Immigration, Search, and Redistribution: A Quantitative Assessment of Native Welfare*

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Abstract

What are the welfare effects of immigration on low-skilled and high-skilled natives? To address this question, we develop a general equilibrium model featuring two skill types, search frictions, wage bargaining, and a welfare state that redistributes income through unemployment benefits and the provision of public goods. Our quantitative analysis suggests that, in all 20 countries studied, immigration attenuates the effects of search frictions. The resulting gains tend to outweigh the welfare costs of redistribution. Immigration has increased native welfare in almost all countries. In two-thirds of countries both high- and low-skilled natives have benefited from the presence of immigrants, contrary to what models without search frictions or redistribution predict. Average total welfare gains from migration are 1.25% and 1.00% for high- and low-skilled natives, respectively.

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1 Introduction

Many OECD countries have experienced high immigration rates during the last two decades. Foreign-born workers now make up a significant share of their labor forces. The overall economic effects of immigration on the native population are debated. Based on simple models of factor complementarity, economists have long been optimistic about the existence of a net immigration surplus for natives (Borjas, 1995). They have also been aware of factor price adjustment effects of immigration (Borjas, 2003) and of the possible consequences for welfare states (Razin and Sadka, 2000). However, once one simultaneously accounts for labor market frictions and redistributive fiscal policies, the net effect of immigration on native welfare is harder to calculate. To our knowledge, no previous paper on the effects of immigration has taken into account both production complementarities under imperfect competition in the labor market and fiscal redistribution. This paper begins to fill this gap.

We document that host OECD countries differ with respect to the size and structure of their immigrant populations. They also differ with respect to their labor market and redistributive institutions. To study how this heterogeneity shapes outcomes for incumbent populations, we develop a parsimonious model that incorporates key aspects of this heterogeneity. We use a setup with search and matching frictions that includes skill heterogeneity, wage bargaining and a welfare state that taxes labor income to provide unemployment benefits and engages in redistributive policies. We calibrate our model separately for 20 OECD countries to evaluate the effects of different migration scenarios on the welfare of different sections of the native and immigrant populations.

The effect of immigration on labor market outcomes and welfare is likely to hinge on four important features of immigrants and host countries. First, it depends on how the skill composition of the immigrant labor force differs from that of natives. By the complementarity channel, additional supply of a certain type of workers negatively affects other workers of the same type (substitutes) and positively affects workers of different types (complements). For example, a new inflow of low-skilled immigrants reduces wages of low-skilled natives and increases those of high-skilled natives. In about a third of the surveyed countries, the share of tertiary educated is larger for immigrants than for natives. In several countries, including France, Germany and the UK, however, that share is substantially smaller for immigrants than for natives. The second key fact relates to the relative

wage levels of immigrants and natives. In all 20 countries, low-skilled natives earn a wage premium over low-skilled immigrants. In 17 out of 20 countries, high-skilled natives earn more than high-skilled immigrants. In the remaining three countries, high-skilled natives and immigrants earn about the same. Wage gaps may reflect differences in labor productivity, but they may also relate to differences in the outside option of natives relative to migrants. These two determinants of wage gaps have different implications on the labor market effects of immigrants. The third fact relates to unemployment risk. In most countries both low- and high-skilled immigrants are much more likely to be unemployed than natives of the same skill level. All countries in our sample provide some unemployment insurance, albeit at different levels of generosity. Such systems lead to net redistribution from the group with lower unemployment rates to the group with higher unemployment rates. Fourth, the size of government (measured by the share of taxes or public expenditures in GDP) has important implications on the fiscal effect of immigrants, and varies significantly across countries. While fiscal effects of migration have been the subject of some research and much public debate, to the best of our knowledge the welfare state has not been included into a general equilibrium model featuring skill heterogeneity and labor market frictions.

These features describe four different margins through which immigrants affect native welfare. In our quantitative analysis, we capture all of them. To this end, we must go beyond the complementarity and labor market competition channels of the canonical frictionless model. We need a setup in which wages and unemployment rates can differ for workers with similar educational attainments, and where the public sector redistributes income to the unemployed and to low-income individuals through unemployment benefits and through the provision of public goods. To this end, we present a model that combines a production function featuring skill complementarity with a labor market characterized by search and matching frictions. Competitive firms create vacancies for high- or low-skilled workers, and cannot target immigrants or natives *ex ante*. Natives and immigrants are perfect substitutes within each skill group, but may differ with respect to their productivity. For given education, our model also allows immigrants to differ from natives with respect to their outside options (for example due to different costs of search for employment while unemployed) and their exogenous job breakup rate, which for immigrants is in part driven by re-migration. Through these differences, the model explains the empirical fact that foreign born workers face higher unemployment risk than natives and have lower wages.

In equilibrium, immigration affects native welfare through four channels. Two of them work through the labor market: the traditional complementarity channel affects wages through relative supply of skills, while a job creation channel arises because an increase in the share of immigrant workers affects the incentives for job creation by firms. This job-creation channel was first pointed out by Chassamboulli and Palivos (2014). Its impact on native employment depends crucially on differences between natives and immigrants regarding productivity and outside options. Redistribution also works through two channels: one through unemployment benefits and another through proportional taxes and lump-sum transfers. How these channels affect native welfare depends on the relative skill composition of immigrants, as well as on the design of labor market institutions and the public sector. While it is impossible to obtain closed-form solutions for our full general equilibrium setup, analytical results are available for simplified versions of our model.

We calibrate the parameters of our model to match 11 salient empirical moments we have collected for 20 OECD countries circa 2011. We use the quantitative model to study the welfare implications of the following four exercises: (i) an increase in immigration equal to one percentage point of the labor force, keeping the skill composition of the immigrant population fixed and starting from the 2011 *status quo*; (ii) an increase of the same size, but only of low-skilled immigrants; (iii) a hypothetical no-immigrant situation (autarky) relative to the status quo in 2011, and (iv) a change in migrant shares and skill composition equivalent to the changes between 2011 and 2014. While we find welfare effects to be heterogeneous across countries and skill groups, in most cases the effects of a marginal increase of immigrants – as in experiment (i) – are positive for natives. In the case of an increase in the stock of unskilled immigrants only – as in experiment (ii) – the impact on welfare of low-skilled natives is usually negative. However, it is small (on average on the order of one tenth of a percentage point) and the average welfare effects for all natives is zero. In 19 of 20 countries, welfare effects of total migration relative to autarky – as experiment in (iii) – are positive for natives in terms of the utilitarian social welfare function. Positive effects on labor market efficiency tend to outweigh costs coming from the welfare state, especially in countries where transfers are relatively unimportant. We include important extensions analyzing the different impact of immigrants on native welfare when their productivity is lower than natives' and when part of the public spending is on non-rival goods such as defense and debt servicing.

Finally, to better understand the relative quantitative importance of the different mechanisms

present in our framework, we perform a simulated comparative statics exercise. For this purpose, based on observational data, we draw a vector of moments for 10,000 artificial economies, calibrate our model to each of them, and run regressions to obtain conditional correlations between these moments and native welfare, which is our variable of interest. Wage and unemployment gaps between immigrants and natives, as well as the size of government, are found to be important determinants of the welfare effects of immigration. A simpler model with competitive labor markets and no government cannot deliver this result.

Our paper is related to at least four strands of research. First, a large empirical literature studies the wage effects of immigration.[1] Using increasingly sophisticated approaches based on dividing the labor market into cells to estimate own- and cross-elasticities of substitution, it simulates the effect of immigration through the complementarity channel.[2] Second, some recent papers apply a structural empirical framework to a setup where wages are set non-competitively. For instance D'Amuri et al. (2010), Felbermayr et al. (2010), Brücker and Jahn (2011) and Brücker et al. (2014) postulate, in reduced form, that wages are decreasing functions of unemployment rates. While these models do allow for unemployment, the labor market imperfections are not micro-founded, and the role of labor market institutions is not explicitly modeled. Moreover, these studies do not have any role for the government and do not discuss welfare. Chassamboulli and Palivos (2014) address the shortcoming related to missing micro-foundations of labor market imperfections, and study immigration in a search-and-matching model in which immigrants have inferior outside options compared to natives. Bargaining results in lower wages for immigrants, which encourages firms to create more vacancies for all workers. This way, immigration can attenuate the effects of labor market frictions for natives.[3] In this paper, we generalize the model presented in Chassamboulli and Palivos (2014). We allow heterogeneity between immigrants and natives in employment duration, thereby allowing unemployment rates to be different between natives and immigrants of the same skill level. We also extend the quantitative exercise to a sample of 20 countries.

[1] Longhi et al. (2008) provide a meta analysis of estimates. In his survey, Hanson (2009) criticizes that the literature is characterized by a "near obsession" with wages.

