immigration flows on less educated natives are above zero for all countries. For Luxembourg, the biggest recipient of immigrants in this period, the effects are as large as +6% for less educated. For Spain, usually considered as the country most affected

by immigrants in the 2000's, the wage effect on less educated natives range between 0 and +2%.

The rest of the paper is organized as follows. Section 1 presents the simple aggregate production and labour supply framework from which we derive wages and employment effects of exogenous immigration and emigration shocks. Section 2 describes the main sources and construction of our dataset, and provides simple summary statistics about the labour force and migrant data and their educational composition. Section 3 presents the basic results of the simulated wage effects of immigration and emigration using our model and the range of parameters available from the literature. Section 4 considers the wage effect of immigration when accounting for undocumented workers, for the downgrading of skills and using the preliminary data on net immigration in the 2000's. Section 5 concludes.

1 Model

We construct a simple aggregate model of an economy where the workers are differentiated by their place of birth (native versus foreign born) as well as their education (skill) levels.[8] This structure allows us to examine the wage and employment effects of immigration of foreign workers into the country and emigration of native workers to other countries. These movements change the relative composition of workers of different education levels in a country. The model shows that the main effects of migration patterns on employment and wages of non-migrant natives depend crucially on the size and educational composition of immigrants and emigrants relative to non-migrants, as well as on the parameters of the model.

1.1 *Aggregate Production Function*

The prevalent models in the literature (Borjas (2003), Card (2009), Ottaviano and Peri (2012)) are based on a production function where the labour aggregate is a nested constant elasticity of substitution (CES) aggregation of different types of workers. We assume that output (homogeneous, perfectly tradable and denoted by y) is produced with a constant-returns-to-scale production function f with two factors, physical

[8] In the paper the terms high-skilled (low-skilled) and highly educated (less educated) are used inter-changeably. Tertiary education is the level defining high-skills.

capital (k), and a composite labour input (q):[9]

$$y = \widetilde{A} f(k, q) \tag{1}$$

The term $\widetilde{A}$ is the total factor productivity (TFP) parameter. Assuming that physical capital is internationally mobile (its supply is perfectly elastic) and that each single country is too small to affect global capital markets, returns to physical capital are equalized across countries. If R^* denotes the global net rate of return to capital, we can impose that marginal productivity of capital is equal to R^* and solve for the equilibrium k/q ratio.[10] Using the constant return to scale property of the production function and substituting the equilibrium k/q ratio into (1) we obtain an expression of aggregate output as a linear function of the aggregate composite labour q:

$$y = Aq \tag{2}$$

In this expression, we have $A \equiv \widetilde{A}\widetilde{f}[\widetilde{f}'^{-1}(R^*/\widetilde{A})]$, which depends on total factor productivity and on the returns to capital. The function $\widetilde{f}(k/q)$ in the expression is equal to $f(k/q, 1)$. Expression (2) can be interpreted as the reduced long-run version of a production function with elastic capital.

Many papers in the labour (Katz and Murphy, 1992; Acemoglu and Zilibotti, 2001; Card and Lemieux, 2001; Card, 2009) and growth (Caselli and Coleman, 2006) literature assume that labour in efficiency units, denoted as q below, is a nested CES function of highly-educated (q_h) and less-educated workers (q_l):

$$q = \left[\theta_q q_h^{\frac{\sigma_q - 1}{\sigma_q}} + (1 - \theta_q) q_l^{\frac{\sigma_q - 1}{\sigma_q}}\right]^{\frac{\sigma_q}{\sigma_q - 1}} \tag{3}$$

[9] All variables are relative to a specific country c and year t. We omit subscripts for compactness of notation.

[10] The condition above holds both in the short and the long run in a small open economy. In a closed economy, as in Ramsey (1928) or Solow (1956), condition (2) holds on the long-run balanced growth path. R^* would be a function of the intertemporal discount rate of individuals (or of the savings rate).

where θ_q and $1-\theta_q$ are the productivity levels of highly-educated workers (tertiary education or above) and less educated workers (less than tertiary education). The parameter σ_q is the elasticity of substitution between these two types of workers. This representation implies two types of simplifications. First, as there are more than two levels of schooling, we assume that the relevant split in terms of production abilities is between college and non college educated workers. This is consistent with Goldin and Katz (2008), Card (2009) and Ottaviano and Peri (2012) who find high substitutability between workers with no schooling and high school degree, but small substitutability between those and workers with college education. Second, we omit the further classification into age groups, considered as imperfectly substitutable skills (as done in Borjas (2003), or Ottaviano and Peri (2012)). The simple reason is that we do not empirically observe the age distribution of migrants for all countries. This omission (as shown in Ottaviano and Peri (2012)) is not very relevant in predicting the wage effects on natives of different education groups, which is our goal in this paper.

We distinguish between natives and immigrants within each education specific labour aggregate, q_h and q_l. If native and immigrant workers of education level $i = (h, l)$ were perfectly substitutable, the economy-wide aggregate q_i would simply be equal to the sum of the native and immigrant labour supplies. However, native and immigrant workers with similar education levels may differ in several respects. First, immigrants have skills and preferences that may set them apart from natives. Second, in manual and intellectual work, they may have country-specific skills and limitations, such as inadequate knowledge of the language or culture of the host country. Third, immigrants tend to concentrate in sectors or occupations different from those mostly chosen by natives because of diaspora networks, information constraints and historical accidents (Beine *et. al*, 2011). In particular, new immigrants tend to cluster disproportionately in those sectors or occupations where previous migrant cohorts are already over-represented. Several papers (Card, 2009; D'Amuri *et al.,* 2010; Ottaviano and Peri, 2012; Manacorda *et al.*, 2012) find imperfect degrees of substitution between natives and immigrants. Hence, we assume that both highly-educated (q_h) and less-educated labour aggregates (q_l) are both nested CES functions of native and immigrant labour stocks with the respective education levels.

This is represented as:

$$q_i = \left[\theta_n q_{i,n}^{\frac{\sigma_m - 1}{\sigma_m}} + (1-\theta_n) q_{i,f}^{\frac{\sigma_m - 1}{\sigma_m}}\right]^{\frac{\sigma_m}{\sigma_m - 1}} \qquad \text{where } i = h, l \tag{4}$$

where $q_{i,n}$ is the number of type-i native workers, $q_{i,f}$ is the number of type-i immigrant workers, and σ_m is the elasticity of substitution between natives and immigrant workers. Finally, θ_n and $1-\theta_n$ are the relative productivity levels of native and immigrant workers, respectively.

1.2 *Schooling Externalities*

As physical capital is perfectly mobile across nations, the average wage effect of immigration on natives could not be negative in a standard model. When the educational composition of the immigrant population differs from that of the native population, natives benefits from a small immigration surplus. However this is not true if the labour supply of natives is endogenous (see Section 2.4) or if immigration affects the TFP. Both channels are at work in our model. We introduce the possibility of externalities from highly skilled workers in the same spirit as several recent papers (Acemoglu and Angrist, 2000; Moretti, 2004a,b; Ciccone and Peri, 2006; Iranzo and Peri, 2009). There is a large body of literature[11] that emphasizes the role of human capital on technological progress, innovation and growth of GDP per capita. The main implication is that TFP could be an increasing function of the schooling level in the labour force. Following Moretti (2004a,b) we express the TFP of a country as follows:

$$A = A_0 e^{\lambda f_h}, \tag{5}$$

where A_0 captures the part of TFP that is independent of the human capital externality; $f_h \equiv (Q_{h,n} + Q_{h,f})/(Q_{h,n} + Q_{h,f} + Q_{l,n} + Q_{l,f})$ is the fraction of highly educated among working age individuals (where $Q_{i,j}$ is the *total* number of working age individuals with education i and nativity-status j) and λ is the

[11] This literature begins with Lucas (1988), and extends to Azariadis and Drazen (1990), Benhabib and Spiegel (2005), Vandenbussche *et al.* (2006) and Cohen and Soto (2007).

semi-elasticity of the modified TFP to f_h. Throughout the paper, upper-case $Q_{i,j}$ denotes total working-age population for skill-group i and nativity j, whereas lower-case $q_{i,j}$ denotes employment of that group. Acemoglu and Angrist (2000) as well as Iranzo and Peri (2009) use a similar formulation to express economy-wide schooling externalities and we use their estimates for the value of the parameter λ.

1.3 *labour Demand*

Each country is a single labour market. We derive the marginal productivity for native workers of both education levels ($w_{h,n}$ and $w_{l,n}$) by substituting (3) and (4) into (2) and taking the derivative with respect to the total quantity of labour $q_{h,n}$ and $q_{l,n}$ respectively. This yields the labour demand for each type of native worker:

$$w_{h,n} = A\theta_q\theta_n \left(\frac{q}{q_h}\right)^{\frac{1}{\sigma_q}} \left(\frac{q_h}{q_{h,n}}\right)^{\frac{1}{\sigma_m}} \tag{6}$$

$$w_{l,n} = A(1-\theta_q)\theta_n \left(\frac{q}{q_l}\right)^{\frac{1}{\sigma_q}} \left(\frac{q_l}{q_{l,n}}\right)^{\frac{1}{\sigma_m}} \tag{7}$$

By taking the logarithm of the demand functions presented above and calculating the total differentials of each one of them with respect to variations (Δ) of the employment of each type of worker, we obtain the percentage change in marginal productivity in response to employment changes. For compactness, we define $\widehat{x} = \Delta x/x$ as the percentage change of any variable x. Then, the percentage change of marginal productivity for native workers of education level $i = (h, l)$ in response to a percentage change in employment of immigrant ($\widehat{q}_{h,f}$ and $\widehat{q}_{l,f}$) and native ($\widehat{q}_{h,n}$ and $\widehat{q}_{l,n}$) workers can be written as follows:[12]

[12] The details of the derivation are fully developed in the Online Appendix.

$$\widehat{w}_{i,n} = \frac{1}{\sigma_q}\left(sh_{h,f}\widehat{q}_{h,f} + sh_{l,f}\widehat{q}_{l,f} + sh_{h,n}\widehat{q}_{h,n} + sh_{l,n}\widehat{q}_{l,n}\right) + \left(\frac{1}{\sigma_m} - \frac{1}{\sigma_q}\right)\left(\frac{sh_{i,f}}{sh_i}\widehat{q}_{i,f} + \frac{sh_{i,n}}{sh_i}\widehat{q}_{i,n}\right) - \frac{1}{\sigma_m}\widehat{q}_{i,n} + \lambda\Delta f_h \quad \text{for} \quad i = (h,l) \tag{8}$$

In equation (8), the term $sh_{i,j}$ represents the share of the wage bill going to workers of education level $i = (h, l)$ and place of origin $j = (n, f)$. The first term in brackets in the summation is the effect of changes in the employment of each group on the marginal productivity of natives of type $i = (h, l)$ through the term q in the wage equation. The second term, which depends only on the change in supply of workers of the same education type i, is the impact on marginal productivity of natives of type i through the terms q_i in the wage equation. The term $-(1/\sigma_m)\widehat{q}_{i,n}$ captures the impact through the term $q_{i,n}$. The final term $\lambda\Delta f_h$ is the effect of a change in the share of the college educated in the working-age population through the TFP.

1.4 *labour Supply*

A native worker of education level $i = (h, l)$ decides on how to split one unit of labour endowment between work l_i and leisure $1 - l_i$ to maximize an instant utility function,[13] which depends positively on consumption c_i and negatively on the amount of labour supplied l_i:

$$U_i = \theta_c c_i^{\delta} - \theta_l l_i^{\eta} \tag{9}$$

The parameters θ_c, θ_l, δ and η $(\geq \delta)$ can be specific to the education level i but we consider them to be identical across groups for simplicity. We assume that individuals consume all of their labour income which leads to the budget constraint $c_i = l_i w_{i,n}$. Substituting this constraint into the utility function and

[13] The model with savings and capital accumulation could be solved with the alternative utility function $U = [c^{1-\theta}\exp(-\zeta l) - 1]/(1-\theta)$ as an inter-temporal optimization model. In that case, which is illustrated in Barro and Sala-i-Martin (2003, p. 422-25), the labor supply along a balanced growth path does not depend on wages. Consumption would be a constant fraction of income and, along a balanced growth path wages would be growing at the rate of $\widetilde{A}$. Hence it would be a special case with perfectly inelastic individual labor supply.

maximizing with respect to l_i we obtain the labour supply for the individual worker of education level i:

$$l_i = \phi w_{i,n}^{\gamma}$$

In this expression, $\phi = (\theta_c \delta / \theta_l \eta)^{\frac{1}{\eta - \delta}}$ is a constant and $\gamma = \delta/(\eta - \delta) \geqq 0$ captures the elasticity of household labour supply. Since there are $Q_{i,n}$ working age individuals among all workers of education level i, the aggregate labour supply of type-i nationals is given by:

$$q_{i,n} = \phi Q_{i,n} w_{i,n}^{\gamma} \quad \text{for } i = (h, l) \tag{10}$$

As described above, $w_{i,n}$ is the wage paid to a native worker of schooling i; $Q_{i,n}$ (defined in section 1.2) is the working-age population in group i; $\gamma \geqslant 0$ is the elasticity of labour supply and ϕ is a constant as defined above.

For immigrants, we make a further simplifying assumption that all working-age immigrants supply a constant amount of labour (call it $\phi_f > 0$) so that total employment of immigrants is given by $q_{i,f} = \phi_f Q_{i,f}$ for $i = (h, l)$. This implies that immigrant supply is rigid (i.e. $\gamma = 0$, which is not far from the measured elasticity for natives which is around $\gamma = 0.1$). Moreover, since we aim to analyze the effects of immigrants on native labour market outcomes, this assumption simply implies that a certain percentage change in immigrant population translates into the same percentage change in immigrant employment.

1.5 *Equilibrium Effect of Immigration and Emigration*

Changes in working-age immigrants ($\Delta Q_{h,f}$ and $\Delta Q_{l,f}$) and natives ($\Delta Q_{h,n}$ and $\Delta Q_{l,n}$) due to migration between countries, are what we refer to as net immigration and net emigration. As discussed in Section 1.6, we consider those as "given". Our model analyzes their implications on wages and employment of native non-migrants. In the new equilibrium, both labour markets (for highly-educated and less-educated native workers) respond to these given flows and adjust wage and employment levels to the new equilibrium.