[2] E.g. Borjas (2003), Ottaviano and Peri (2012) and the references therein.

[3] An older theoretical literature suggests that immigrants generate efficiency gains by weakening the bargaining power of labor unions; see Schmidt et al. (1994). Borjas (2001) argues that immigrant workers react more flexibly to differences in job opportunities than native workers because they are not tied to any specific location, thereby smoothing labor market frictions. Angrist and Kugler (2003) conclude that low labor market flexibility increases the negative effects of immigration in Europe.

The cited papers also abstract from the fiscal effects of immigration. This is the focus of a separate literature. Calibrating dynamic equilibrium models featuring demographics and fiscal policy for the US and Sweden, Storesletten (2000, 2003) find that immigration can strongly benefit natives when immigrants are middle-aged and have sufficiently high employment rates. Actual immigration, however, may differ from such a composition; immigration may turn out to be a burden for the native taxpayer.[4] Dustmann and Frattini (2014) provide a comprehensive analysis of the net fiscal contribution of immigrants in the UK and find an overall positive impact. Virtually all papers in this literature abstract from a micro-founded modeling of labor market imperfections. They instead use an "accounting approach" based on observed taxes and transfers, without considering labor market interactions and the equilibrium responses of the economy.

Finally, a handful of papers evaluate the welfare gains from immigration within a general equilibrium framework. Benhabib and Jovanovic (2012) use a model with human capital externalities similar to Lucas (1990) to estimate the level of international migration that maximizes world welfare. They find that global migration flows ought to be much larger than they are today. Di Giovanni et al. (2015) quantify the welfare effects of international migration in a model that incorporates total factor productivity and skill differences, within a Melitz (2003) framework of international trade with a home market effect. Klein and Ventura (2007, 2009) analyze the effects of international migration driven by productivity differences, in models where capital is mobile in the long-run. They find substantial gains from migration, accruing in large part to the immigrants themselves. Docquier, Ozden and Peri (2014), instead, evaluate wage and employment gains from immigration and emigration for non-migrants in all OECD countries. These papers assume Walrasian labor markets and do not include a public sector.

In addition to affecting wages and fiscal budgets, large-scale immigration may be capitalized in rents and property values. Like other papers on the wage effects of immigration, we abstain from modeling this mechanism. As most land is owned by native citizens, changes in rents can be expected to generate winners and losers within the native population, but largely cancel out at the level of aggregate native income. Nonetheless, such a distributional conflict could be a reason why tenants may be worried about increases in immigration. Glazer et al. (2008) present a model

[4] In many countries there has been a fierce debate about the net fiscal contribution of immigrants. For Germany, see Sinn et al. (2001) and Bonin (2002).

in which utility depends on housing location and other consumption, and land is heterogeneous. They show that if a utilitarian government does not care about the welfare of landowners, it may tax the rich more once they become mobile in order to push rents down.

The remainder of this paper is structured as follows. Section 2 presents cross country variation of measures related to migration and institutions in 20 OECD countries. Section 3 presents our model. Section 4 discusses our calibration strategy and presents our quantitative results and extensions. Section 5 concludes.

2 Cross-country summary statistics

In this section, we document cross-country heterogeneity in the labor market performance of immigrants and in relevant institutions. These summary statistics motivate our modeling approach and play a central role in our quantitative exercise.

2.1 Immigrants in the labor force

Table 1 provides summary statistics on eight important measures that characterize immigration, the labor market, and the generosity of welfare states in the 20 countries of our sample.[5] Row [1] of Table 1 shows that immigrants represent a substantial percentage of the labor force in the countries considered, with the average across countries standing at about 17%, the lowest equal to 10% (Portugal) and the highest as large as 39% (Luxembourg).[6] Row [2] refers to the skill composition of immigrants relative to natives. On average, the share of tertiary-educated immigrants relative to the share of tertiary-educated natives is almost unity, revealing similar average skill composition. However, there is substantial heterogeneity across countries. In Canada, this share for immigrants is 1.63 times the share of college-educated natives. In Slovenia, the share for college-educated immigrants is only 0.40 times that of natives. Based on this heterogeneity in relative skill patterns, we expect different distributional effects of immigration in different countries.

[5] We have been able to compile a set of comparative and reliable moments for 16 EU member states, plus Switzerland, the United States, Canada and Australia. The data are taken from national censuses or similar sources and generally refer to year 2011. See Appendix B for details.

[6] The countries in our sample have a larger share of immigrants than the average OECD country, which has 10%.

Table 1: Summary statistics of moments of interest

	Variable	Average	75th PCTL	25th PCTL	Top value (country)	Bottom value (country)
[1]	Share of immigrants in the labor force	17.1%	17.9%	13.4%	39.1% (Luxembourg)	9.9% (Portugal)
[2]	Share of tertiary educated, immigrants rel. to natives	0.99	1.16	0.78	1.63 (Canada)	0.40 (Slovenia)
[3]	Low skilled average wage, immigrants rel. to natives	0.86	0.90	0.78	0.99 (Canada)	0.72 (Greece)
[4]	High skilled average wage, immigrants rel. to natives	0.86	0.93	0.81	1.01 (Switzerland)	0.64 (Italy)
[5]	Low skilled unemployment, immigrants rel. to natives	1.62	2.07	1.23	2.43 (Switzerland)	0.91 (United States)
[6]	High skilled unemployment, immigrants rel. to natives	2.19	2.78	1.69	3.50 (Austria)	1.14 (Portugal)
[7]	Replacement ratio (benefits/wages)	38.9%	49.8%	26.6%	62.9% (Belgium)	21.9% (Greece)
[8]	Public spending as share of GDP	45.3%	49.7%	41.0%	54.8% (Denmark)	33.4% (Switzerland)

Data sources: see Appendix B for details. PCTL: Percentile.

2.2 Labor market outcomes of natives and immigrants

Native and immigrant workers also differ in their labor market outcomes. Rows [3] and [4] in Table 1 show that – across the countries in our sample – the average wage received by immigrants is typically lower than the one received by natives of the same skill class. Using EU-SILC and Census data, both for high- and low-skilled workers,[7] the average yearly wage paid to immigrants equals 86% of that paid to natives, with large cross-country heterogeneity. For example, there is no wage gap for low-skilled immigrants in Canada and high-skilled immigrants in Switzerland. The wage gap is highest in Greece for low-skilled workers and Italy for high-skilled workers.

The lower wages for immigrants relative to similarly skilled natives could derive from different factors. First, the wage gaps could be due to lower bargaining power of migrants. Second, even within the same skill class, migrants may have lower productivity than natives because of poorer language skills or imperfect portability of human capital (Poutvaara, 2008). While several studies document that the native-immigrant wage gap declines with years spent in the host country, most of them find a positive native-immigrant wage gap which persists even after many years of linguistic

[7] In all of our analysis, we define skills based on educational attainment. Highly skilled workers are those with (any completed) tertiary education.

and skill assimilation.[8] This wage difference affects the value to the firm of a job filled with a migrant. It can be higher or lower than the one of a job filled with a native, depending on whether the bargaining effect or the productivity effect dominates.[9]

Rows [5] and [6] of Table 1 report summary statistics on unemployment rates of immigrants compared to natives, within the groups of low- and high-skilled workers. Differences are substantial, in particular for the highly skilled. Cross-country heterogeneity is large, too. On average, the likelihood of unemployment for an immigrant is 1.6 times (for low skilled) and 2.2 times (for high skilled) the corresponding likelihood for a native. Unemployment gaps are largest in Switzerland for the low skilled and in Austria for the high skilled, and lowest in the US for the low skilled and in Portugal for the high skilled. These discrepancies in unemployment rates are consistent with immigrants facing higher job destruction rates than natives, a fact documented in the empirical literature for several countries, as we discuss below. *Ceteris paribus*, the shorter expected duration of a match with an immigrant, due to a variety of reasons, reduces incentives for vacancy creation.

2.3 Welfare state characteristics

Different wages and unemployment rates between natives and immigrants have important implications: first, they open the door for immigration to affect job creation incentives; second, they may generate redistribution through taxation and unemployment benefits. The relative importance of unemployment benefits as a redistribution channel between natives and immigrants depends on equilibrium unemployment rates, and on the generosity of benefits. Following the literature, we measure this as the average replacement ratio, i.e. the size of unemployment benefits as a percentage of after-tax wage income.[10] Row [7] of Table 1 shows this rate averages 39% and varies from 63% in Belgium to 22% in Greece. The generosity of unemployment benefits changes the effective bargaining power of workers, their wages, and the degree of labor market tightness.

The overall scale of fiscal redistribution is quantitatively more relevant. Many European countries engage in substantial redistribution. Government spending as a share of GDP, which we report

[8] This is especially true in Europe; see Kerr and Kerr (2011).

[9] An alternative possibility, which we rule out in this paper, is classical employer discrimination, whereby the additional surplus from employing an immigrant compensates the firm for its "distaste" of employing immigrants.

[10] This stylized measure abstracts from many complications of real-life unemployment insurance systems, but is the only harmonized measure available.

in Row [8] of Table 1, is a simple measure of the redistributive role of governments.[11] Government spending as a share of GDP averages 45%, ranging between 33% (Switzerland) and 55% (Denmark). While transfers and public goods may imply redistribution towards migrants, they also alter the distributional effects of immigration on natives of different skill levels.

3 Model

We model each country as an economy producing one output good, with native and immigrant workers and perfectly mobile physical capital. In the tradition of papers on the impact of immigrants on national labor markets (Borjas, 2003; Ottaviano and Peri, 2012) and recent multi-country extensions (Docquier et al., 2014; di Giovanni et al., 2015), we take the stock of international migrants as an exogenous variable. There is a single final output good and two intermediate goods. The government redistributes income through unemployment benefits and a lump-sum transfer. Taxes are a linear function of wage income. Utility is linear in consumption.

3.1 Production

The final output good Y, whose price is normalized to unity, is produced using capital K and a composite input good Z. In turn, good Z is produced using a CES combination of two intermediate inputs. We denote them by Y_L and Y_H, and assume them to be linear functions of employment of low- and high-skilled workers, respectively. This is common in the macro-labor literature that analyzes skill premia and skill bias (see, i.a., Acemoglu, 2002; Katz and Murphy, 1992; Autor et al., 2006). More precisely, the supply side is characterized by the following expressions:

$$\begin{aligned} Y &= AK^{\alpha}Z^{1-\alpha}, \alpha \in (0,1) \\ Z &= \left[xY_L^{\rho} + (1-x)\,Y_H^{\rho}\right]^{\frac{1}{\rho}}, \rho \in (0,1) \\ Y_i &= \sum_{j \in \{N,I\}} (1-u_{ij})\,\pi_{ij} Q_{ij}, i \in \{L,H\}, \end{aligned} \tag{1}$$

[11] We find this a better measure than the share of income transfers in GDP. Many publicly provided goods, like health care, schooling, and infrastructure, provide benefits independent from the recipient's income. Taxes, however, are income-dependent, thereby entailing an important redistributive component.

where α is the output elasticity of capital, A denotes total factor productivity, ρ governs the elasticity of substitution between the low skill intensive intermediate input Y_L and the high skill intensive intermediate input Y_H, $x \in (0,1)$ is a productivity parameter, Q_{ij} is the supply of different types of labor, with $i \in \{L,H\}$ indexing skills (high and low levels of education) and $j \in \{N,I\}$ distinguishing native (N) and immigrant (I) workers. Finally, u_{ij} is the unemployment rate and π_{ij} is labor productivity (effectiveness) for group $i \times j$.[12] Expression (1) implies that natives and migrants of the same skill level are perfect substitutes in production and that two skills, usually identified with workers who completed a college education and workers who did not complete a college education, are sufficient to capture the main differences in workers' roles in production. This bipartition is typical of models that identify education-based skills (e.g. Goldin and Katz, 2008, Card, 2009, Docquier et al., 2014) and it recognizes that workers with a completed college education and those without a college education are performing different productive roles associated, most likely, with cognitive-analytical abilities (the first group) and non-cognitive abilities (the second group). This distinction acknowledges the crucial complementarity in production between workers with a (completed) college education and those without a (completed) college education, which is at the core of modeling labor demand and labor supply in the last decades (e.g. Autor et al., 2006).

Recently, Autor and Dorn (2013) and Goos et al. (2009) have shown how distinguishing between "routine" and "service" tasks within skill classes can shed light on the role of technological change in explaining wage polarization. We do not follow this task-based approach because our main focus is on labor supply side rather than on labor demand, and because it would be difficult to empirically assess the suitability of immigrants for either task in the available cross-country data. Rather, we simply analyze average wage and employment effects for workers without distinguishing by productive tasks.[13]

Since we assume capital to be freely mobile internationally, the return to capital is determined on world markets. The simplest assumption about capital ownership is that each individual owns

[12] Acemoglu (2002) and Ottaviano and Peri (2012) use a similar structure. In contrast, Chassamboulli and Palivos (2014) assume that capital is needed only in the production of the high-skilled good. This implies a positive correlation between relative employment of skilled and unskilled, and the capital share. In our sample of 20 countries, this correlation is not statistically significant, and so we follow Acemoglu (2002).

[13] We rule out complementarity effects within skill groups. This assumption implies that the positive wage-impact on natives may be understated. See the debate in Ottaviano and Peri (2012).

an equal share of capital invested across countries to mirror exactly the cross-country distribution of capital that equates its marginal return across countries. Hence, the stock of capital owned by natives of a country is given by $\bar{K}$ and its amount and return do not change with immigration (although its cross-country allocation will). The amount of capital used in production by a country may differ from $\bar{K}$. It is determined by the usual first order condition $r+\delta = \alpha A K^{\alpha-1} Z^{1-\alpha}$, where $r+\delta$ is the user cost of capital given by the sum of the interest rate on a risk-free asset and the depreciation rate of capital. Hence, gross capital income R generated in the economy is given by:

$$R \equiv (r+\delta)K = \alpha A K^{\alpha} Z^{1-\alpha} = \alpha Y. \tag{2}$$

Intermediate goods are produced under perfect competition. So, their prices equal their marginal contributions to the production of the final good Y, namely:

$$p_L = A K^{\alpha}(1-\alpha) x Y_L^{\rho-1} \left[x Y_L^{\rho} + (1-x) Y_H^{\rho} \right]^{\frac{1-\alpha-\rho}{\rho}}, \tag{3}$$

$$p_H = A K^{\alpha}(1-\alpha)(1-x) Y_H^{\rho-1} \left[x Y_L^{\rho} + (1-x) Y_H^{\rho} \right]^{\frac{1-\alpha-\rho}{\rho}}. \tag{4}$$

The production function of the intermediate goods is very simple: once a worker of group $i \times j$ ($i \in \{L, H\}$, $j \in \{N, I\}$) has been hired, he or she produces π_{ij} units of the good Y_i. The labor market, however, is not competitive, and therefore wages are not equal to intermediate goods prices.

3.2 Labor markets

There is a separate labor market for each skill type (H and L for high and low skilled), so that natives and immigrants of the same skill level compete for the same jobs. Firms post vacancies specific to a skill. Depending on the numbers of vacancies and unemployed workers in each market, matches are formed continuously. The total supply of workers in labor market i is taken as exogenous and given by $Q_i = \sum_{j \in \{N,I\}} Q_{ij}, i \in \{H, L\}$. Immigration represents an exogenous change in the number of foreign-born workers Q_{iI}. Strictly speaking, the changes in the stock of foreign-born are equilibrium outcomes, deriving from the interaction of immigration policies and the potential supply of immigrants. However, given the current immigration restrictions in OECD countries and the potential economic gains from migration for non-OECD immigrants (estimated to be on

average 2-3 times as large as the migrant's wage income at home, as found in Clemens et al., 2010; see also Gibson et al., 2010 and Clemens, 2013), an exogenous relaxation of immigration quotas by a few percentage points of the host country population will certainly imply that the quotas remain binding.[14] By the same token, migration pressure will not change as a consequence of the migration flows that we consider. Feedback effects will be irrelevant and therefore we believe that maintaining a policy-determined exogenous change in the number of immigrants is rather reasonable.

Matching process. Firms post vacancies in skill-specific markets (H and L). At the time in which the firm pays the cost to open a vacancy, it cannot target immigrants or natives. When firms and workers meet and negotiate, however, immigrants and natives are distinguishable and may be offered different wages. In other words, firms cannot direct their search activities *ex ante* (when they post vacancies), but can treat immigrants and natives differently *ex post* (at the wage determination stage). This assumption follows Chassamboulli and Palivos (2014), and explains immigrant-native wage gaps appealing to the intuitive idea that immigrants have a different, perhaps weaker, bargaining position than natives.[15]

Therefore, in our model there are four types of workers and two labor markets (for high- and low-skilled workers). At each instant of time, a mass V_i of open vacancies and a mass $U_i = \sum_{j\in\{N,I\}} U_{ij}$ of unemployed workers exist in each labor market i. Below, M denotes the flow contact rate as a function of U_i and V_i. For each market, we use a standard constant returns to scale matching function, increasing in both its arguments, concave and homogeneous of degree one:

$$M(U_i, V_i) = \xi U_i^{\varepsilon} V_i^{1-\varepsilon}, \quad i = H, L, \tag{5}$$

where $\varepsilon \in (0,1)$ is the matching elasticity and ξ is a scale parameter. Labor market tightness is defined as $\theta_i \equiv V_i/U_i$, measuring the number of vacancies per unemployed person. The rate at

[14] The only exception to this situation are the internal migration flows between Western European countries which have been free for the period considered. For all other countries, and especially for migration from non-OECD to OECD countries, restrictions are generally binding, as high migration pressure shows.