We next consider a given immigration flow, represented by $\widehat{Q}_{i,f}$ and a given emigration flow, given by

$\widehat{Q}_{i,n}$ for $i = (h, l)$. Building on (8) and (10), the following four conditions (i.e. two conditions for each worker type i) represent the response of native labour demand and supply in percentage changes for each labour market i:

$$\begin{aligned} \widehat{w}_{i,n} &= \frac{1}{\sigma_q}\left(sh_{h,f}\widehat{Q}_{h,f} + sh_{l,f}\widehat{Q}_{l,f} + sh_{h,n}\widehat{q}_{h,n} + sh_{l,n}\widehat{q}_{l,n}\right) + \\ &\left(\frac{1}{\sigma_m} - \frac{1}{\sigma_q}\right)\left(\frac{sh_{i,f}}{sh_i}\widehat{Q}_{i,f} + \frac{sh_{i,n}}{sh_i}\widehat{q}_{i,n}\right) - \frac{1}{\sigma_m}\widehat{q}_{i,n} + \lambda\Delta f_h \quad \text{for} \quad i = (h, l) \end{aligned} \tag{11}$$

$$\widehat{w}_{i,n} = \frac{1}{\gamma}\left(\widehat{q}_{i,n} - \widehat{Q}_{i,n}\right) \quad \text{for} \quad i = (h, l) \tag{12}$$

The equilibrium response of native wage and employment for each skill group are obtained solving simultaneously the above system of four equations in four unknowns to find the following equilibrium native employment responses:

$$\widehat{q}^*_{h,n} = \frac{\left(\frac{1}{\gamma} + d_l\right)\left(\widehat{mp}_{h,n} + \frac{1}{\gamma}\widehat{Q}_{h,n}\right) + \frac{sh_{l,n}}{\sigma_q}\left(\widehat{mp}_{l,n} + \frac{1}{\gamma}\widehat{Q}_{l,n}\right)}{\left(\frac{1}{\gamma} + d_l\right)\left(\frac{1}{\gamma} + d_h\right) - \frac{sh_{l,n}}{\sigma_q}\frac{sh_{h,n}}{\sigma_q}} \tag{13}$$

$$\widehat{q}^*_{l,n} = \frac{\left(\frac{1}{\gamma} + d_h\right)\left(\widehat{mp}_{l,n} + \frac{1}{\gamma}\widehat{Q}_{l,n}\right) + \frac{sh_{h,n}}{\sigma_q}\left(\widehat{mp}_{h,n} + \frac{1}{\gamma}\widehat{Q}_{h,n}\right)}{\left(\frac{1}{\gamma} + d_l\right)\left(\frac{1}{\gamma} + d_h\right) - \frac{sh_{l,n}}{\sigma_q}\frac{sh_{h,n}}{\sigma_q}} \tag{14}$$

By substituting them into the supply functions, we obtain the equilibrium native wage response:

$$\widehat{w}^*_{i,n} = \frac{1}{\gamma}\left(\widehat{q}^*_{i,n} - \widehat{Q}_{i,n}\right) \quad \text{for} \quad i = (h, l) \tag{15}$$

In expression (13) and (14) the terms $\widehat{mp}_{i,n}$ (for $i = h, l$) are equal to

$$\widehat{mp}_{i,n} \equiv \frac{1}{\sigma_q}\left(sh_{h,f}\widehat{Q}_{h,f} + sh_{l,f}\widehat{Q}_{l,f}\right) + \left(\frac{1}{\sigma_m} - \frac{1}{\sigma_q}\right)\frac{sh_{i,f}}{sh_i}\widehat{Q}_{i,f} + \lambda\Delta f_h \ , \tag{16}$$

and represent the impact of immigration on the marginal productivity of native workers (n) of education level i for fixed native employment. The coefficients d_i ($i = h, l$) are equal to $1/\sigma_m - (1/\sigma_m - 1/\sigma_q)\,(sh_{i,n}/sh_i) - (sh_{i,n}/\sigma_q)$ and capture the (absolute value) of the slope of the logarithmic demand function for native workers of type i. The interactions between the two markets (h and l) and the need to solve simultaneously arise from the fact that a change in employment of workers with schooling level l affects the demand for workers of schooling level h through the term $(sh_{l,n}/\sigma_q)\widehat{q}_{l,n}$ and, in turn, employment in the h market affects the demand for workers of type l through $(sh_{h,n}/\sigma_q)\widehat{q}_{h,n}$ in the demand equation (11).

1.6 *Simulations: Discussion and Caveats*

Our goal is to quantify the impact of recent immigration and emigration flows on the wage and employment of non-migrant natives in OECD countries. Migration decisions are endogenous and depend, among other factors, on wage and employment disparities across countries. There are several models and studies analyzing the determinants of migration.[14] The present study, however, focuses on its consequences as do most studies of the labour market effects of immigration (e.g. Borjas (2003), Card (2009), D'Amuri *et al.* (2010), Ottaviano and Peri (2012)) and emigration (e.g. Mishra (2007), Elsner (2011)). The specific consequences we are interested in are the impact of immigration (or emigration, respectively) on wages and employment outcomes of non-migrants in the host country (or source country, respectively). We disregard indirect effects related to possible long-term education responses of natives or linkages between immigration and emigration, which is rarely considered and not very plausible in the cross-country literature. Rather than assessing the global effect of all migration flows in the world taken jointly, we isolate, by construction, the effect of migration

[14] Recently Mayda (2010) and Grogger and Hanson (2011), among others, have tested empirically simple models of migration decisions.

on native wages and employment rates in each specific country without other potential confounding factors. In short, our model does not explain migration flows but it quantifies their effects, operating through labour market mechanisms, on native wage and employment. One interpretation of our results is that if the total migration flows of the 1990s were mainly driven by factors exogenous to the model (such as the opening of Eastern Europe to international mobility, the reduction of transportation costs or the relaxation of border controls between Western European Countries) then the model would produce the observed changes on native wage and employment caused by immigration, through labour markets. Alternatively, if migration flows in the 90's were driven by factors endogenous to the model, such as an increase in a country's productivity (the term A_0 in equation 5), then observed changes in native wages would combine the productivity effect and the labour market effect due to new immigration. In this case an estimation approach would need to use exogenous variation from an instrument. Our simulation, instead, by keeping A_0 fixed, only accounts for the labour market effects of immigration. This is genuinely the "effect" of immigration. It could not be observable separately in the actual wage data because of the simultaneity between productivity and immigration. Our model, however isolates it.

Our simulation exercise consists of using equations (13-14-15) to calculate the equilibrium responses of native wage and employment levels to immigration and emigration flows. We do this for each OECD country, for the decade 1990-2000. In order to perform the simulations, we need several sets of variables. The first is the share of the wage bill for each group by skill and country of origin, $sh_{i,j}$. Second we need the percentage change in the population of each group caused by migration $\widehat{Q}_{i,j}$. Finally we also need the values for the key parameters, namely the elasticities $\sigma_q, \sigma_m, \lambda$ and γ. The variables that we use are country-specific, so that we can account for the skill distribution, the skill premium and migration flows by country. The model parameters, on the other hand, are assumed to be common across countries, and driven mainly by technology/preferences as is usually the case in cross-country studies (e.g. Hall and Jones, 1999; Caselli and Coleman, 2006). We are aware this is a simplification, but we will allow for a range of parameter values that reflects differences in aggregate demand and supply elasticities possibly driven by differences in institutions, productivity levels and specialization across countries. We describe in detail the construction of variables and the range of parameters in section 3.1 below.

2 Description of the New Data Set

The section presents the database used to quantify net migration flows and the domestic labour force of OECD countries. We first describe the data sources and then discuss the main patterns observed for the period 1990-2000.

2.1 *Net Migration Data: Sources and Definitions*

The relevant migration data to be used in our analysis are net immigration and emigration flows for each OECD country between 1990 and 2000. Even though the description of the relevant migration data is simple, the construction was complicated and time-consuming. There are several sources documenting yearly migration flows by receiving country (e.g. OECD International Migration Database, UN migration statistics). Quite problematically, these only include gross inflows of people from administrative records and do not correct for migrants who leave or return to their country of origin. Moreover, those records do not include undocumented migrants and often record immigrants when they achieve resident status rather than when they first enter the country. Most importantly for our purposes, these data do not have information on the education levels of migrants. Data by education level are available from national censuses. Those data are more representative, accurate and complete than other data sources. National Censuses account for undocumented immigrants in some countries like the US, and they categorize immigrants by place of birth (an immutable characteristic), rather than nationality (that may change). The net flow of immigrants to a country can be recovered by measuring the stock of foreign born people in a destination country (from a certain origin country) at different points in time and then taking the difference. Finally, such direct data do not exist for emigration, which needs to be calculated from immigration data from all destination countries. For that purpose, the global bilateral matrices need to be complete.

Our database is described in greater detail in Docquier *et al.* (2012). It consists of bilateral immigrant and emigrant stocks for 195 countries in 1990 and 2000 for two skill/education levels. The starting point is the database assembled by Docquier *et al.* (2009) which includes the stock of foreign-born individuals in all OECD destination countries in 1990 and 2000, by country of origin and level of schooling (primary, secondary and tertiary), using censuses as primary data sources. The immigration data (and the analysis

of its impact) is fully based on primary Census data for those OECD countries. As far as emigration is concerned, the database does not quantify migration stocks to non-OECD destination countries. Hence, the OECD immigration data of Docquier *et al.* (2009) were supplemented with similar Census data from the censuses of 70 and 31 additional destination countries in 2000 and 1990, respectively. For the rest of the destination countries with no available data, bilateral migrant stocks were predicted using a gravity framework as described in greater detail in Docquier *et al.* (2012). Table A1 in the Online Appendix shows that on average, imputed data account for a small proportion of the emigration stocks (only 5.9 percent in 2000) and emigration net flows (only 3.6 percent on the period 1990-2000) of OECD countries.[15] However they represent a larger share of emigration in some countries (such as Israel, the Baltic States and France).

The database distinguishes between two schooling levels indexed by i. Highly educated people ($i = h$) are defined as tertiary education graduates whereas $i = l$ denotes individuals with secondary or lower education (referred to as less educated). The dataset only includes people aged 25 and over as a proxy of the working-age population. This choice maximizes comparability between data on migration and on labour force for a given level of education. Furthermore, it excludes a large number of students who emigrate temporarily to complete their education or children who migrate with their families and are not yet active in the labour market.

We let $M_i^{ab}(t)$ denote the stock of migrants with education level i in year t working in country a and born in country b, i.e. an entry in the migration matrix. It is quite straightforward to calculate immigrant and emigrant stocks for any country once we have the complete migration matrix. The total immigrant stock in country a for education level i in year t is simply the sum of all bilateral immigrant stocks and it is given by $Q_{i,f}^a(t) \equiv \sum_{b \neq a} M_i^{ab}(t)$. Similarly, the stock of emigrants originally from country b is given by $E_i^b(t) \equiv \sum_{a \neq b} M_i^{ab}(t)$. The earlier databases allowed the calculation of total immigrant stocks for the OECD countries but had limited set of destination countries. Since some important destination countries (such as Russia, South Africa, Brazil, Argentina, and Singapore) are outside the OECD, this new database ensures significantly better coverage of emigration from OECD countries relative to Docquier, Lowell and Marfouk (2009).

[15] This pattern is also confirmed in Ozden *et al.* (2011) which presents global bilateral migration stocks.

The last step is the construction of the immigration and emigration flows between 1990 and 2000 for each country and each skill level. We do this simply by taking the difference between the (immigrant or emigrant) stock in 2000 and 1990. For example, the flow of new immigrants with skill level i into country a is given by $\Delta Q^a_{i,f} = Q^a_{i,f}(2000) - Q^a_{i,f}(1990)$ and the emigrant flow is similarly defined.

The final data needed are the numbers of working-age residents in each country by level of education. The size of the adult population (i.e. population aged 25 and over) is provided by the United Nations. Missing data in the case of several small countries can be estimated using several issues of the C.I.A. world factbook.[16] Adult population data is then split across education groups using international indicators of educational attainment. We follow Docquier *et al.* (2009) in combining different data sets documenting the proportion of tertiary educated workers in the population aged 25 and over. The main sources are De La Fuente and Domenech (2006) for OECD countries, and Barro and Lee (2010) and Cohen and Soto (2007) for non-OECD countries. In the remaining non-OECD countries where both Barro–Lee and Cohen–Soto are missing data (about 70 countries in 2000), we apply the educational proportion of the neighboring country with the closest tertiary education enrollment rate and GDP per capita.

2.2 *Description and General Trends*

Table 1 shows the immigration patterns during the period 1990-2000 for all of the countries considered in this study. These are member countries of the OECD as well as several non-OECD countries in Eastern Europe. Columns 1 and 2 show immigration rates in total population and among the college educated population, respectively. Columns 3 and 4 show immigration rates, considering only non-OECD countries of origin distinguished between total and College-educated. Immigration rates, in Column 1 of Table 1 are calculated as net inflow of immigrants (age 25 and older) during the period 1990-2000, $\Delta Q_{h,f} + \Delta Q_{l,f}$, divided by the initial working-age population in 1990. For instance, during this time period, the net inflow of immigrants was equal to 14.35% of the 1990 population in Israel. This large value is a consequence of the removal of the migration restrictions in Soviet Union in the early 1990s.[17] Luxembourg, Austria, and Ireland also received

[16] See https://www.cia.gov/library/publications/the-world-factbook/index.html (accessed June, 13 2013).

[17] There are several studies analyzing the economic impact of this episode on Israel's economy such as Friedberg (2001), Cohen-Goldner and Paserman (2012).

significant inflows of immigrants relative to their populations. Their total rates range between 7.6 and 12.5%. Three countries at the bottom of the table are also worth mentioning. The three Baltic countries (Estonia, Latvia and Lithuania), emerging after the break-up of the Soviet Union, experienced massive negative net-immigration flows. This was a result of the return of many ethnic Russians (born in Russia) after having immigrated to these Baltic countries during the Soviet era. Several other Eastern European countries (e.g. Romania, Slovenia, Hungary and Poland) had similar experiences during this decade.

The second column of Table 1 presents the net immigration rates for College educated workers, referred to as "highly educated". These are calculated as the net change (between 1990 and 2000) in the stock of college educated foreign-born workers, $\Delta Q_{h,f}$, relative to the similarly educated resident population in 1990. An interesting pattern worth emphasizing is that in all countries with positive net immigration rates (with the exception of Austria), the immigration rates of the college educated were larger than the rates for the total population. In some prominent destinations such as Israel, Ireland, Iceland, Canada, Australia and the United Kingdom, the immigration rates for college educated workers were more than twice the overall immigration rates. Immigration, therefore, contributed to a considerable increase in the share of college educated individuals in the labour forces for all countries in our sample (again with the exception of Austria). Latvia and Estonia had negative immigration rates, implying large returns of existing immigrants and even larger return rates for college educated immigrants. Remarkably, columns 3 and 4 confirm the pattern of larger immigration rates for college educated individuals, even when we consider only immigrants from non-OECD countries. Most countries have higher rates for college immigration than for total immigration even from non-OECD origin countries.

Table 2 presents the emigration rates for the countries in our sample where Column 1 is the total emigration rate, calculated as the net outflow of natives (25 year and older) during the period 1990-2000, $(\Delta Q_{h,n} + \Delta Q_{l,n})$ relative to the total resident population (age 25 and above) in 1990. Column 2 contains the net emigration rate of college-educated natives, $\Delta Q_{h,n}$, relative to the similarly educated resident population in 1990. A negative emigration rate implies that the return rate of emigrants (natives who were abroad in 1990) was larger than the outflow of new emigrants during the period 1990-2000. Countries are ranked in decreasing order of their high-skilled emigration rates. Few observations are in order. First, as in the

case of immigration, emigration rates are also larger for college educated natives than on average (with the exception of Israel). For some small countries (Cyprus, Malta, and Ireland), a large emigration rate for the college educated is associated with negative or very small overall emigration rates, implying large rates of return for non-college educated natives from abroad. In some of these small countries, however, immigration of tertiary educated foreign born workers compensated the emigration of the natives. Several Eastern European countries (such as Poland, Romania, Slovenia, and Slovakia) and some western European countries (Portugal and Greece) had significant college educated emigration flows, that were not compensated by similar immigration inflows. For those countries, emigration was a significant source of decrease in the relative supply of highly educated workers. Other European countries such as the United Kingdom, Luxembourg, Switzerland, and the Netherlands had significant rates of college-educated emigration that were compensated with significant immigration from mostly non-OECD countries. The United States, Canada, and Australia were, as is widely known, mainly destination countries as the immigration rates (total and for highly educated) were much larger than the corresponding emigration rates of the natives. In summary, during the 1990s both the immigration and emigration flows were very skill-intensive in most OECD countries. Less well-known, but clearly visible in our data, many OECD countries experienced emigration rates that were just as large as immigration rates.

3 Simulated labour-market effects

This section presents the results of the simulated wage and employment effects of migration using our model. We first describe how parameters are combined in our scenarios. Then we discuss the effects of immigration and emigration.

3.1 *Parameterization and Variable Measurement*

As one can see from equations (13-14-15), we need three sets of variables for each country in order to simulate the labour market effects of immigration and emigration flows. The first is the share of the wage income that accrues to each of the four main groups in the labour force as of 1990. As mentioned in the previous section, these shares are denoted as $sh_{i,j}$, where i is the education level (high vs. low) and j is the country

of birth (immigrant vs. native-born). The second variable is the percentage change in employment among each of these four groups due to immigration and emigration during the decade 1990-2000. This is denoted by $\widehat{Q}_{i,j}$. The last variable is the change in the ratio of college educated individuals in the labour force due to immigration and emigration which we denote by Δf_H.

The shares of wage income accruing to different groups of workers depend on their employment levels (that we proxy with population in working age) and wages. Since there is no comprehensive global database on wages of college educated and less educated, we proceed as follows. We take the estimated returns to a year of schooling in each country for the year as close as possible to 1990 from the Hendricks (2004) database.[18] We then calculate the average years of education for each of the two education groups (those with and without college degrees) using the Barro and Lee (2010) database. We multiply the return on education by the difference between average years of schooling of the two groups to identify the college wage premium in a given country. Table A2 in the Online Appendix shows the individual data and sources used for each country. Then, from several different sources (most of which are reviewed in Kerr and Kerr, 2009), we obtain the country-specific estimate of the native-foreign wage premium to adjust the wages of immigrants at each level of education. If any of the data is not available for a specific country, we use the estimate for the geographically closest country with the most similar income per capita.[19] We obtain the wage bill for that group by multiplying the group-specific employment level by the group-specific wage (standardized for the wage of less educated natives). This number provides the share ${sh_{i,j}}^{20}$ when divided by the total wage bill. These shares of wage income for each of the four groups in each country are reported in Table A4 in the Online Appendix. The percentage change in the employment of each group due to immigration and emigration during the period 1990-2000, as well as the change in the share of college-educated, are calculated from the dataset on stocks of migrants in 1990-2000 as described above.

[18] If the estimate was not available for a country we chose the estimate for the country sharing a border with the closest level of income per capita. We experimented with different imputation methods (countries with similar income or simply using the average return for all countries) and the differences are minuscule.

[19] The values used for the foreign/native wage ratios and their sources are reported in Table A3 of the Online Appendix. When we find more than one estimate for a country, we use the median value. Using different imputation methods for this variable does not change the results much. In fact even imputing to all countries a fixed immigrant/native wage ratio at 0.99 (the average value in the sample) generates essentially identical simulated effects.

[20] This procedure assumes that the population in working age for each group approximates actual employment. While employment rates of immigrants can be different from those of natives, there is no systematic tendencies of being larger or smaller across countries and the differences are only by few percentage points. The largest part of the differences in wage shares is driven by differences in size of the population.

The next critical step is the determination of the values of the four fundamental parameters of the model. σ_q is the elasticity of substitution between highly- and less-educated workers; σ_m is the elasticity of substitution between natives and immigrants with the same education level; λ is the intensity of college-externalities, and γ is the labour supply elasticity of more and less educated natives.

Table 3 presents the values of the parameters chosen in each of three scenarios considered in the main numerical simulations. The values are chosen to span the range found in the literature. There are several estimates in the literature for the parameter σ_q, the elasticity of substitution between more and less educated workers. Johnson (1970), Katz and Murphy (1992), Murphy *et al.* (1998) and Caselli and Coleman (2006) estimate values around 1.3-1.4 whereas Fallon and Layard (1975), Angrist (1995), Krusell *et al.* (2000) and Ciccone and Peri (2005) estimate values around 1.5-1.75 using data on the US, on Canada or a cross-section of world countries. Ottaviano and Peri (2012) estimate values around 2. Hence the values 1.3, 1.75 and 2 span the entire range of estimates and we use them in the three main scenarios.

The elasticity of substitution between natives and immigrants, σ_m, has been the focus of many recent papers and has generated a certain level of debate. This parameter is important in determining the effect of immigration on the wages of non-migrant natives, and the value of this parameter influences the estimated wage-effects of migration in many countries much more than other parameters. Borjas *et al.* (2012), Peri (2011), and Ottaviano and Peri (2012) use US data and Manacorda *et al.* (2012) use UK data in their estimation of σ_m. The first study finds a value of infinity; the second and third papers estimate an elasticity between 10 and 20 and the paper on UK data finds a value of 6.[21] We use infinity, 20, and 6 as the three parameter values in the three main scenarios.

The parameter λ, measuring the externality generated by the share of the tertiary educated in the labour force, has been estimated using data from US cities (Moretti, 2004a,b) or US states (Acemoglu and Angrist, 2000; Iranzo and Peri, 2009). It is also subject to a certain level of debate since some studies find substantial schooling externalities ($\lambda = 0.75$ in Moretti, 2004b) while others do not ($\lambda = 0$ in Acemoglu and Angrist, 2000). These values define the range we use in our three scenarios ($0, 0.45$ and 0.75).

Finally, the estimates of the elasticity of labour supply γ (as summarized by Evers *et. al.* (2008) for

[21] Less known studies have also estimated this parameter value for Germany (D'Amuri *et al.* (2010)) and for Italy (Romiti (2012)). Those estimate all range between 12 and 20.

several European countries and the US) range from 0, in a study on the US by Flood and MaCurdy (1992), to 0.17, in a study on the Netherlands by van Soest *et al.* (1990).[22] One can argue that labour supply elasticity close to 0 (corresponding to rigid labour supply and maximum wage adjustment) would correspond more closely to the US, the UK and Canada. Several continental European countries, on the other hand, may exhibit a degree of wage rigidity captured by a supply elasticity of 0.2. As a result, we choose 0, 0.10, and 0.20 as the representative values for this parameter. We also show the effect of choosing a very high parameter value (i.e. 0.40) that is at the top of the 95% confidence interval for the parameter estimates as presented in the literature (see Panel 6.4 in Table 6).[23]

3.2 *Wage and Employment Effects of Immigration*

The percentage effects of immigration on the wages of less educated non-migrant native workers are shown in Figure 1.a and those on the average wages of all native workers are presented in Figure 1.b. Similarly Figures 2.a and 2.b show the percentage effects of immigration on employment of less educated and on overall employment of natives, respectively. Our simulations compare the actual situation with one in which countries would have not allowed any immigration in the 1990's (everything else equal) and we identify the wage effect of immigration through this counterfactual experiment.

In addition to the average effects, we mainly discuss the implications for the less educated workers since that has been the main focus of the debate on immigration. Some academic studies (e.g. Borjas, 2003) and many public opinion pieces have argued that immigration is disruptive for less educated native workers. On the other hand, the average wage effect gives an idea about the overall impact of immigration on natives. Each figure reports the simulated values under three configurations of the parameters (shown in Table 3) which we refer to as the "pessimistic", "intermediate", and "optimistic" scenarios reflecting their implications for the average wage of natives (from least to most positive).

The bold, solid and dashed lines connect the simulated values from the optimistic, intermediate and pessimistic scenarios, respectively. Hence the distance between the bold and the dashed lines encompasses

[22] Some studies found a negative and small elasticity of labor supply. We consider 0 as lower bound as in the surveyed studies none of the negative estimates is signifcant.

[23] Our simulations are "long-run" in the sense that we are assuming perfect elastic capital supply. In the previous version of this paper, Docquier *et al.* (2010) we also simulated the short-run effect with sluggish capital adjustment which are available upon request.

the range of possible effects for each country, using the parameter ranges discussed in section 3.1. In order to show the effect of changes in each individual parameter on the estimated range of wage and employment outcomes, we also report the numerical values in Table 4. More specifically, the table reports the effects for the top, median and bottom country (ranked according to the size of the overall effect) and it includes the effects on highly educated (not reported in the figures), less educated as well as the average worker. In the first four columns of Table 4, we report the value of each parameter, beginning with a baseline scenario in which all parameters take their baseline value and then separately vary each one, from the lowest to the highest value in the range. The last two rows show the "Optimistic" and the "Pessimistic" configuration and the relative simulated effects.[24]

The countries in Figures 1 and 2 are listed in decreasing order of their total immigration rate as defined in Table 1. A number of interesting features immediately become clear looking at Figures 1 and 2, and Table 4. First, all simulated wage effects on less educated natives (with the exception of the "pessimistic" scenario for Austria) are *positive*. This indicates that in all countries and scenarios, less educated native workers gain from the labour market effects of immigration. For some countries with high immigration rates, such as Ireland, Canada, and Australia the wage gains for less educated natives are quite significant and reach values as high as 6%. For other countries with intermediate levels of immigration, such as Belgium, the United Kingdom, and Switzerland, the effects are non-negligible and are between 1 and 2%. The median effect (Table 4, last two rows) on less educated workers, ranges from 0.2% in the pessimistic scenario to 0.8% in the optimistic scenario. The effects on average native wages, in the optimistic scenario, are larger than 3% for countries like Canada, Ireland and Australia. The effects on employment, reported in Figures 2a and 2b, and in the last three columns of Table 4, have the same qualitative features as the wages changes but they are smaller in magnitude. They range between 0 and 0.5% in most of the countries in any scenario.

The inspection of different rows of Table 4 reveals the sensitivity of the simulated effects to each individual parameter. We clearly see that the effect on average native wages are strongly influenced by the parameters σ_m and λ. Moving from perfect substitution ($\sigma_m = \infty$) between natives and immigrants to a lower elasticity

[24] In the figures and tables we drop Israel and the Baltic countries (Lithuania, Latvia, and Estonia) from the sample. Israel's massive immigration experience, especially from Russia in the 1990s, makes it an outlier. Lithuania, Latvia, and Estonia on the other hand experienced large *negative* net immigration rates, as discussed above in more detail, due to ethnic Russians returning after the disintegration of the Soviet Union. This really was more of an emigration phenomenon (return migration) in terms of the main characteristics and implications.

of substitution ($\sigma_m = 6$) increases the median effect from 0.1% to 0.4%. The wage effect on the top country rises from 1.6% to 3.2%. On the other hand, increasing the strength of human capital externalities (λ) from 0 to 0.75 increases the average wage effect of immigrants on the median country by 0.2 percentage points and on the top country by 2 percentage points. Changing the elasticity of substitution between more and less educated workers (σ_q) has no substantial effect on the average wage effects.

Focusing on the wage effect for less educated natives we see that imperfect substitution among different education categories, imperfect substitution between immigrants and natives as well as large human capital externalities all contribute in similar magnitudes. In the optimistic scenario, less educated workers gain 0.8% from immigration in the median country and up to 7.5% in the top country (Luxembourg). In the pessimistic scenario, less educated workers gain 0.2% in the median country and 2.9% in the top country. Changing the parameters σ_q, σ_m and λ one at the time (from the bottom to the top of the range) increases the median effect by 0.2 to 0.3 percentage points in each case.

The effect of immigration on the wages of highly educated natives is mostly negative. Especially in the scenarios with no externalities (seventh row of Table 4) and the one with low substitutability between more and less educated workers (third row), the effect on highly educated natives are -0.6 and -0.8%, respectively, in the median country considered. Finally, changing the elasticity of supply (γ) from 0 (in row 8) to 0.2 (in row 9) barely changes the wage effects. The employment effects, however, are increased with a top-effect on less educated employment of 1% and a bottom effect on more educated employment equal to -1.6% in the case with highest elasticity of supply ($\gamma = 0.2$).

The magnitude of the wage effect of immigrants depends critically on the ratio of the highly educated to the less educated among the immigrants. Countries where laws explicitly favor more educated immigrants (such as Australia and Canada) experience larger positive effects for both the less educated natives and the total workforce. However, other countries without such explicit laws (such as Ireland, UK, and Switzerland) also enjoy significant positive effects since the composition of their immigrants was also tilted towards the highly educated. On the other hand, if the skill composition of immigration flows was not biased in favor of the educated, then the net wage effect on natives becomes quite small. The simulation results are fully determined by the composition and the size of the immigrant flows and by the chosen parameters. It is interesting to see

how, within the reasonable parameter range, wage effects of immigrants are quite consistent. Immigration benefits less educated workers, through complementarities between high and low-skilled workers; it increases average productivity through schooling externalities and imperfect substitution with natives. These effects generate small positive wage effects on average and positive wage effects for less educated non-migrant native workers. For reasonable assumptions on the elasticity of labour supply, they have almost no effect on native employment. Finally highly educated natives experience a wage decrease as a result of immigration. One group that we exclude from our analysis are the previous cohorts of immigrants who are more likely to experience a negative effect than natives from immigration due to closer substitutability.

3.3 *Wage and Employment Effects of Emigration*

We showed in Table 2 that net emigration rates for some of the OECD countries were even larger than net immigration rates, during the considered period of 1990-2000. This was especially true for college educated workers. While the literature almost exclusively focuses on the labour market effects of immigration, one original contribution of this paper is the analysis of the wage impact of emigration flows, modeling them as a decline in the supply of the relevant native worker group. In this case, our simulations compare the actual situation with one in which countries would allow no emigration [25] and identifies the wage effect of emigration through this counter-factual experiment.