[15] A possible alternative is to allow directed search by firms, implying separate labor markets for immigrants and natives. In that case, however, one should consider immigrants and natives as two different factors of production, and hence focus on immigrants' substitutability with natives. That complementarity channel is analyzed in Ottaviano and Peri (2012), while here we assume it away, opting for a more conservative assumption (as in Borjas, 2003). Interestingly, if immigrants and natives are not different factors ex-ante (i.e. they are perfect substitutes), it makes sense for them to match with the same opening so that the firm will not target them specifically. This is what produces the job-creation effect if immigrants have higher value for the firm.

which firms fill vacancies is $M_i/V_i = q(\theta_i) = \xi\theta^{-\varepsilon}$. The rate at which unemployed workers find jobs is $M_i/U_i = m(\theta_i) = \xi\theta^{1-\varepsilon}$. Higher market tightness makes it easier for the unemployed to find a job and harder for a firm to fill a vacancy. Existing matches are broken at the exogenous rate s_{ij}, which may differ between natives and migrants, and across skill types. Differences in separation rates between natives and immigrants may at least in part come from the fact that immigrants are more likely to re-migrate, i.e., to return to their home country or to migrate to other locations, due to exogenous events. As their families are often in different locations, their status is more precarious and they have less attachment to the current location. Hence, we consider the separation rates of immigrants as the sum of exogenous re-migration rates and standard separation rates. Empirically, we will measure re-migration rates as including return to the home country, or a move to a different country or region (internal migration is part of what constitutes re-migration to the extent that workers separate from their employers). We capture re-migration rates as part of the separation rates of immigrants as follows: $s_{iI} = \bar{s}_{iI} + \psi_j$ where ψ_j denotes the re-migration probability of migrants of type j. We will discuss in Section 4.1 the plausible values of ψ_j based on data on international re-migration. The parameter s_{iI} plays a key role for job creation incentives from the perspective of the firm (see below), but from the firm's perspective it is irrelevant whether the separation of the worker takes place because he or she moves internally or because he or she re-migrates internationally,[16] or because of other exogenous reasons, captured by $\bar{s}_{iI}$.

Bellman equations. Under these assumptions, the Bellman (asset) equations determining the value of an open vacancy J_i^V to a firm producing good i can be written as follows:

$$rJ_i^V = q(\theta_i)\left[\phi_{iN}J_{iN}^F + \phi_{iI}J_{iI}^F - J_i^V\right] - c_i. \tag{6}$$

[16] From the workers' point of view, return migration affects welfare level to the extent that the value associated with this re-migration event differs from that in the host country. However, in our Online Appendix we show that all equilibrium outcomes are unaffected by the value of re-migration provided that that value does not depend on whether re-migration follows an employment spell or an unemployment spell. Since the value of re-migration does not play a role for any of the outcomes we investigate, simply for notational conciseness we assume it to be equal to the value of unemployment in the home country, without loss of generality. The unemployment rate is not directly affected by the re-migration rate, because in the steady-state of our model re-migration must be compensated by new arrivals. In terms of the writing of the model, this is equivalent to interpreting the re-migration shock to immigrants as relating to exogenous relocation within the host country. The Bellman equations in the body of the text therefore do not explicitly include re-migration, but are also valid for a model with an exogenous probability of re-migration that affects both employed and unemployed immigrants.

The flow value of an open vacancy, rJ_i^V (where r denotes the risk-free interest rate), has no index j because firms cannot direct their search ex ante to natives or immigrants. From an ex ante perspective, whether the vacancy is filled by an immigrant or a native worker is not known to the firm and depends on the share of immigrants among the unemployed of a particular skill group. In equation (6) the value of a vacancy depends on expected capital gains, which equal the probability the vacancy is turned into a filled job, represented by the rate $q(\theta_i)$, multiplied by the value of the filled job, minus the value of the open vacancy. The variable $\phi_{ij} \equiv U_{ij}/(\sum_j U_{ij})$ denotes the share of workers of skill level i and of type j (either immigrants or natives) among those searching for a job. We then need to subtract the flow cost of an open vacancy, c_i, denoted in terms of the numéraire good. The flow value of a filled vacancy, J_{ij}^F, can be written as follows:

$$rJ_{ij}^F = \pi_{ij} p_i - w_{ij} - s_{ij}\left[J_{ij}^F - J_i^V\right]. \tag{7}$$

The flow value of a filled vacancy is equal to its rate of return, net of the wage paid to the worker ($\pi_{ij} p_i - w_{ij}$), minus the expected capital loss occurring if the match between worker and firm is broken. The exogenous separation occurs at rate s_{ij} and entails a loss equal to the difference between the value of a filled vacancy and that of an open vacancy, i.e. $J_{ij}^F - J_i^V$. Unlike the value of an open vacancy, the value of a filled vacancy depends both on the skill $i \in \{H, L\}$ and on the type of the worker $j \in \{I, N\}$.

For workers, we can then define Bellman equations determining the value of employment and unemployment. The flow value of employment can be written as

$$rJ_{ij}^E = g + rk_{ij} + (1-t)\, w_{ij} - s_{ij}\left[J_{ij}^E - J_{ij}^U\right]. \tag{8}$$

The flow value of employment is given by the sum of a lump-sum per-capita transfer g, capital income rk_{ij}, the after-tax wage $(1-t)\, w_{ij}$, where t is a proportional tax rate on labor income, minus the expected capital loss arising from job destruction. This loss occurs at rate s_{ij} and is equal to the difference between the value of employment and that of unemployment, i.e. $J_{ij}^E - J_{ij}^U$.

The flow value of unemployment can be written as

$$rJ_{ij}^U = g + rk_{ij} + b_{ij} + h_{ij} + m(\theta_i)\left[J_{ij}^E - J_{ij}^U\right]. \tag{9}$$

The flow value of unemployment is equal to the transfer g, capital income rk_{ij}, unemployment benefits b_{ij}, which will be determined from wages and replacement rates, as well as the term h_{ij}, which denotes the utility value of being unemployed, capturing the fact that the utility effect of unemployment may not be fully captured by monetary benefits. These must satisfy $b_{ij} + h_{ij} < w_{ij}(1-t)$. We set h_{ij} to zero for natives ($h_{HN} = h_{LN} = 0$). The value of h_{iI} will be negative for immigrants if they experience larger disutility from unemployment due to being outside their home country.[17] Alternatively, the disutility from unemployment h_{iI} for immigrants can be interpreted to reflect higher utility costs of searching for employment (as pointed out by Chassamboulli and Palivos, 2014) because of less advantageous social network and more limited knowledge of labor market institutions, which increase the effort needed to search for a job while unemployed. The flow value of unemployment also needs to include the expected capital gain arising from a successful match: the difference between the value of employment and that of unemployment and occurring with probability $m(\theta_i)$.

Wage bargaining. We assume that firms post vacancies until the value of posting a vacancy drops to zero. The free entry condition, $J_i^V = 0$, applies to vacancies in both skill classes. As it is customary in the literature, we assume a simple Nash bargaining model for wage determination.[18] Wages are bargained efficiently once a match has been formed and the identity of the matched worker, native or immigrant, has been revealed. Let the bargaining power of the worker be $\beta \in (0,1)$; then, the worker receives the share β of the total surplus of the match $\left(J_{ij}^E + J_{ij}^F - J_{ij}^U - J_i^V\right)$. Incorporating the free entry condition, Nash bargaining implies

$$(1-\beta)\left(J_{ij}^E - J_{ij}^U\right) = \beta J_{ij}^F. \tag{10}$$

As usual in this type of model, we focus on the steady state, i.e. the situation where the flows into and out of unemployment are equal to each other for each type of worker: $s_{ij}(Q_{ij} - U_{ij}) = m(\theta_i)U_{ij}$

[17] One might argue that h_{ij} should be a positive value of leisure, as those without a job have more time available. However, the social psychologist Jahoda (1981) highlights that employment provides several important non-monetary payoffs, including social contacts beyond the family. There is evidence of significant utility costs of unemployment for the United States and the United Kingdom (Blanchflower and Oswald, 2004), and for Germany (Winkelmann and Winkelmann, 1995 and Schöb, 2012), suggest a negative value of h_{ij}. Chassamboulli and Palivos (2014) make the same assumption. In Section 4.3.3 we present the results of a sensitivity analysis where we evaluate the extent to which this assumption affects our results. We find our results to be very robust to changing h_{LN} and h_{HN}.

[18] Note that the model features an implicit minimum wage which is equal to the outside option $(b_{ij} + h_{ij})/(1-t)$.

for $i \in \{H, L\}$ and $j \in \{N, I\}$. Thus, we obtain

$$U_{ij} = \frac{s_{ij}}{s_{ij} + m(\theta_i)} Q_{ij}, \text{ and } E_{ij} = \frac{m(\theta_i)}{s_{ij} + m(\theta_i)} Q_{ij}; \text{ for } i \in \{H, L\} \text{ and } j \in \{N, I\}, \tag{11}$$

where E_{ij} is total employment in labor market cell $i \times j$. Higher labor market tightness and lower separation rates lead to lower equilibrium unemployment.

3.3 Public sector

We consider a very simple government budget constraint. This allows for fiscal effects from immigration.[19] The government collects income by raising proportional taxes on labor income. We assume that capital income is not taxed.[20] The government uses its revenues to finance the payment of unemployment benefits and of the lump-sum transfer g, which may be viewed as a publicly-provided rival good.[21] Therefore, the government budget constraint is

$$\sum_i \sum_j b_{ij} U_{ij} + g \sum_i \sum_j Q_{ij} = t \sum_i \sum_j w_{ij} E_{ij}. \tag{12}$$

The left-hand side of equation (12) corresponds to government expenditures, given by the sum of total unemployment benefits and lump-sum transfers. The right-hand side corresponds to government revenues. We will treat b_{ij} and g as exogenous and let t adjust to satisfy (12).[22] In the comparative static simulations of Section 4.2, we set the values of b_{ij} and g to their baseline values and let t adjust in response to migration.[23]

[19] Given the static structure of the model we are able to analyze fiscal redistribution between high- and low-skilled – and between employed and unemployed – workers, but not between generations. Immigration may change the age profile of the population and hence affect intergenerational redistribution, but this is not the focus of this paper.

[20] The optimality of zero taxation of capital income follows from our small open economy assumption. In addition, since we assume capital is distributed evenly among natives and returns to capital do not change with migration, introducing a proportional taxation of capital income would not have any first-order qualitative effects on our results.

[21] Assuming the government additionally provides a pure public good would increase the gains of immigration mechanically, as costs would be distributed over a larger population. Our baseline formulation provides conservative estimates on potential benefits of immigration. In our data, regressing the log of public expenditures on the log of population size produces a coefficient of 1.03 (t-statistic: 18.66; R-squared: 0.95). This is consistent with our baseline hypothesis that government expenditures can be expressed in terms of per capita transfers, the role for pure public goods being limited. In a sensitivity analysis (Section 4.3.2), we consider defense and the service of public debt as non-rival components of public spending.

[22] We calculate unemployment benefits using data on replacement rates and wages.

[23] Table C.3 reports results based on an alternative specification, in which t is fixed and g adjusts to satisfy the budget constraint. Results are very similar.

3.4 Equilibrium

Job-creation conditions. Combining the Bellman Equations (6), (7), and the free entry condition $J_i^V = 0$, we derive, for each labor market i, a relationship between labor market tightness θ_i and the expected present discounted value of the job surplus to the firm:

$$q(\theta_i) \sum_{j \in \{N,I\}} \phi_{ij} \frac{\pi_{ij} p_i - w_{ij}}{r + s_{ij}} - c_i = 0. \tag{13}$$

This can be seen as a job creation condition. It states that the flow-cost of an open vacancy c_i must be equal to the expected profit from a job filled with either a native or a migrant, $\pi_{ij} p_i - w_{ij}$, weighted by the probability of the candidate being either a native or an immigrant ϕ_{ij}, discounted at the specific effective discount rate $r + s_{ij}$ and multiplied by the probability of the vacancy being filled $q(\theta_i)$. The expected surplus to the firm from opening a vacancy can be high because market tightness is low, because the worker has high productivity π_{ij}, because he or she is paid a low wage w_{ij}, or because he or she has a low separation rate s_{ij}. This points at two channels through which immigrants affect labor markets for natives. If immigrants are paid a lower wage than natives with the same productivity, an increase in their share ϕ_{iI} increases the firm's surplus and in equilibrium it must increase job creation and labor market tightness θ_i. However, if immigrants have larger separation rates s_{ij}, an increase in their share ϕ_{iI} decreases the firm's surplus and induces less job creation.

Wage equations. Substituting the value functions (9) and (8) into (10), and because the free entry condition implies $J_{ij}^F = (\pi_{ij} p_i - w_{ij}) / (r + s_{ij})$ from (7), we can write the wage rate as

$$\begin{aligned} w_{ij} = \beta & \frac{r + s_{ij} + m(\theta_i)}{(r + s_{ij})[1 - t(1 - \beta)] + \beta m(\theta_i)} \pi_{ij} p_i \\ & + (1 - \beta) \frac{r + s_{ij}}{(r + s_{ij})[1 - t(1 - \beta)] + \beta m(\theta_i)} (b_{ij} + h_{ij}). \end{aligned} \tag{14}$$

The lower the worker's bargaining power β, the closer the wage is to the outside option. If $\beta = 0$, $w_{ij} = (b_{ij} + h_{ij}) / (1 - t)$, which is exactly the outside option. As β approaches unity, the worker's income approaches the product of her labor $\pi_{ij} p_i$ and the outside option becomes irrelevant. Moreover, the tighter the market, the larger the weight on $\pi_{ij} p_i$ (given that $m'(\theta_i) > 0$), since

workers have a stronger effective bargaining position.[24] It is also straightforward to show that, for a given equilibrium value of labor market tightness, higher separation rates are associated with lower wages. If we adjust the separation rates of two groups in such a way that market tightness is unaffected, the group with a higher separation rate is going to have lower equilibrium wages.

Equations (13) and (14) show that heterogeneity between native and immigrant workers in their productivity π_{ij} and in their separation rates s_{ij} (to be understood as including re-migration probabilities) has effects operating in a similar way, although in opposite directions. Lower productivity of migrants and higher separation rates represent a downward shift of the job creation curve in wage-tightness space. A lower outside option h_{ij} also commands lower wages.

Definition of equilibrium. The equations above define a set of ten equilibrium conditions: one first-order condition governing the optimal capital stock (2), two profit maximizing conditions on goods markets (3) and (4), the government budget constraint (12), two job-creation conditions (13), and four wage equations (14). We use them to solve for ten equilibrium values: $\{K; p_L, p_H; t; \theta_L, \theta_H; w_{LN}, w_{LI}, w_{HN}, w_{HI}\}$. Knowing θ_i, one can get U_{ij} and E_{ij} from (11). Choosing the price of the final output good as the numéraire implies a restriction on goods prices p_L and p_H, which makes either (3) or (4) redundant by Walras' Law.[25]

Existence and uniqueness. As in other applications of search-and-matching models, existence requires parameter constellations that ensure that the surplus from a filled job is non-negative (Pissarides, 2000). In our Online Appendix, we discuss sufficient conditions for existence. In particular, we require $\pi_{ij}(1-t) > b_{ij}+h_{ij}$, which implies a positive match surplus.[26] For uniqueness, we additionally need the value of ρ and the flow value of vacancy posting to be sufficiently high. Necessary conditions are difficult to derive, given the complicated feedback mechanisms in the model. However, assuming a joint normal distribution, we have drawn 1,000 artificial economies which reproduce our sample of 20 OECD countries in terms of means and variances of targeted moments. We find that an equilibrium exists in all cases. Moreover, our numerical algorithm always

[24] Utility obtained from public goods consumption drops out of (14) because public goods are enjoyed irrespective of employment status.

[25] This restriction arises from setting the price index dual to the production function system (1) equal to unity. I.e., $P = A^{-1}(r+\delta)^{\alpha}\Pi^{1-\alpha}(\alpha^{-\alpha}(1-\alpha)^{\alpha-1})$ with $\Pi = (p_L^{\rho/(\rho-1)}x^{1/(1-\rho)} + p_H^{\rho/(\rho-1)}(1-x)^{1/(1-\rho)})^{\rho/(1-\rho)}$.

[26] In our Online Appendix, we also impose $s_{iI} > s_{iN}$, which is always met in the data, but is certainly not necessary.

converges to the same equilibria regardless of whether we choose very high or very low initial values for our endogenous variables.