Figure 3.a shows the simulated effects of emigration on the wages of less educated non-migrant adults in their countries of origin. Figure 3.b shows the same effect on average non-migrant wages. Figure 4.a and 4.b show the employment effects of emigration on less educated natives and natives overall, respectively. We report the effects for the optimistic, the intermediate and the pessimistic scenarios. Notice that in this case the optimistic scenario is the one that produces the most negative effects of emigration (on wages and employment of non-migrants). This is because the parameter configuration that made skill-intensive immigration beneficial to the average non-migrant natives implies that skill-intensive emigration now has a negative effect. The pessimistic scenario produces the smallest (negative) effects. In Figures 3 and 4 the countries are listed from left to right in decreasing order of college-educated emigration rates, as shown in

[25] Admittedly these type of policies are not literally implemented by democratic governments. However increasing the cost of migrating or encouraging return migration can be considered as ways to achieve zero net emigration.

Table 2. Table 5 shows the simulated values for the effects of emigration, including the wage and employment effect on the group of less educated, more educated and on average. It includes, as in Table 4, only the effect on the median country and on the countries at the top and the bottom of the simulated range.

Focusing on Figure 3.a, the most striking fact is that the wage impact is opposite of what is seen in the previous section on immigration. Net emigration involves a larger percentage decline of college educated workers and, hence, it has a negative effect on less educated native workers. In countries with large emigration rates (left area of the graph, including countries such as Cyprus, Malta, Ireland, New Zealand, and Portugal), the impact on wages of less educated natives is significantly negative. The range is between -1% (Portugal) and -6% (Ireland and Cyprus depending on the elasticity scenario). The effects on employment levels of less educated non-migrants are much smaller but still negative. Figure 4.a shows that in countries like Cyprus, Ireland and New Zealand, employment levels declined by 0.6 to 0.8% in the most optimistic scenario. Even at intermediate rates of emigration, some countries still experience negative wage effects on the less educated workers of around -1% (e.g. Latvia, South Korea, United Kingdom, and Canada). The losses are due to the lost externalities from the departure of college educated individuals. In particular, Table 5 shows that the median loss to less educated natives from emigration ranges from 0 to -1% (last two rows), where half of that difference is driven by the intensity of human capital externalities and the other half by the degree of substitutability between more and less educated. On the other hand, the median effect on average wages ranges from -0.3% to 0% and that variation is fully driven by the assumed intensity of human capital externalities (comparison of rows 6 and 7).

Overall the employment effects of emigration are very small on less educated workers as well as the average worker. Table 5 also shows that highly educated non-movers usually benefit from emigration. This is because competition is reduced and skill biased emigration makes highly educated more scarce in the labour force. While the effects are generally small, for some small countries with large "brain drain" such as Cyprus or Ireland, the positive effect of emigration in the 1990s on the wages of highly educated could be as large as 15 to 20%.

Some of the countries that experience negative average effects from emigration (such as Ireland and the UK) offset these effects, partially or completely, with the positive effects of immigration. Others, however,

such as Cyprus, Poland and Malta, fail to do so. The simulated effects of emigration, therefore, revealed some interesting patterns. First, in all scenarios and for all countries, emigration causes wage and (to a much smaller extent) employment levels of less educated natives to decrease. While the median loss is small (ranging between -0.4% and 0), the less educated in some countries lose as much as 9%. Second in most parameter configurations emigration decreases average native wages (and increases wages of more educated native non-movers). The aggregate effects of emigration on employment of non-migrants are usually very small and often negligible. The losses for less educated natives depend positively on the complementarity between more and less educated and on the intensity of human capital externalities. When those are set at the lowest level in the parameter range, the effects of emigration on wages of less educated are negligible. When they are set at their largest values, the losses are between 5 and 8% for some countries.

4 Extensions and Robustness Checks

The simulated wage and employment effects of immigration and emigration discussed in the previous section are subject to caveats and possible measurement errors. The migration data are less than perfect. For example, emigration flows to some less developed countries are imputed; undocumented migrants are not fully measured among immigrants, and schooling is an imperfect measure of their human capital levels. Other issues may be due to the fact that the parameters used are estimated with error that should be accounted for. Finally, our exercise considers data from the 1990's which misses some recent large immigration flows from North Africa and the Middle East to Europe, and from Latin America to the US. These recent immigrant cohorts are also believed to be less educated which would influence our results. In this section we tackle all of these issues in turn.[26]

[26] In the Online appendix we also perform a further extension: we calculate the effect of immigration when we limit it to people coming from "poor" (i.e. non-OECD) countries. Most of the qualitative results are similar to those shown here for total immigration. We show these results as sometimes countries are particularly reluctant to open their borders to immigration from poor countries (see Figures A1 and A2).

4.1 *Actual Emigration Data Only*

As described in detail in section 2, we have census data on the stock of foreign-born migrants for a common set of 61 destination countries in 1990 and 2000, including all of the OECD countries used in our analysis. However, for some of the remaining countries in the world, we use the existing data and the gravity-based imputations described in section 2 to produce figures on their immigrant stocks. This implies that for the group of OECD countries in this paper, the data on immigration are actual data from national censuses. However, the emigration data include a combination of actual and imputed data. Table A1 in the Online Appendix shows what percentage of total emigration is imputed for each country. For most countries this is a very small, or even negligible percentage, but for a few countries it is as large as 30%. To asses how the presence of the imputed data affect our results, we show, in Figure 5.a and 5.b, the wage effects of emigration, using only the actual data and removing the imputed portion of the emigration flows. Also panel 6.1 in Table 6 shows the range of the effects under the optimistic and pessimistic scenarios, when we include only the actual emigration data. The estimated effects are very similar to those of Table 5. For the countries that are most affected, because of the scale and selection of their emigration, the impact on the wages of less educated was between -6% and -8% in the optimistic scenario while it was between -2% and -3% for the pessimistic scenario. For most countries, however, the negative effect on less educated native wages was much smaller in any scenario. The effect on the median country ranges between 0 and -1%. The effect on average wages is even smaller (in the range -0.4% to 0%) and also negative in most cases. The employment effects are all negligible. More importantly, these effects are very similar to those obtained when using all emigrant data (compare Panel 6.1 with the last two rows of Table 5). The differences in the ranges of the effects and in specific effects for countries are usually as small as 0.1%.

4.2 *Undocumented Immigrants and Skill Downgrading*

The census data are the primary sources used to construct our immigration data for OECD countries. Yet national censuses vary in their ability to properly measure undocumented immigration due to a variety of legal, economic, and political constraints. In some countries, such as the United States and Canada, the coverage of the resident population should be quite extensive and hence include (possibly with some small

underestimates) the undocumented immigrant population. In other countries, such as many in continental Europe, the censuses have a harder time in properly accounting for undocumented immigrants.

Several countries in Europe recently joined forces for the "Clandestino" study (European Union, 2010) which produced a picture of the undocumented population in 12 European Countries for the years between 2000 and 2007. The study used several methods including surveys, data from regularization laws and data on apprehension and expulsions of undocumented individuals, to produce estimates of the variable p_i, the fraction of undocumented in the total immigrant population of country i. We utilize these estimates, from around 2000 and we multiply the inflow of documented (measured) immigrants over the period 1990-2000 by $p_i/(1-p_i)$ to obtain a number of undocumented immigrants. Then, in order to maximize the possible impact of undocumented immigration on our estimates, we assume that *all* undocumented immigrants belong to the less educated category and we add these imputed numbers to the corresponding groups in our database.[27] It is worth noting that only in Eastern European countries, Italy, and Greece, the upper-bound estimates of undocumented individuals reach values that are higher than 20% of the total immigrant population (e.g. 30% in Czech Republic, 37% in Poland, 23% in Greece and 33% in Italy). In all other European countries, the upper bound estimates were lower than 10%. In particular, for the countries with the largest net inflows (Austria, Spain, and Ireland), the estimates range between 3 and 10%.

A second reason that might cause under-estimation of the actual size of the unskilled immigrant population is due to "skill downgrading". As shown in several studies (such as Dustman *et al.* (2008) for the UK, Cohen-Goldner and Paserman (2012) for Israel as well as Mattoo *et al.* (2008) for the US) immigrants with intermediate and high education tend to find jobs in occupations typically staffed by natives with lower levels of schooling. Moreover, the quality of education abroad may not be as high as the quality in the receiving OECD countries. Hence, the actual "human capital" supplied to the labour market might not correspond to what indicated by their education levels as reported in the census data. We might be over-estimating their contribution to the ratio of highly educated in the labour force by considering college-educated immigrants as fully equivalent to similarly educated natives. In order to correct for this bias, we use information on

[27] Table A5 in the Online Appendix shows the upper and lower estimates for p_i in all of the countries. For the European countries not covered by the study, we assign the p_i of the closest country for which it is available. For non-European countries with a census system that covers all residents, we assume that undocumented individuals are included in our data. For Japan, South Korea, and Chile, for which we have no information, we set the upper and lower bound of p_i to the average values in the sample.

the occupations in which immigrants and natives are employed, by level of schooling in different countries (see OECD, 2010) and we assign immigrants to high and low education group based on their occupational distribution, relative to more and less educated natives.[28]

Figures 6.a and 6.b show the simulated wage effects on less educated and average native workers once we account for undocumented immigrants and downgrading of their education levels using the methods described above. Panel 6.2 in Table 6, shows the results of the same exercise for different parameter combinations. The thick solid line (both in Figures 6.a and 6.b) connects the values obtained using the intermediate parameter configuration and accounting for downgrading and for the lower estimate for the share of undocumented workers. The thin solid line assumes the intermediate scenario and includes downgrading with high estimates of undocumented. The dashed line shows the pessimistic scenario with downgrading and high estimates of undocumented. The dashed line is really the most pessimistic scenario we can construct in accounting for undocumented migrants and skill downgrading: in it immigrants are perfect substitutes for natives; there are no externalities; undocumented immigrants are all counted as less educated and a part of highly educated immigrants are counted as low skilled because of their occupations. Despite these extreme assumptions, we still see positive effects on wages of less educated and on average in every country, with the exception of Austria. Less educated workers experience either no effect (such as the US, Denmark, Italy, and Greece) or positive effects (as large as 3.5% in Ireland, Canada, and Australia). Similarly, for average wages, the effect is zero (or very close) in most countries in the worst-case scenario (dashed line). In the baseline and optimistic scenario, accounting for downgrading and undocumented still leaves average wage gains for natives in the order of 0 to 0.5%. These corrections attenuate the positive effects of the previous section but in most cases they do not cancel, let alone reverse, them. A look at the ranges of simulated effects on employment of less educated and overall (Panel 6.2), reveals that employment effects are still very small and positive ranging between 0 and 0.5%.

[28] The detailed procedure used to convert immigrants into native skill groups using occupation is described in the Online Appendix (Section 2.1).

4.3 *Estimated Parameter's Confidence Intervals*

Another source of uncertainty in the simulated effects is due to the fact that, while we chose a large range in the parameter value, we did not account for the standard errors in their estimates. Are those errors so large that the estimated range is not very informative? In this section we account for the estimation error in our simulations. In particular, in Table 6, panel 6.3 we show the lower bound of the 95% confidence interval for the pessimistic estimates and the upper bound for the 95% confidence interval for the optimistic scenario. We can be confident that the simulated effects are between these two bounds 95% of the time, no matter what scenario we choose, accounting for the sampling error of the parameter estimates. In particular what we do is to consider, for each parameter estimate in the "optimistic" scenario, the estimated standard error from the study that provides that parameter estimate. Then we construct the parameter values at the boundary of the 95% confidence interval.[29] We do this for all parameter and we report the largest effect. For the pessimistic scenario we do the same for all parameters and we report the lowest effect.[30] Panel 6.3 in Table 6 shows the parameter configuration at the 95% upper bound of the optimistic scenario, and at the 95% lower bound of the pessimistic one. Notice, interestingly that the lower bound of the pessimistic scenario implies essentially zero effects for employment and wages of less educated natives in any country. Similarly, for the effect on average wages that at the lower bound of the pessimistic scenario are very close to zero for all countries. Having eliminated any source of complementarity and externality and making more and less educated as substitutable as possible we obtain a very small effect of immigration on average wages and on wages of less educated. At the other end of the spectrum, the upper bound of the optimistic estimates implies effects on wages of less educated and average natives that are quite high (+11% and +6.6% respectively, for the most affected country). Notice in the case that the estimated elasticity of labour supply is negative, large increases in wages of less educated (and average) imply a slight decline in native employment, which decrease by as much as 1.6% for the most affected country. Overall, however, it is remarkable how even at the 95% boundaries, immigration is found to be either neutral or mildly positive in its effect on less educated and average wages. No parameter configuration implies a significant negative effect of immigration

[29] We use, that is, the estimates equal to (average estimate) $\pm 1.96\times$(standard error).

[30] The details for the choice of parameters and standard errors to construct the lower and upper bound of the interval are reported in the Online appendix.

on less educated (or average) wages in any OECD country. This is a result of the significantly skill-biased composition of immigrants for all the considered countries.

4.4 *Effects of Immigration in the 2000's*

The data used so far cover migration patterns in the 1990's. Only with the collection and dissemination of data from the 2010 censuses, will an analysis of the last decade of migration be possible. The recent economic crisis, starting in 2007, reduced net immigration rates to OECD countries drastically according to preliminary data (e.g. Papademetriou *et al.,* 2011). During the 2000-2007 period, some destination countries, especially in Europe (mainly Spain, Italy, Greece, and Ireland) experienced immigration rates even larger than the ones observed during the 1990's. Were these flows very different from the previous ones? Was their composition less college-intensive? Were their effects on wages comparable to those of the 1990-2000 flows? To answer these questions, we consider net immigration to 13 European countries for the period 2000-2007 plus immigration to the United States during the 2000-2009 period. The European Data are from the EU labour Force surveys, that allow us to identify adults (older than 25) by education level, separating natives from foreign-born immigrants.[31] For the US, we use the American Community Survey data on the same definition of natives and immigrants with different education levels. Table 7 shows the immigration rates for the 2000-2007[32] period for all the countries. We only included countries for which the database includes the years 2000 as well as 2007 and for which the relevant characteristics (age, education, and place of birth) had fewer than 10% of missing observations. This restriction excluded the UK, Italy, and Ireland (among others). As we see in Table 7, the country with a real boom, relative to the previous decade, was Spain with an immigration rate of 11%. Luxembourg, Austria, and the US, the other countries with highest immigration rates, had lower rates than for the 1990's. As we are excluding the crisis period (post 2007) for the European countries, most will end up with even lower rates when the whole decade is considered. Figures 7.a and 7.b show the simulated native wage effects (for less educated and for the average, respectively) due to immigration 2000-2007. Panel 6.4 in Table 6 shows the corresponding numerical values

[31] We thank Francesco D'Amuri for his help with the EULFS data.

[32] Immigration rates are calculated, as usual, as net immigrants during the period 2000-2007 divided by total residents in 2000.

for the range of effects in 2000-2007 using the most optimistic and most pessimistic parameter configurations. In Figure 7, the countries are listed in decreasing order of total immigration rates for the 2000-2007 period. In most cases all specifications produce positive effects ranging from 0 to 2% in Figure 7.a and between 0 and 1% in Figure 7.b. Exceptions are Luxembourg, with potentially large positive effects on less educated wages (between 3 and 7%). Only Lithuania, which experienced negative net immigration (hence emigration of foreign residents) suffered a 1-2% wage loss for less educated. The other countries experienced average wage effects on natives between 0 and 4.7%, depending on the country and on the scenario. The effect on wages of less educated are almost always positive in all scenarios. One specification (intermediate dashed line) includes the corrections for undocumented and downgrading which somewhat reduce the gains but do not change the overall picture. Overall the large immigration magnets of the 2000's (Spain, Austria and the United States) experienced small to moderate positive effects for the wages of their less educated. The impact on employment were very small, in the order of few tenths of a percentage point.

5 Conclusions

Closing the borders to immigrants, restricting the inflow of people from poor countries, and making their entry more costly are sometimes presented as a way of protecting employment and wages of domestic workers, especially those at the bottom of the income distribution. This paper uses a new global dataset on migration patterns and a simple aggregate model to show that immigration is likely to help native wages and employment. This is simply due to the fact that immigrants in OECD countries are more educated than non-migrant natives and college educated workers are likely to create more opportunities for the receiving economy. We show that, in the long-run, the wage and employment effects of immigration in the 1990's and in the 2000's were rather small and always positive for less educated workers of all OECD countries. Less educated workers in Canada, Australia, the US, Luxembourg, the UK, and Switzerland, which were among the magnets of international migrants, all experienced positive long-run labour market effects from immigration, between 1 and 5%. Our most important and novel results are, however, on emigration, which entails the loss of talent and brains in much larger proportion than the loss of unskilled workers. Our resutls indicate that emigration poses a bigger threat for low-skilled workers left behind, even in some OECD coun-

tries. Less educated workers in Cyprus, Malta, Ireland, New Zealand, and Portugal all lost between 1 and 6% of their wages because of the flight of highly educated emigrants. While net emigration, especially of college educated individuals, may be a symptom of economic malaise and not its cause, it certainly directly contributes to lower productivity and wages of the remaining workers.

These results are striking. Hence, we undertake a series of robustness checks. We use estimates of the undocumented immigrants to correct for their flows. Second, we account for the actual occupations of highly educated immigrants to correct for skill downgrading. Third we consider the largest 95% confidence interval for the effects. None of the corrections reverses (although some attenuate) the findings of positive long-run effects of immigrants on wage and employment of less educated workers in all OECD countries.

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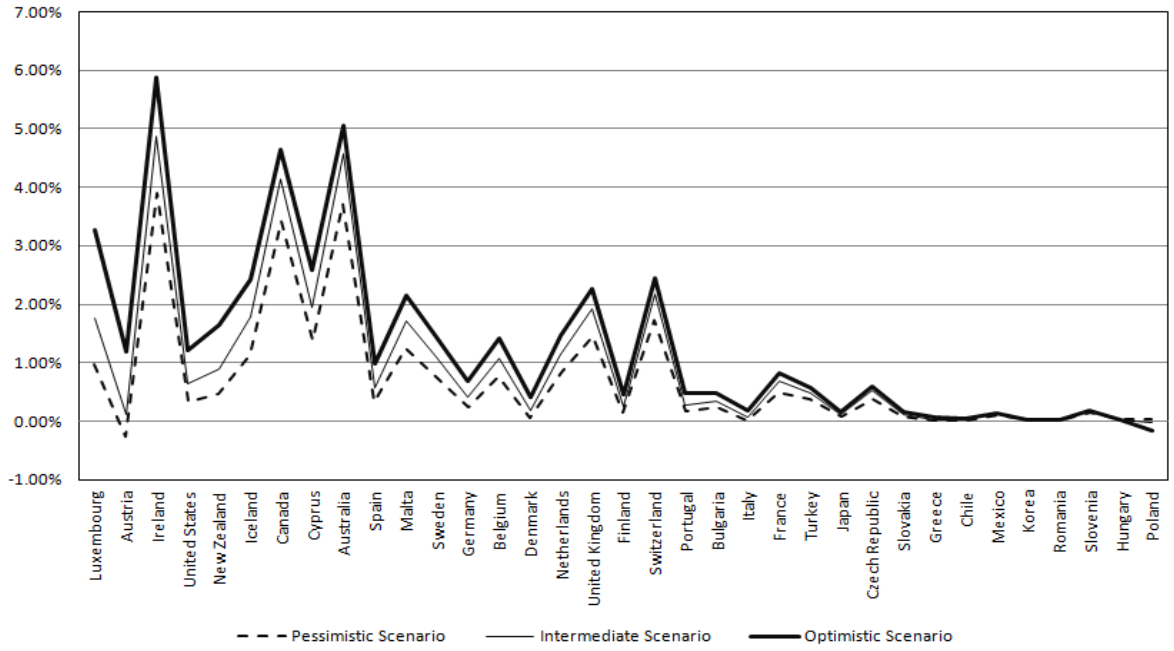
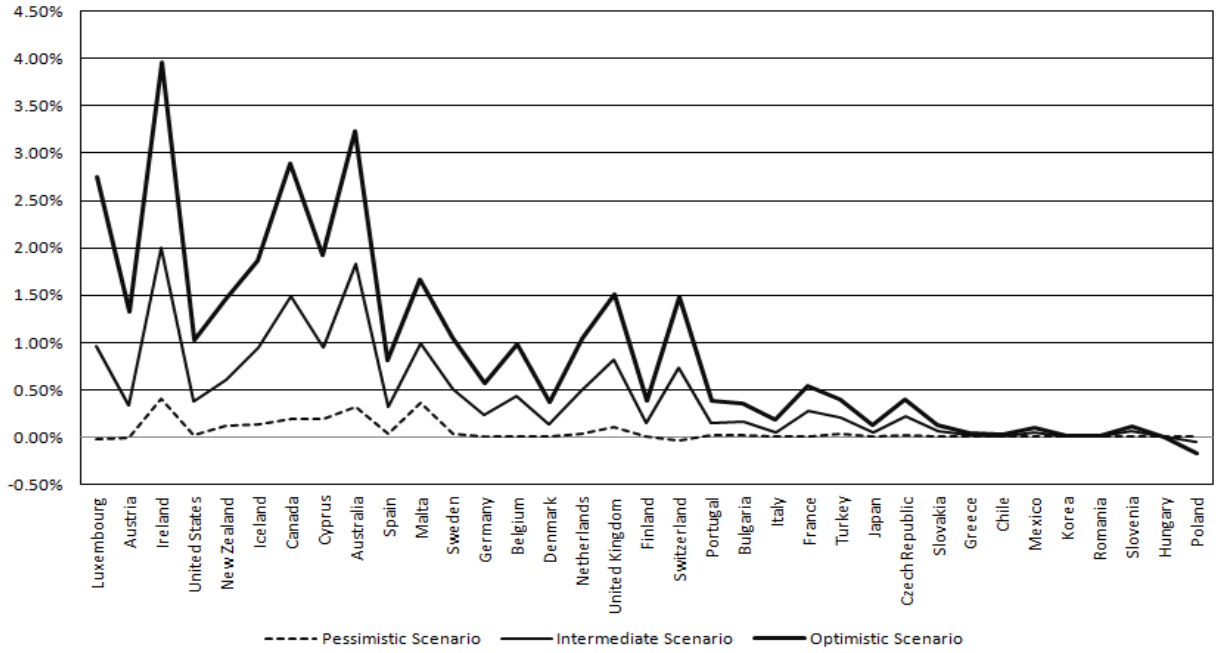
Figures and Tables

Fig. 1. *Wage Effects of Immigration on Native Workers, 1990-2000*
(Countries ranked left-to-right by immigration rate)

1.a. *Percentage Effects on Less Educated Native Wages*



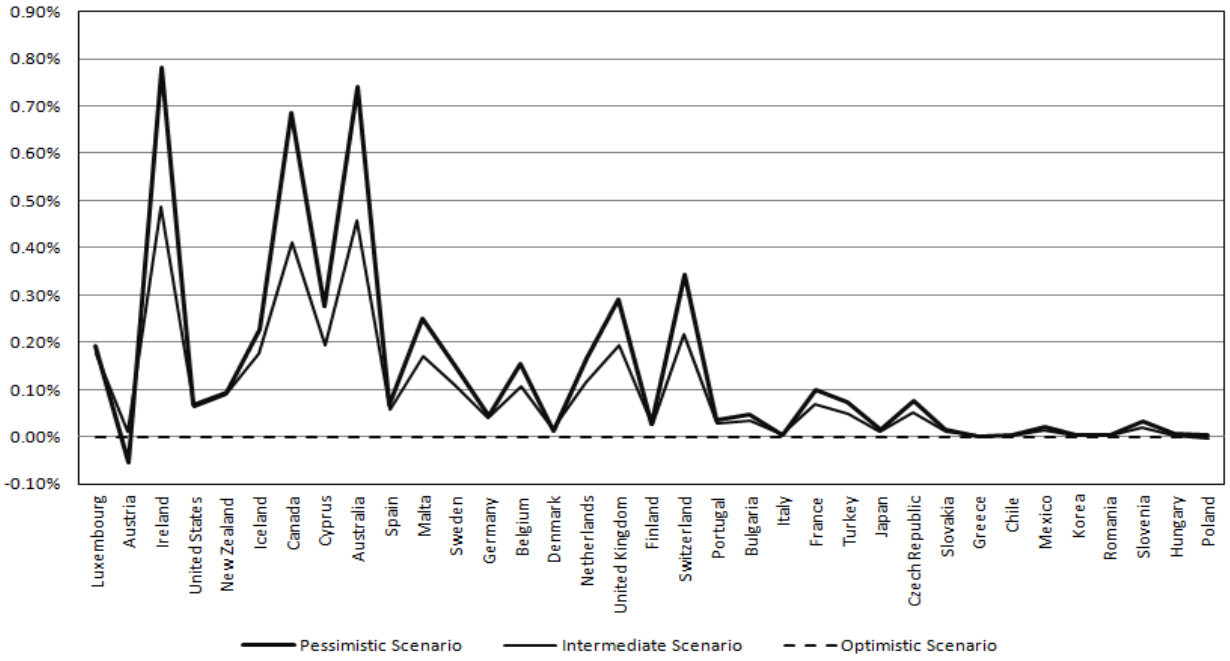
1.b. *Percentage Effects on Average Native Wages*



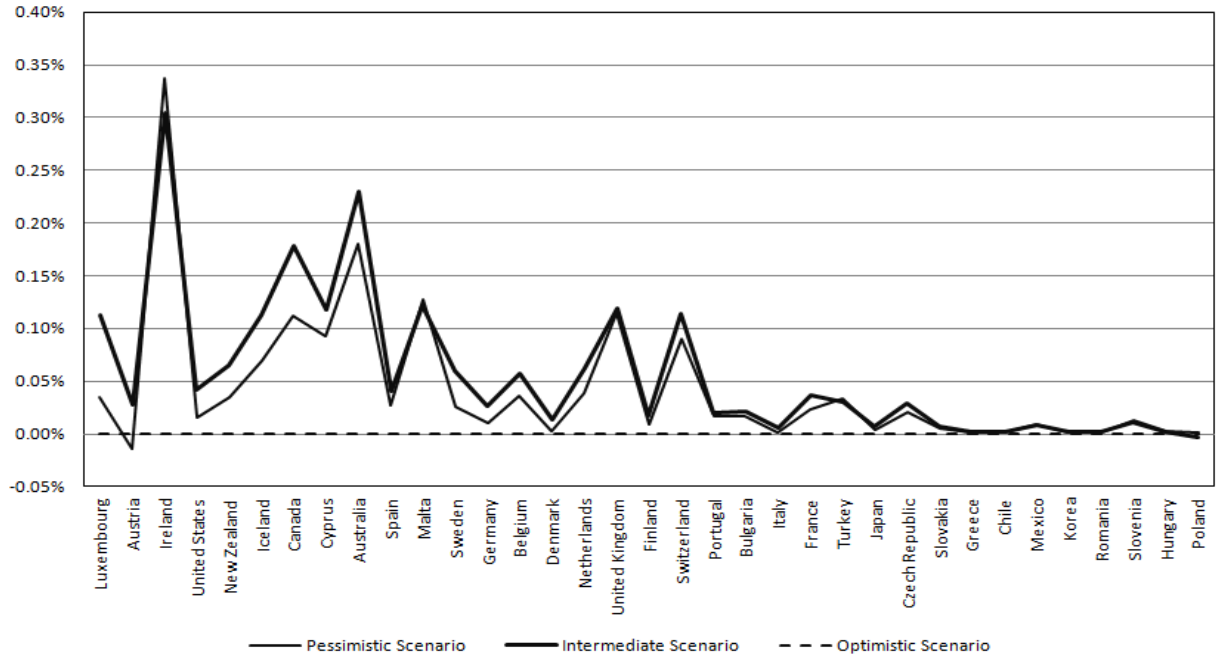
Note: Values on the vertical axis are the simulated wage effect (in percentage of the initial wage) of immigration on natives. We omit Israel and Lithuania, Latvia and Estonia from the chart as they are outliers (see Table A4). The parameter values corresponding to the "Pessimistic", "Intermediate" and "Optimistic" scenarios are reported in Table 3.