3.5 Analytical results without a public sector

The model outlined above captures several mechanisms through which natives' outcomes are affected by the characteristics and size of the immigrant population. It is too complex for a full-fledged analytical solution. Therefore, we analyze it numerically. However, before we do so, we present analytical results for a simplified version.

Proposition 1. *Let us abstract from a public sector so that* $g = b_{ij} = 0$*, and assume natives and immigrants are identical except for the possibility that immigrants have worse outside options, so that* $s_{ij} = s_i$*,* $\pi_{ij} = 1$*, and* $h_{iI} < 0$*. Then, the model implies:*

(i) *an inflow of immigrants with the same skill composition as natives increases wages and decreases unemployment rates of natives, and therefore increases native welfare;*

(ii) *an inflow of immigrants of skill* i *will unambiguously benefit natives of skill* $i' \neq i$*. Depending on parameters, it may also benefit natives of skill* i;

(iii) *a worsening of the outside option of immigrants increases wages of natives, decreases unemployment rates for all workers and increases welfare of natives.*

Proof. See Appendix A.

Result (i) is relatively straightforward. In a model where immigrants have worse outside options than natives (but have the same productivity and same break-up rates), immigrants affect natives through skill complementarity and through their effect on vacancy creation. The skill complementarity channel is inactive if immigrants have the same skill distribution as natives. The job creation channel is driven by immigrants' lower outside option, implying the firm's surplus is larger. A higher share of immigrants, therefore, encourages firms to create more vacancies. The resulting tighter labor market implies lower unemployment rates and higher wages for natives.

The intuition for (ii) is also straightforward: without a government, an inflow of immigrants of skill i will affect natives of skill $i' \neq i$ only through the factor complementarity channel, which is

unambiguously positive. On the other hand, this model cannot deliver sharp predictions concerning the effect on natives of the same skill as immigrants. The reason is that there are two counteracting effects at work: a factor competition effect (negative for natives) and a vacancy creation effect (positive for natives). The latter will tend to dominate when natives have high unemployment rates and when wage gaps between immigrants and natives are large. The result in (iii) is driven by the same mechanism as (i): the surplus from the match the firm gets is a negative function of the outside option of the worker. And because vacancies cannot be directed to immigrants or natives, the additional vacancies benefit natives as well. While Proposition 1 illustrates effects already present in Chassamboulli and Palivos (2014), the next result is not part of their analysis.

Proposition 2. *Let us abstract from a public sector so that* $g = b_{ij} = 0$*, and assume natives and immigrants are identical except for separation rates, so that* $h_{iI} = 0$*,* $\pi_{ij} = 1$*, and* $s_{iI} > s_{iN}$*. Then, the model implies:*

(i) *an inflow of immigrants with the same skill composition as natives decreases wages and increases unemployment rates of all natives, therefore decreasing native welfare;*

(ii) *an inflow of immigrants of skill* i *will unambiguously reduce the welfare of natives of skill* i*, and may have either positive or negative effect on natives of skill* $i' \neq i$*;*

(iii) *an increase in the separation rate for immigrants negatively affects welfare of all natives, through both wages and unemployment rates.*

Proof. See intuition below and further details in Appendix A.

The intuition for the result in (i) above is the same (in the opposite direction) as the intuition for result (i) of Proposition 1. The only effect of a balanced immigrant inflow is through the vacancy creation effect, which is negative in this case because the value of a vacancy matched with an immigrant is lower than the value of one matched with a native due to immigrants' higher separation rates. Here, a larger number of immigrants implies that the firm's expected surplus from a match is lower, which reduces the number of posted vacancies and lowers market tightness, putting downward pressure on wages and upward pressure on unemployment of natives. The first part of the result in (ii) arises from negative effects driven by both the factor competition and

the vacancy creation channels. The effect on natives of the other skill type is indeterminate and depends on whether the inflow of immigrants of the other type results in an increase or decrease in the number of filled jobs of that type. Result (iii) follows the same intuition: if immigrants have higher separation rates, expected surplus and welfare for workers of the same skill class will be lower. Through production complementarity, there will also be a spillover effect for natives of different skills.

The two propositions above illustrate the mechanisms at work in the labor markets of our model and emphasize the importance of immigrants' outside options and separation rates in determining their impact on natives. Next, we will simulate welfare effects using our fully fledged model and employ country-level moments for the calibration of the parameters.

4 Quantitative analysis

We parameterize the model for each of the 20 countries included in our analysis. Our main object of interest is group-specific per-capita welfare $\mathcal{W}_{ij}$,

$$\mathcal{W}_{ij} = (1 - U_{ij})(1 - t)w_{ij} + U_{ij}(b_{ij} + h_{ij}) + rk_{ij} + g. \tag{15}$$

It consists of four parts: (i) after-tax income multiplied by the probability of being employed, (ii) the unemployment benefit and the non-monetary utility of being jobless multiplied by the probability of being unemployed, (iii) capital income, and (iv) the lump-sum transfer g. We are also interested in average native or immigrant welfare, which we define as follows: $\mathcal{W}_j = \sum_i \frac{Q_{ij}}{\sum_i Q_{ij}} \mathcal{W}_{ij}$.

4.1 Calibration

External parameters. In the calibration, we tie model parameters to empirical counterparts and moments obtained from the data. First, we set unemployment benefits b_{ij} equal to the net wage $w_{ij}\,(1-t)$ times the observable country-specific replacement rate ϱ, so that $b_{ij} = \varrho w_{ij}\,(1-t)$. Second, we assume all capital in a country in the pre-migration equilibrium to be native owned, so that $\bar{K} = K$. We determine this value using information on the user cost of capital and on the observable capital share, α. Since our small open economy assumption fixes the return to

capital, and capital per person does not vary in the comparative statics, the assumption that domestic capital is fully native-owned is without loss of generality. GDP is denoted by Y so that $\bar{K} = \alpha Y/(r+\delta)$. Third, we normalize $c_L = 0.5$.[27] This leaves us with a total of 27 exogenous parameters to be determined: $\{Q_{ij}, s_{ij}, \pi_{ij}, h_{iI}, \varrho, c_H, \xi, A, x, G, \beta, \varepsilon, \rho, r, \delta, \alpha, \psi\}$, with $i \in \{H, L\}$ and $j \in \{N, I\}$.[28]

There are two types of parameters in the model. Some can be directly equated to their empirical counterparts or can be taken from the literature. Others are obtained by matching a set of moments in the data. Moreover, while most model parameters vary across countries, some are assumed to be fixed. Table 2 below lists those model parameters that we take from the literature or observe directly in standard databases. We follow Petrongolo and Pissarides (2001) and most of the search literature in setting the bargaining power of workers, β, equal to the elasticity of the matching function, ε, ensuring the Hosios condition is met. The parameter, ρ, determining the elasticity of substitution between the high-skill-intensive and the low-skill-intensive good is set in line with Ottaviano and Peri (2012) at $\rho = 0.5$, which corresponds to an elasticity of 2. The user cost of capital $(r+\delta)$ is about 12% per year, or about 1% per month, following Chassamboulli and Palivos (2014) and related papers in the literature.

Table 2: Parameters taken from available data or the literature

Parameter	Description	Mean	s.d.	Source
Parameters without country variation				
β	worker bargaining power	0.5	n.a.	Petrongolo and Pissarides (2001)
ε	matching elasticity	0.5	n.a.	Petrongolo and Pissarides (2001)
ρ	parameter governing the substitution elasticity	0.5	n.a.	Ottaviano and Peri (2012)
r	interest rate (monthly)	0.004	n.a.	Chassamboulli and Palivos (2014)
δ	depreciation rate (monthly)	0.0061	n.a.	Chassamboulli and Palivos (2014)
ψ	re-migration rate (monthly)	0.0100	n.a.	OECD International Migration Outlook
Parameters varying across countries				
ϱ	replacement rate	0.39	0.13	OECD Benefits and Wages
α	capital share	0.35	0.05	OECD Labour Cost Indicators
Q_{LN}	low-skilled natives	0.72	0.07	Eurostat, Census, HILDA
Q_{HN}	high-skilled natives	0.28	0.07	Eurostat, Census, HILDA
Q_{LI}	low-skilled immigrants	0.15	0.08	Eurostat, Census, HILDA
Q_{HI}	high-skilled immigrants	0.06	0.05	Eurostat, Census, HILDA

Notes: we normalize the size of the native labor force to unity: $Q_{LN} + Q_{HN} = 1$. *Data sources:* see Appendix B for details.

An important parameter is the exogenous re-migration rate ψ for immigrants,[29] which accounts

[27] We checked that this is just a normalization by changing the value of c_L and verified that results are unaffected.

[28] We were unable to find reliable data on re-migration probabilities that are skill specific, so we will need to use an average value for both low-skilled and high-skilled immigrants.