Fig. 2. *Employment Effects of Immigration on Native Workers, 1990-2000*
(Countries ranked left-to-right by immigration rate)

2.a. *Percentage Effects on Employment of Less Educated Natives*



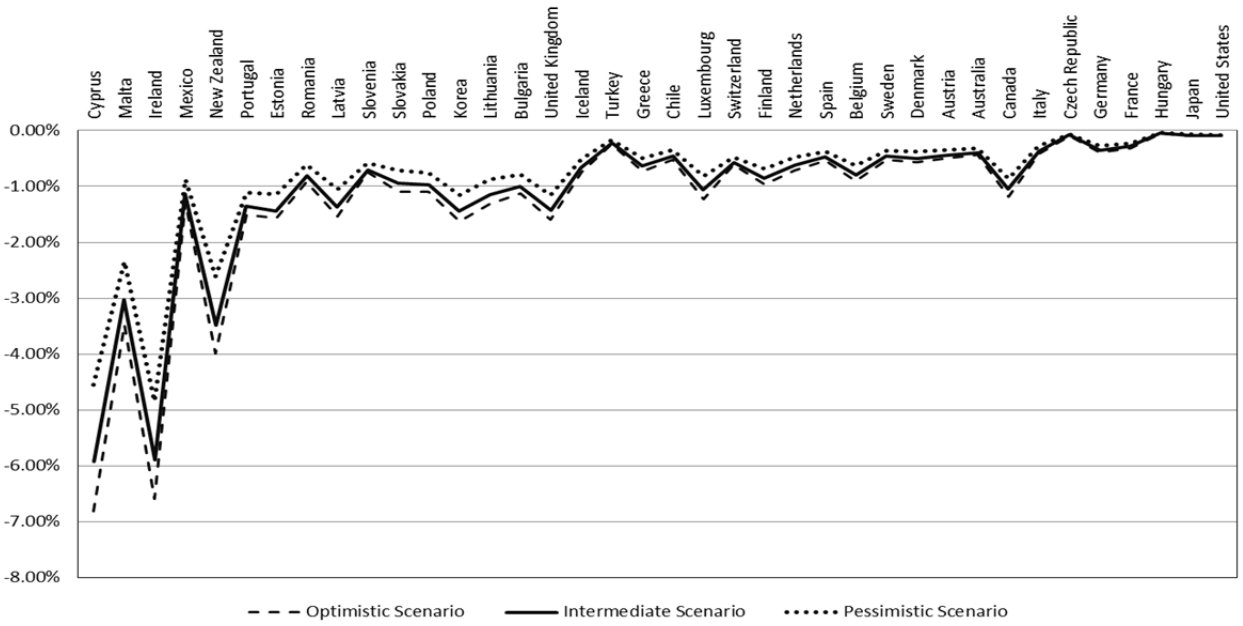
2.b. *Percentage Effects on Employment of All Natives*



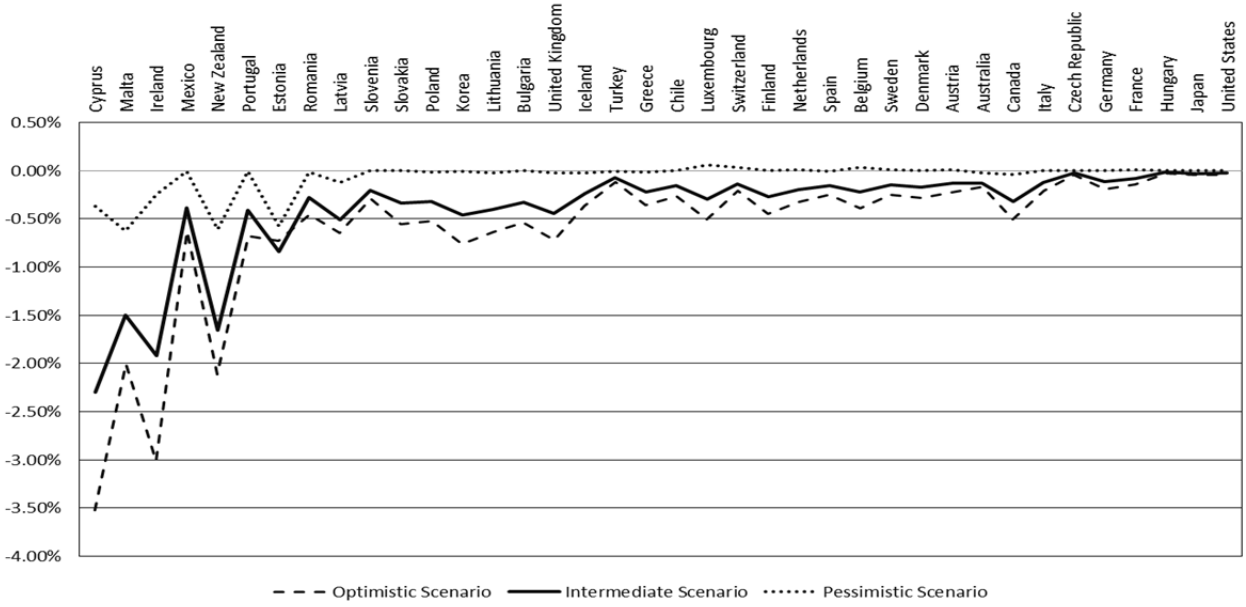
Note: Values on the vertical axis are the simulated aggregate employment effects (in percentage of the initial employment) of immigration on natives. We omit Israel and Lithuania, Latvia and Estonia from the chart as they are outliers see (Table A5). The parameter values corresponding to the Pessimistic, Intermediate and Optimistic Scenario are reported in Table 3.

Fig. 3. *Wage Effects of Emigration on Native Workers, 1990-2000*
(Countries ranked left-to-right by emigration rate of college educated)

3.a. *Percentage Effects on Less Educated Native Wages*



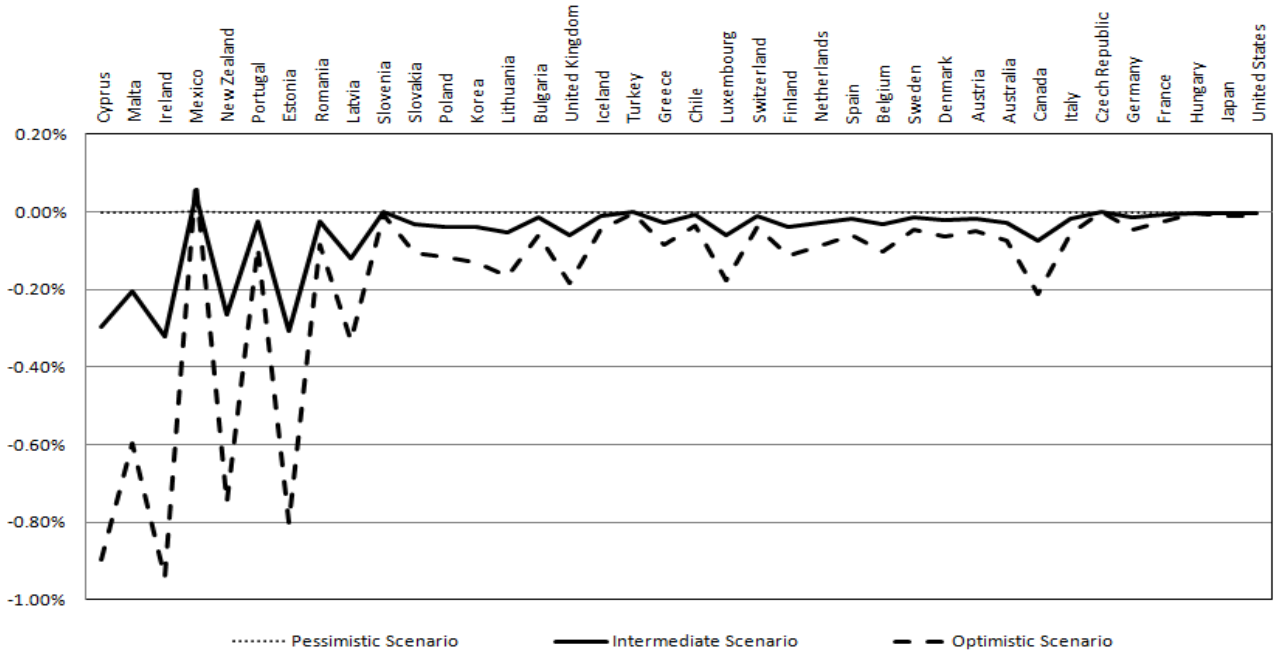
3.b. *Percentage Effects on Average Native Wages*



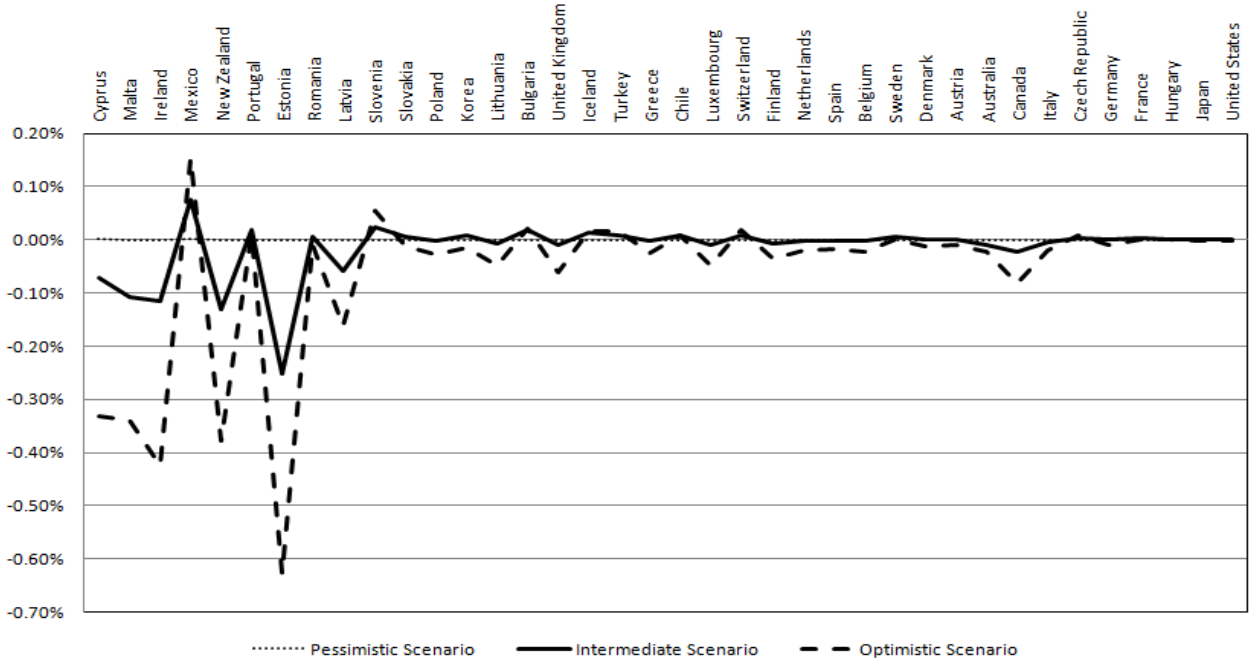
Note: Values on the vertical axis are the simulated wage effects (in percentage of the initial wage). We omit Israel from the chart. The parameter values corresponding to the "Pessimistic", "Intermediate" and "Optimistic" scenarios are reported in Table 3.

Fig. 4. *Employment Effects of Emigration on Native Workers, 1990-2000*
(Countries ranked left-to-right by emigration rate of college educated)

4.a. *Percentage Effects on Less Educated Native Employment*



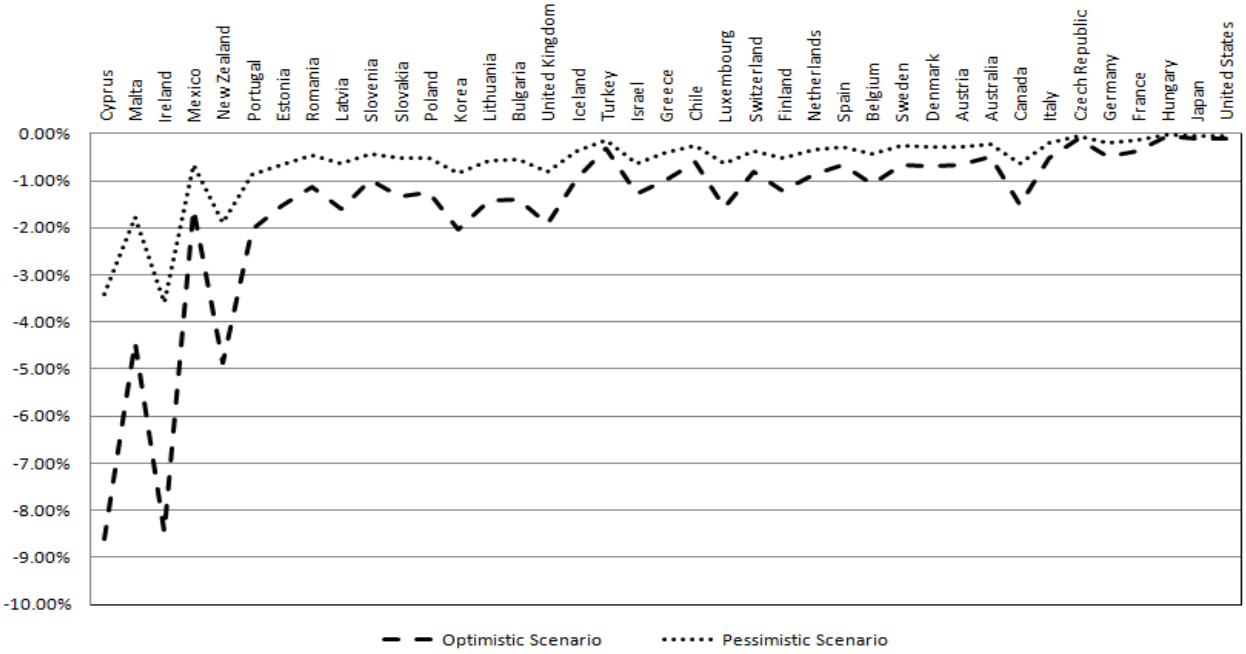
4.b. *Percentage Effects on Average Native Employment*



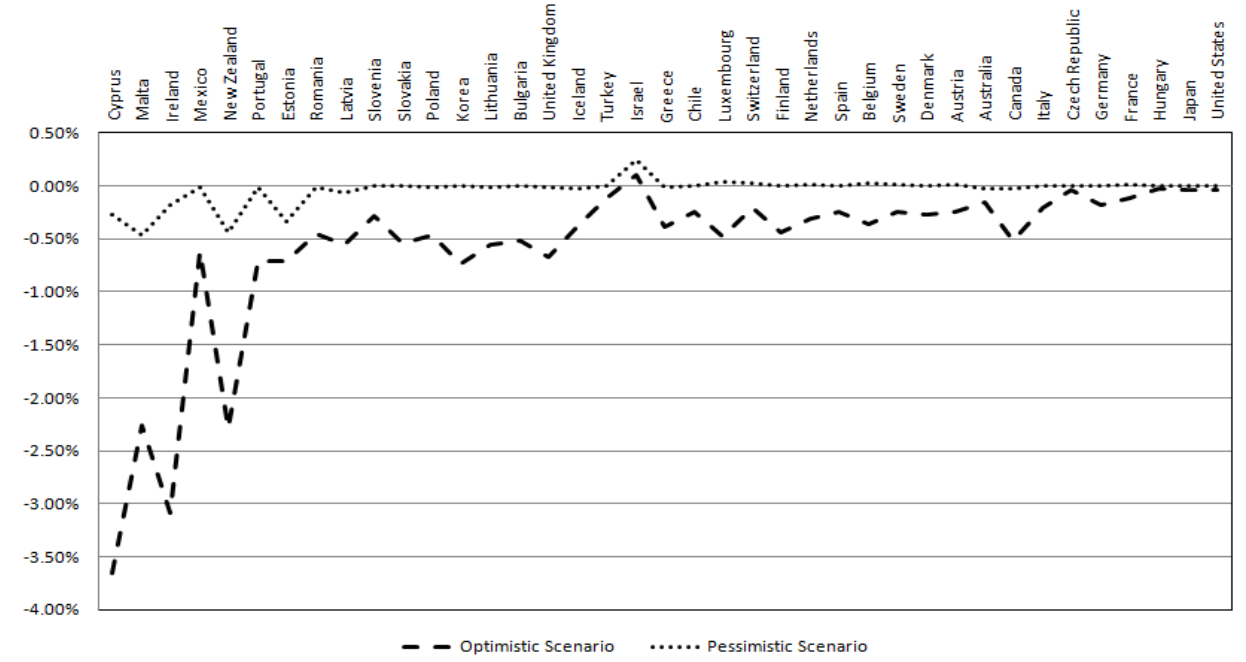
Note: Values on the vertical axis are the simulated employment effects (in percentage of the initial employment) of emigration on native non-migrants. We omit Israel from the chart. The parameter values corresponding to the "Pessimistic", "Intermediate" and "Optimistic" scenarios are reported in Table 3.