[29] We drop the subscript since we are not able to distinguish this by skill in our data.

for a major part of the difference between immigrant and native separation rates. OECD (2008) presents various estimates of re-migration rates over the first five years since arrival. Unfortunately, there is such data for very few countries, which prevents us from including worker-type or country-specific rates. In our baseline calibration, for each county, we use the median rate, but we also produce results based on the high or low values reported in OECD (2008). The cross-country median is 45% (close to the re-migration rate in the UK).[30] These five-year rates imply that monthly separation rates for migrants are about one percentage point higher than for natives.[31]

Table 2 also presents means and standard deviations of exogenous parameters we take from the data that vary by country. We use data on the average replacement rate, ϱ, from the OECD Benefits and Wages data base. We allow capital shares, α, to vary by country. Finally, we use observed data on immigrant stocks, Q_{ij}. Without loss of generality, we normalize the native labor force of each country to one.[32]

Calibration of unobserved model parameters. We pin down the remaining parameters of the model to ensure the baseline equilibrium of our model matches a number of empirical moments. We have 11 such moments (Table 3), but need to determine 15 parameters $\{s_{ij}, \pi_{ij}, h_{iI}, c_H, \xi, A, x, G\}$.[33] Thus, we face an identification problem. It arises because the same combination of wages and unemployment rates for natives and immigrants of each skill type can be obtained with different combinations of break-up rates s_{ij}, productivity levels π_{ij} and values of unemployment h_{iI}.

First, we standardize the effectiveness of natives such that $\pi_{iN} = 1$. In order to solve the

[30] Several other studies find similar re-migration rates. Jensen and Pedersen (2007) estimate a five year return rate of 55% for Denmark. Bratsberg et al. (2010) estimate a 50% re-migration rate for Norway. Bijwaard et al. (2014) estimates a re-migration of 47% for the Netherlands in the window 1999-2007. Recent studies for the US (Cadena and Kovak, 2016) and Germany (Schündeln, 2014) show that immigrants also exhibit larger internal mobility, relative to natives, and less attachment to their location. These facts are consistent with larger exogenous mobility of immigrants.

[31] Only a few studies present direct evidence on job separation rates for natives relative to immigrants. Using Swedish data, Arai and Vilhelmsson (2004) find that immigrants have higher chances of becoming unemployed compared to natives. Sá (2011) presents cross-country evidence from the EU Labour Force Survey showing employment duration tends to be shorter for immigrants. Dustmann et al. (2010) provide evidence that immigrants have higher separation rates compared with natives of similar skill levels in Germany, and argue that this depends on re-migration. Hirsch and Jahn (2015) also use German data and find higher separation rates into non-employment for immigrants. Carrasco and Garcia-Perez (2015) find that average employment duration for natives is significantly longer than for immigrants in Spain, using 2000-2014 data.

[32] We construct the four population shares from the immigrant share of the population in working age, the skill ratio of native and immigrant labor force, and this normalization.

[33] Out of the 11 empirical moments, 10 are linearly independent. We have country-specific information on job duration by skill only for the U.S. and Germany. In our baseline calibration, we use the U.S. values for all countries. Table C.4 in the Appendix reports results obtained from using German microdata for all countries instead. This choice only makes a negligible quantitative difference.

indeterminacy problem, we need to assume immigrants have a certain relative effectiveness vis-à-vis natives. While relative effectiveness is hard to measure, we begin by considering the case in which – once we control for skills – immigrants and natives have the same productivity; namely, $\pi_{iI} = 1$. As we allow the empirical moments in the data to determine s_{ij} and h_{iI}, even with identical effectiveness of immigrants and natives, our model is rich enough to capture a non-trivial effect of immigrants on job creation. Moreover, empirical results by LaLonde and Topel (1991), Borjas and Friedberg (2009), and the survey by Kerr and Kerr (2011) show immigrants are paid less than natives, even after controlling for observable productivity drivers such as education and language. Thus, we consider the skill level as the main determinant of productivity and assume that wage differentials are driven by other types of heterogeneity. We investigate the effects of allowing for productivity differences between immigrants and natives in a sensitivity analysis in Section 4.3.1.

Table 3: Matched moments

Moment	**Source**	**Mean**	**S.d.**
Moments without country variation			
Average job duration, low skilled (months)	Chassamboulli and Palivos (2014)	29.4	n.a.
Average job duration, high skilled (months)	Chassamboulli and Palivos (2014)	52.6	n.a.
Moments varying across countries			
Native wage premium, low skilled	EU-SILC, Censuses, HILDA	1.179	0.112
Native wage premium, high skilled	EU-SILC, Censuses, HILDA	1.177	0.146
Skilled-unskilled wage ratio, native workers	EU-SILC, Censuses, HILDA	1.541	0.227
Unemployment rate low-skilled natives	EU and Canadian LFS, CPS, HILDA	0.082	0.035
Unemployment rate low-skilled immigrants	EU and Canadian LFS, CPS, HILDA	0.124	0.046
Unemployment rate high-skilled natives	EU and Canadian LFS, CPS, HILDA	0.040	0.022
Unemployment rate high-skilled immigrants	EU and Canadian LFS, CPS, HILDA	0.079	0.034
Government expenditures as % of GDP	IMF	0.453	0.059
Real per capita GDP, US=1 (PPP)	World Bank WDI	0.823	0.289

Notes: all shares refer to working age population, aged 15-64. For unemployment rates, we use 2005-2011 averages. See Appendix B for details. All moments are constructed for each of our 20 countries.

We calibrate the remaining parameters so that our model exactly reproduces the set of moments for each country. Table 4 presents average and cross-country standard deviations of the calibrated parameters. Differences in unemployment rates between natives and immigrants are mainly explained by the higher separation rates of immigrants, due to re-migration. After accounting for average international re-migration probabilities, in fact, differences in pure separation rates are small for both low skilled and high skilled and compatible with larger internal re-migration shocks for immigrants. We use data on international re-migration only, because we lack reliable data on internal migration, but internal mobility may play a role as well. To the extent that internal mobil-

ity is higher for immigrants, our measure of ψ_j may underestimate the true value. The parameters h_{LI} and h_{HI} are mostly negative, capturing worse outside options for immigrants. This is revealed by the lower equilibrium wage for immigrants.[34] Three exceptions are high-skilled immigrants in Australia, Switzerland and the US, for which the values of h_{HI} are positive.

Table 4: Calibrated parameter values

Parameter	Description	Mean	S.d.
ξ	Match efficiency parameter	0.419	0.182
A	Total factor productivity	0.569	0.110
x	Low skill share in production of intermediates	0.514	0.048
c_H	Cost of a high skill vacancy	0.723	0.552
g	Public expenditures (per capita)	0.328	0.119
$\bar{s}_{LN}$	Monthly job separation rate, low-skilled natives	0.030	0.003
$\bar{s}_{LI}$	Monthly job separation rate, low-skilled immigrants	0.040	0.012
$\bar{s}_{HN}$	Monthly job separation rate, high-skilled natives	0.016	0.002
$\bar{s}_{HI}$	Monthly job separation rate, high-skilled immigrants	0.025	0.009
h_{LI}	Unemployment disutility for low-skilled immigrants	-0.973	1.091
h_{HI}	Unemployment disutility for high-skilled immigrants	-1.602	1.246

Notes: summary statistics of parameters calibrated on empirical moments for 20 countries. Separation rates exclude re-migration rates.

4.2 Results

In our simulations, we focus on the welfare effects of immigrants on native workers. We study four scenarios, having year 2011 as our baseline year: (i) an increase in the stock of migrants by one percent of the labor force, holding skill structures constant, (ii) an inflow as in (i) but assuming all new immigrants are unskilled, (iii) a hypothetical situation in which all foreign-born workers left their host countries, and (iv) immigration as observed between 2011 and 2014.

4.2.1 The effects of immigration with constant skill composition

We begin by simulating the welfare effects of an increase in the immigrant stock by one percent of the baseline labor force relative to the 2011 baseline level, leaving the skill composition of immigrants unchanged. In other words, we inflate the immigrant labor force holding skill shares constant, so that the proportion of high skilled among immigrants remains the same before and after the change.

We use this setup to study the welfare results obtained from progressively richer models to provide insights regarding different mechanisms. Beginning with the simplest version in which

[34] In reality, it is likely that unemployment benefits packages are better for natives than for immigrants, and therefore that some of what the differences in the disutility from unemployment may pick up are differences in benefits.

immigrants are essentially identical to natives within skill groups and where there is no government, we gradually add all features of our framework. This procedure illustrates the relative role of each "ingredient" in shaping the effect on native welfare. To save space, Table 5 provides results for two countries only, the US and Germany, in each of the increasingly complex models. We report welfare effects on natives and immigrants in all countries for the complete model in Table 6. Table C.2 in our Appendix provides full country coverage on the stripped-down model variants.