Fig. 5. *Wage Effects of Emigration Using Non-imputed Data Only, 1990-2000*

5.a. *Percentage Effects on Less Educated Native Wages*



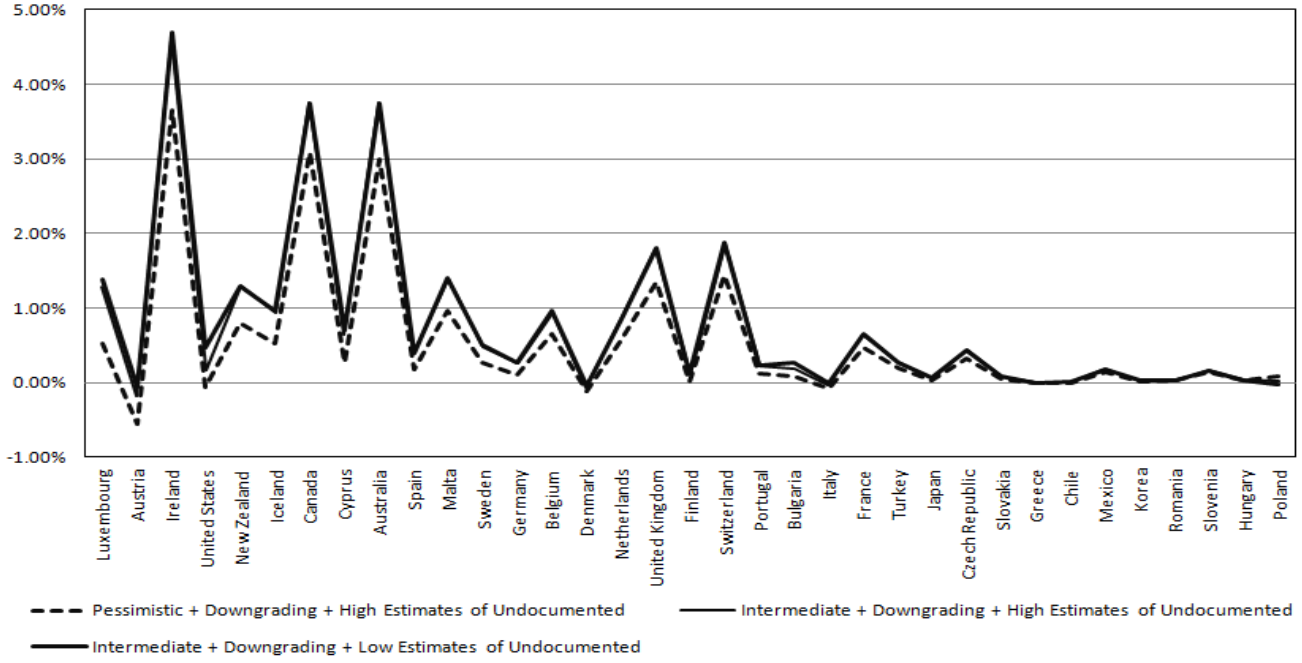
5.b. *Percentage Effects on Average Educated Native Wages*



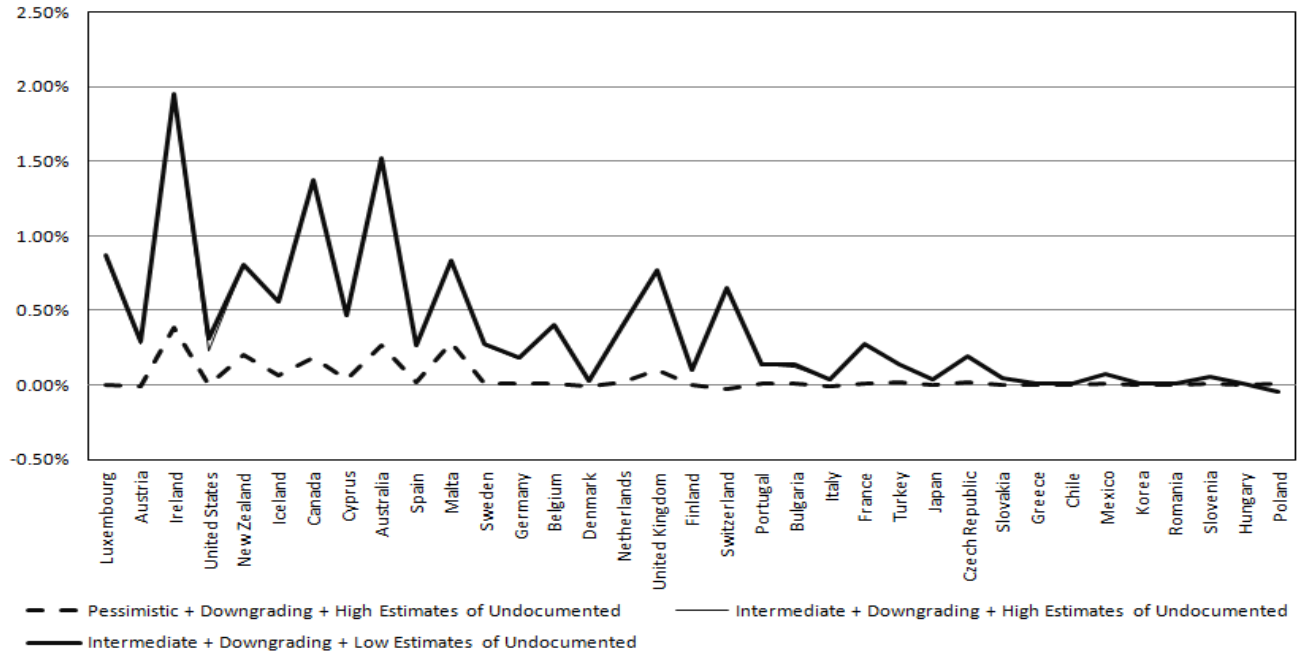
Note: Values on the vertical axis are the simulated wage effects (in percentage of the initial wage) of emigration on native non-migrants. The parameter values corresponding to the "Pessimistic" and "Optimistic" scenarios are reported in Table 3.

Fig. 6. *Wage Effects of Immigration Accounting for Undocumented and Downgrading, 1990-2000*
(Countries ranked left-to-right by immigration rate)

6.a. *Percentage Effects on Less Educated Native Wages*



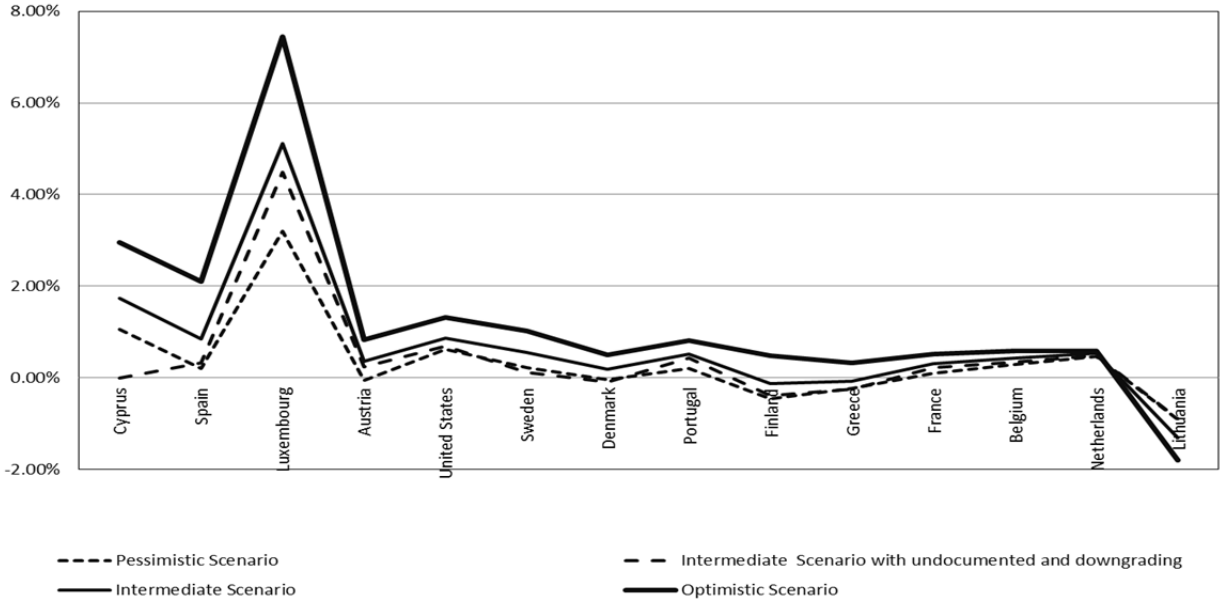
6.b. *Percentage Effects on Average Native Wages*



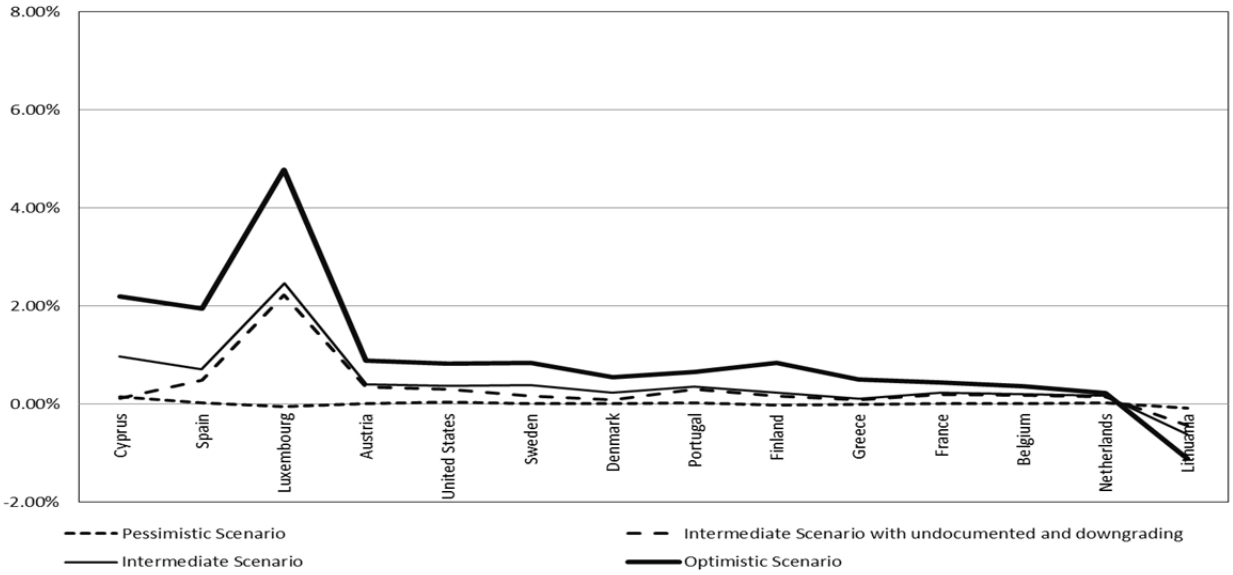
Note: Values on the vertical axis are the simulated wage effects (in percentage of the initial wage) of immigration on natives. We omit Israel and Lithuania, Latvia and Estonia from the chart as they are outliers. The parameter values corresponding to the "Pessimistic", "Intermediate" and "Optimistic" scenarios are reported in Table 3. The correction for undocumented is done using data from the European Union (2010) dataset. The correction for downgrading uses occupational distribution of immigrants by schooling in each country from the OECD DIOC-E database.

Fig. 7. *Wage Effects of Total Immigration on Native Workers, 2000-2007*
(Countries ranked left-to-right by immigration rate - Sample for the US and EU countries)

7.a. *Percentage Effects on Less Educated Native Wages*



7.b. *Percentage Effects on Average Native Wages*



Note: The stock of immigrants and net immigration are calculated using EU Labor Force Survey data for European countries and American Community Survey data for the US. The years considered are 2000 and 2007 for the European countries and 2000-2009 for the US. We only include European countries with at least 80% of non-missing observations for age, schooling and country of birth.

Table 1 *Immigration Rates, 1990-2000* (ranked by total immigration rate)

Country	Total Immigration rates from all countries	College Educated Immigration rates from all countries	Total Immigration rates from non-OECD countries	College Educated Immigration rates from non-OECD countries
Israel	14.35%	60.19%	15.14%	47.03%
Luxembourg	12.53%	16.47%	3.03%	2.17%
Austria	9.35%	7.87%	3.42%	2.11%
Ireland	7.60%	28.02%	1.65%	6.12%
United States	5.71%	6.50%	3.40%	4.71%
New Zealand	5.61%	7.61%	4.79%	8.11%
Iceland	5.25%	16.44%	2.17%	5.41%
Canada	5.21%	10.81%	5.59%	9.06%
Cyprus	4.76%	13.07%	2.50%	5.95%
Australia	3.79%	13.70%	3.66%	6.82%
Spain	3.32%	5.80%	2.02%	3.28%
Malta	2.84%	18.73%	0.59%	4.41%
Sweden	2.66%	6.63%	2.59%	4.29%
Germany	2.64%	3.91%	0.90%	1.65%
Belgium	2.63%	5.68%	1.69%	2.40%
Denmark	2.54%	2.95%	1.82%	1.57%
Netherlands	2.39%	6.60%	1.77%	3.16%
United Kingdom	2.13%	11.26%	1.64%	6.13%
Finland	1.74%	2.34%	0.65%	0.70%
Switzerland	1.61%	9.29%	2.63%	2.96%
Portugal	1.55%	2.99%	1.23%	1.76%
Bulgaria	1.06%	2.52%	0.62%	1.56%
Italy	1.00%	1.08%	0.73%	0.57%
France	0.81%	3.38%	1.01%	1.89%
Turkey	0.71%	7.10%	0.06%	1.27%
Japan	0.46%	0.78%	0.39%	0.54%
Czech Republic	0.39%	5.35%	0.07%	1.02%
Slovakia	0.35%	1.24%	0.08%	0.29%
Greece	0.24%	0.34%	0.19%	0.21%
Chile	0.13%	0.26%	0.12%	0.15%
Mexico	0.11%	1.09%	0.03%	0.36%
Korea	0.00%	0.15%	0.00%	0.11%
Romania	-0.04%	0.27%	-0.02%	0.13%
Slovenia	-0.09%	1.31%	-0.08%	0.84%
Hungary	-0.12%	0.17%	-0.03%	0.04%
Poland	-1.14%	-0.87%	-0.77%	-0.63%
Lithuania	-2.96%	0.36%	-2.71%	0.34%
Latvia	-15.58%	-17.93%	-16.88%	-19.79%
Estonia	-16.73%	-25.46%	-16.60%	-25.80%

Note: Immigration rates are equal to the net change in the stock of immigrants within the group in the period 1990-2000 divided by the population of natives and immigrants within the group in 1990.

Table 2 *Emigration Rates, Total and College Graduates, 1990-2000* (ranked by college-emigration rates)

Country	Total Emigration rates	College graduates Emigration rates
Cyprus	1.78%	29.31%
Malta	-1.77%	27.99%
Ireland	-4.23%	23.30%
Mexico	11.58%	19.76%
New Zealand	6.82%	16.85%
Portugal	3.09%	12.57%
Estonia	4.89%	9.89%
Romania	1.23%	9.89%
Latvia	2.42%	9.17%
Slovenia	4.90%	9.15%
Slovakia	1.04%	8.74%
Poland	0.49%	8.32%
Korea	1.76%	8.20%
Lithuania	0.76%	7.51%
Bulgaria	2.50%	7.19%
United Kingdom	0.40%	6.36%
Iceland	2.68%	5.99%
Turkey	2.43%	5.57%
Greece	0.25%	4.57%
Chile	1.24%	4.05%
Luxembourg	0.73%	3.92%
Switzerland	2.13%	3.64%
Finland	0.02%	2.95%
Netherlands	0.61%	2.94%
Spain	0.06%	2.92%
Belgium	0.51%	2.91%
Sweden	0.82%	2.30%
Denmark	0.30%	2.22%
Austria	0.32%	2.03%
Australia	1.07%	1.70%
Canada	0.17%	1.65%
Italy	-0.29%	1.63%
Czech Republic	0.74%	1.48%
Germany	0.20%	1.37%
France	0.44%	1.31%
Hungary	0.04%	0.37%
Japan	0.06%	0.36%
United States	0.10%	0.23%

Note: emigration rates are equal to the net change in the stock of emigrants in the period 1990-2000 divided by the total population of natives and immigrant residents in 1990.

Table 3

Parameter Values

Parameters:	**Pessimistic Scenario**	**Intermediate scenario**	**Optimistic scenario**
σ_q: Elasticity of Substitution between more and less educated	2.00	1.75	1.3
σ_m: Elasticity of substitution between immigrants and natives	Infinite	20	6
λ: Intensity of college externalities	0	0.45	0.75
γ: Elasticity of labor supply	0.2	0.1	0

Note: The estimates used in each scenario are from the literature. The specific sources are specified in the text.

Table 4 *Simulated Effects of Immigration on Employment and Wage of Natives*

Model	**Parameter Values**			**Percentage change in wages**			**Percentage Change in Employment**		
	σ_q σ_m λ	γ	Country rank, by size of the effect:	Less educated, Natives	Overall Natives	More educated, Natives	Less educated, Natives	Overall Natives	More educated, Natives
Basic	1.75	0.1	Top	4.8%	2.0%	1.0%	0.5%	0.3%	0.1%
	20		Median	0.5%	0.2%	-0.5%	0.1%	0.0%	0.0%
	0.45		Bottom	0.0%	0.0%	-8.2%	0.0%	0.0%	-0.8%
High σ_q	2.00	0.1	Top	4.4%	1.9%	0.9%	0.4%	0.3%	0.1%
	20		Median	0.4%	0.2%	-0.4%	0.0%	0.0%	0.0%
	0.45		Bottom	0.0%	0.0%	-6.9%	0.0%	0.0%	-0.7%
Low σ_q	1.3	0.1	Top	6.0%	2.1%	1.2%	0.6%	0.4%	0.1%
	20		Median	0.6%	0.2%	-0.8%	0.0%	0.0%	-0.1%
	0.45		Bottom	0.0%	0.0%	-11.8%	0.0%	0.0%	-1.2%
High σ_m	1.75	0.1	Top	4.6%	1.6%	0.6%	0.5%	0.3%	0.1%
	Infinity		Median	0.4%	0.1%	-0.7%	0.0%	0.0%	-0.1%
	0.45		Bottom	-0.3%	-0.1%	-9.8%	0.0%	0.0%	-1.0%
Low σ_m	1.75	0.1	Top	5.4%	3.2%	1.9%	0.5%	0.4%	0.1%
	6		Median	0.6%	0.4%	-0.2%	0.0%	0.0%	0.0%
	0.45		Bottom	-0.1%	-0.1%	-4.9%	0.0%	0.0%	-0.5%
High λ	1.75	0.1	Top	5.7%	2.8%	0.9%	0.6%	0.4%	0.1%
	20		Median	0.6%	0.3%	-0.5%	0.1%	0.0%	0.0%
	0.75		Bottom	0.0%	0.0%	-7.4%	0.0%	0.0%	-0.7%
Low λ	1.75	0.1	Top	3.6%	0.8%	1.1%	0.4%	0.2%	0.1%
	20		Median	0.3%	0.1%	-0.6%	0.0%	0.0%	0.0%
	0		Bottom	0.0%	0.0%	-9.5%	0.0%	0.0%	-0.9%
High γ	1.75	0.2	Top	4.8%	2.0%	1.0%	1.0%	0.1%	0.2%
	20		Median	0.5%	0.2%	-0.5%	0.0%	0.0%	-0.1%
	0.45		Bottom	0.0%	0.0%	-7.8%	0.0%	-0.06%	-1.6%
Low γ	1.75	0	Top	4.9%	1.9%	1.0%	0.0%	0.0%	0.0%
	20		Median	0.5%	0.2%	-0.6%	0.0%	0.0%	0.0%
	0.45		Bottom	0.0%	0.0%	-8.8%	0.0%	0.0%	0.0%
Optimistic	1.3	0	Top	7.5%	4.0%	2.1%	0.0%	0.0%	0.0%
	6		Median	0.8%	0.5%	-0.4%	0.0%	0.0%	0.0%
	0.75		Bottom	0.0%	-0.1%	-8.4%	0.0%	0.0%	0.0%
Pessimistic	2.0	0.2	Top	2.9%	0.3%	0.6%	0.6%	0.2%	0.1%
	Infinity		Median	0.2%	0.0%	-0.6%	0.0%	0.0%	-0.1%
	0		Bottom	-0.2%	-0.1%	-9.3%	0.0%	-0.06%	-1.8%

Note: Each three rows correspond to a simulation using the specified values of the parameters. We report the effects of immigration in the 1990's on wages and employment of native less educated, overall and more educated (respectively) in percentage changes. We show only the simulated effects for the countries with the highest (top), the median and lowest (bottom) values for each outcome.

Table 5 *Simulated Effects of Emigration on Employment and Wage of Non-moving Natives*

Model	**Parameter Values**			**Percentage change in wages of non-migrant natives**			**Percentage Change in Employment of non-migrant natives**		
	σ_q σ_m λ	γ	Country rank, by size of the effect:	Less educated, Natives	Overall Natives	More educated, Natives	Less educated, Natives	Overall Natives	More educated, Natives
Basic	1.75	0.1	Top	0.0%	0.0%	15.7%	0.0%	0.0%	1.5%
	20		Median	-0.7%	-0.2%	1.3%	0.0%	0.0%	0.1%
	0.45		Bottom	-5.9%	-2.3%	0.0%	-0.3%	-0.1%	0.0%
High σ_q	2.00	0.1	Top	0.0%	0.0%	13.7%	0.0%	0.1%	1.3%
	20		Median	-0.6%	-0.2%	1.2%	0.0%	0.0%	0.1%
	0.45		Bottom	-5.4%	-2.3%	0.0%	-0.3%	-0.3%	0.0%
Low σ_q	1.3	0.1	Top	0.0%	0.0%	21.3%	0.1%	0.1%	2.0%
	20		Median	-0.8%	-0.2%	1.9%	0.0%	0.0%	0.2%
	0.45		Bottom	-7.3%	-2.4%	0.1%	-0.3%	-0.1%	0.0%
High σ_m	1.75	0.1	Top	0.0%	0.0%	15.7%	0.0%	0.0%	1.5%
	Infinity		Median	-0.7%	-0.2%	1.3%	0.0%	0.0%	0.1%
	0.45		Bottom	-5.9%	-2.3%	0.0%	-0.3%	-0.1%	0.0%
Low σ_m	1.75	0.1	Top	0.0%	0.0%	15.7%	0.0%	0.0%	1.5%
	6		Median	-0.7%	-0.2%	1.3%	0.0%	0.0%	0.1%
	0.45		Bottom	-5.9%	-2.3%	0.0%	-0.3%	-0.1%	0.0%
High λ	1.75	0.1	Top	0.0%	0.0%	15.0%	0.0%	0.0%	1.4%
	20		Median	-0.8%	-0.3%	1.3%	0.0%	0.0%	0.1%
	0.75		Bottom	-7.3%	-3.6%	0.0%	-0.4%	-0.2%	0.0%
Low λ	1.75	0.1	Top	0.0%	0.0%	16.7%	0.1%	0.1%	1.6%
	20		Median	-0.4%	0.0%	1.5%	0.0%	0.0%	0.1%
	0		Bottom	-4.2%	-0.5%	0.0%	-0.2%	0.0%	0.0%
High γ	1.75	0.2	Top	0.0%	0.0%	15.7%	0.1%	0.1%	2.9%
	20		Median	-0.7%	-0.2%	1.3%	0.0%	0.0%	0.2%
	0.45		Bottom	-5.9%	-2.3%	0.0%	-0.6%	-0.3%	0.0%
Low γ	1.75	0	Top	0.0%	0.0%	15.7%	0.0%	0.0%	0.0%
	20		Median	-0.7%	-0.2%	1.4%	0.0%	0.0%	0.0%
	0.45		Bottom	-5.9%	-2.3%	0.0%	0.0%	0.0%	0.0%
Optimistic	1.3	0	Top	0.0%	0.0%	20.0%	0.0%	0.0%	0.0%
	6		Median	-1.0%	-0.4%	1.8%	0.0%	0.0%	0.0%
	0.75		Bottom	-8.6%	-3.8%	0.0%	0.0%	0.0%	0.0%
Pessimistic	2.0	0.2	Top	0.3%	0.1%	16.2%	0.1%	0.1%	3.5%
	Infinity		Median	0.0%	0.0%	1.3%	0.0%	0.0%	0.3%
	0		Bottom	-3.7%	-0.3%	0.0%	-0.9%	-0.5%	0.0%

Note: Each three rows correspond to one simulation using the specified values of the parameters. We report the effects of emigration in the 1990's on wages and employment of non-migrant native less educated, overall and more educated (respectively) in percentage changes. We show only the simulated effects for the countries with the highest (top), the median and lowest (Bottom) values for each outcome.

Table 6 *Robustness Checks*

Model	Parameter Values			Percentage change in wages			Percentage Change in Employment		
	σ_q σ_m λ	γ	Country rank, by size of the effect:	Less educated, Natives	Overall Natives	More educated, Natives	Less educated, Natives	Overall Natives	More educated, Natives
6.1 Effects of Emigration, using only non-imputed data									
Optimistic	1.3	0	Top	-0.1%	0.0%	22.1%	0.1%	0.0%	0.0%
	6		Median	-1.0%	-0.4%	1.71%	0.0%	0.0%	0.0%
	0.75		Bottom	-8.6%	-3.6%	0.0%	0.0%	0.0%	0.0%
Pessimistic	2.0	0.2	Top	0.0%	0.0%	14.1%	0.1%	0.2%	2.6%
	Infinity		Median	0.0%	0.0%	1.3%	0.0%	0.0%	0.2%
	0		Bottom	-3.6%	-0.5%	0.0%	-0.2%	0.0%	0.0%
6.2 Effects of immigration including undocumented and skill downgrading									
Optimistic	1.3	0	Top	7.26%	4.0%	2.9%	0.0%	0.0%	0.0%
	6		Median	0.7%	0.5%	-0.1%	0.0%	0.0%	0.0%
	0.75		Bottom	-0.1%	-0.2%	-7.6%	0.0%	0.0%	0.0%
Pessimistic	2.0	0.2	Top	2.7%	0.2%	1.2%	0.5%	0.2%	0.2%
	Infinity		Median	0.1%	0.0%	-0.5%	0.0%	0.0%	-0.1%
	0		Bottom	-0.4%	0.0%	-8.7%	0.0%	0.0%	-1.7%
6.3 Lower and upper-bound of the 95% confidence interval									
Optimistic,	1.01	-0.2	Top	11.2%	6.6%	3.8%	0.0%	0.0%	2.0%
95% upper	3.03		Median	1.3%	0.9%	-0.4%	-0.2%	-0.2%	0.0%
bound	1.10		Bottom	-0.3%	-0.3%	-10.6%	-2.0%	-1.6%	-0.7%
Pessimistic,	10	0.4	Top	0.6%	0.0%	0.1%	0.2%	0.1%	0.,0%
95% lower	Infinity		Median	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%
bound	0		Bottom	0.0%	0.0%	-1.9%	0.0%	0.0%	-0.8%
6.4 Effects of Immigration during the 2000's									
Optimistic	1.3	0	Top	7.9%	4.7%	1.9%	0.0%	0.0%	0.0%
	6		Median	0.7%	0.6%	0.2%	0.0%	0.0%	0.0%
	0.75		Bottom	0.3%	0.2%	-2.6%	0.0%	0.0%	0.0%
Pessimistic	2.0	0.2	Top	2.4%	0.1%	0.9%	0.4%	0.2%	0.6%
	0		Median	0.1%	0.0%	-0.4%	0.0%	0.0%	-0.1%
	infinity		Bottom	-0.3%	0.0%	-5.8%	-0.1%	0.0%	-1.1%

Note: Each three rows correspond to one simulation using the specified values of the parameters. We report the effects of immigration on wages and employment of native less educated, overall and more educated (respectively) in percentage changes. We show only the simulated effects for the countries with the highest (top), the median and lowest (bottom) values for each outcome.

Table 7 *Immigration Rates for a Sample of EU Countries and the US, 1990-2000 and 2000-2007*

Country	1990-2000	2000-2007
Cyprus	4.76%	11.31%
Spain	3.32%	11.26%
Luxembourg	12.53%	8.46%
Austria	9.35%	5.06%
United States	5.71%	3.76%
Sweden	2.66%	3.66%
Denmark	2.54%	2.86%
Portugal	1.55%	2.81%
Finland	1.74%	2.68%
Greece	0.24%	2.46%
France	0.81%	1.26%
Belgium	2.63%	0.39%
Netherlands	2.39%	-0.45%
Lithuania	-2.96%	-1.71%

Note: the 2000-07 figures are obtained as our elaborations from the EULFS data for the European countries, and using the ACS data for the US. The US rates are relative to the 2000-2009 period. The 1990-2000 figures are taken from Table 1.