Table 5 begins with the simulated effects of Model 1, which features the classical complementarity only. In this case, by setting $h_{ij} = 0$; $s_{iI} = s_{iN}$; $b_{ij} = 0$; and $g = 0$, we eliminate the effects of any labor market heterogeneity and the public sector. This setup corresponds to more traditional models such as those by Borjas (2003), Ottaviano and Peri (2012), or Docquier et al. (2014).[35] We find overall welfare effects on natives $\mathcal{W}_N$ are positive, but very close to zero both in Germany and the US. However, effects on specific skill groups are more pronounced. High-skilled natives in Germany see a 0.11% increase in their welfare, while low-skilled natives lose 0.05%. In the US, high-skilled individuals lose 0.02%, while low-skilled individuals gain 0.01%. This pattern reflects the fact that, in the US, the skill composition of the stock of immigrants approximately resembled that of natives as of 2011, while in Germany it was biased towards unskilled workers.

Table 5: Native welfare effects of a one percentage point increase in migration: different models

	US			**Germany**		
	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$
Model 1: only complementarity effects	0.00%	0.01%	-0.02%	0.00%	-0.05%	0.11%
Model 2: adding wage heterogeneity	0.04%	0.08%	0.00%	0.07%	0.03%	0.17%
Model 3: adding unemployment heterogeneity	0.04%	0.08%	0.00%	0.02%	-0.03%	0.12%
Model 4: adding redistribution through b_{ij}	0.05%	0.08%	0.01%	0.02%	-0.02%	0.12%
Model 5: adding redistribution through g	0.05%	0.06%	0.03%	-0.01%	-0.03%	0.04%

Model 2 accounts for observed immigrant-native wage differences by allowing for differences in the outside option of immigrants and natives (i.e., $h_{iI} \neq 0$). This model is similar to Chassamboulli and Palivos (2014)), adding the job creation effect of immigrants described in Proposition 1 above. In both the US and Germany, this channel adds incentives to create jobs, meaning that immigration can lead to lower unemployment rates. Average native welfare increases by 0.07% in Germany and by 0.04% in the US. Moreover, in both countries both skill groups benefit from immigration. When looking at all countries (Table C.2 in the Appendix), both skill groups experience gains in 14 out

[35] These models do not feature search frictions on the labor market, while our Model 1 does.

of 20 countries when the job creation channel is present. In the remaining six cases, a distributive conflict remains, often due to the skill composition of migrants being heavily tilted towards the high skilled, for whom the job creation channel is less important.

Model 3 matches the heterogeneity in the ratio between natives' and immigrants' unemployment rates by allowing different separation rates (i.e., $s_{iI} \neq s_{iN}$). Matches with migrants have a shorter expected duration as documented in the literature reviewed in Section 4.1. Whatever the reason for such short duration in a model with costly search, this feature weakens both the strength of the vacancy creation effect and of the complementarity channel. The introduction of this channel has a very small effect in the US, while it reduces the total immigration surplus to less than a third in Germany. The reason lies in the high unemployment rates among German immigrants relative to natives, which implies higher separation rates for immigrants in the model, and hence a much reduced job creation effect from immigration. Unemployment rates of natives and immigrants are almost identical in the US; hence, this channel is not at work.

Model 4 further adds unemployment benefits, ($b_{ij} > 0$), financed with taxes on labor income. Model 5, the most comprehensive variant, also includes the general redistribution channel with lump-sum transfers, ($g > 0$), financed by taxes. Both in Germany and in the US, unemployment benefits generate relatively little redistribution and do not change welfare effects by much.[36] Introducing other public expenditures matters more. This is particularly true in Germany, where the overall native welfare effect turns negative, mostly due to much lower gains for the high skilled. In the US, public transfers are less relevant, so their introduction has no major effect on native welfare gains. Table C.2 shows that the presence of a redistributive welfare state is important in many other countries, turning an aggregate gain into a loss in 7 of 20 countries.

Table 6 shows the welfare effects for all countries when using the full model (Model 5). Natives in most countries benefit from a marginal increase in the immigrant share of the labor force. However, in Austria, Belgium, Germany, Luxembourg, the Netherlands, Sweden and Switzerland, native welfare falls. In these cases, welfare gains turn negative for natives because of general redistribution, which plays a larger role than unemployment benefits. Countries with initially high unemployment rates (Italy, Greece, Portugal) are among those benefiting most from the job-

[36] The small effect of adding unemployment insurance is a robust finding across our entire country sample (see Table C.2 in the Appendix).

Table 6: Welfare effects of a one percentage point increase in immigration: full model

	Natives			Incumbent Immigrants		
Countries	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$	$\mathcal{W}_I$	$\mathcal{W}_{LI}$	$\mathcal{W}_{HI}$
Australia	0.01%	0.06%	-0.08%	-0.01%	0.09%	-0.11%
Austria	-0.03%	-0.03%	-0.03%	0.19%	0.20%	0.11%
Belgium	-0.02%	-0.03%	-0.01%	0.12%	0.12%	0.12%
Canada	0.04%	0.08%	-0.08%	0.08%	0.11%	0.03%
Denmark	0.06%	0.11%	-0.05%	0.18%	0.27%	0.10%
Estonia	0.05%	0.07%	0.02%	0.24%	0.16%	0.37%
France	0.02%	0.00%	0.05%	0.09%	0.09%	0.08%
Germany	-0.01%	-0.03%	0.04%	0.06%	0.02%	0.20%
Greece	0.07%	0.02%	0.18%	0.26%	0.22%	0.48%
Ireland	0.05%	0.10%	-0.03%	0.18%	0.16%	0.21%
Italy	0.07%	0.05%	0.14%	0.37%	0.30%	0.81%
Luxembourg	-0.02%	-0.03%	-0.01%	0.04%	0.05%	0.02%
Netherlands	-0.01%	-0.03%	0.02%	0.10%	0.07%	0.19%
Portugal	0.08%	0.09%	0.07%	0.21%	0.15%	0.37%
Slovenia	0.02%	-0.04%	0.17%	0.04%	0.01%	0.22%
Spain	0.04%	-0.01%	0.12%	0.18%	0.10%	0.42%
Sweden	-0.02%	-0.01%	-0.04%	0.08%	0.10%	0.04%
Switzerland	-0.04%	-0.03%	-0.04%	0.00%	0.03%	-0.06%
United Kingdom	0.00%	-0.03%	0.05%	0.06%	-0.03%	0.21%
United States	0.05%	0.06%	0.03%	0.09%	0.14%	0.03%
Average	0.02%	0.02%	0.03%	0.13%	0.12%	0.19%
Median	0.02%	0.00%	0.02%	0.10%	0.10%	0.16%

Notes: all columns refer to our full model, i.e. Model 5 as of Table 5.

creation channel. In all countries, welfare effects are relatively small in absolute value, ranging between -0.04% (Switzerland) and +0.08% (Portugal), averaging +0.02%.

Table 6 also shows that incumbent immigrants benefit from additional immigration in most countries.[37] They benefit strongly from the vacancy creation effect, and do not suffer much from much increased redistribution as their incomes are lower than those of natives. Therefore, in a non-Walrasian market, the vacancy creation effect can turn the conventional wisdom upside down: incumbent immigrants, even if potentially competing with new immigrants, may actually gain from immigration rather than being the group losing the most.

4.2.2 The effects of low skilled immigration

Cross-country differences in the native welfare effects discussed in the previous section depend not only on the labor market and institutional features of each country, but also on the type of shock we

[37] Table 6 reports welfare effects on immigrants already in the receiving country as of 2011. Therefore, in this exercise we do not consider the welfare gains for new immigrants arising from comparing welfare in their country of origin and their destination country. Such gains are likely to be much larger than our estimates in most cases.

analyze. In order to isolate the first aspect, and to investigate how institutions and labor markets of different countries may react to the same shock, we now look at the native welfare effects arising from an increase of one percentage point of the labor force,[38] all made up of low-skilled immigrants. The size of the shock is the same as the one we analyze in Section 4.2.1, but the skill composition of the additional immigrants is different.[39] Table 7 presents native welfare effects from this simulation, where we add this additional shock to our baseline (year 2011) calibrated model.

Table 7: Native Welfare Effects of Low Skilled Migration

	Increase in the migrant stock	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$
Australia	3.7%	-0.02%	-0.15%	0.22%
Austria	4.4%	-0.02%	-0.07%	0.19%
Belgium	4.6%	-0.04%	-0.14%	0.15%
Canada	4.0%	-0.03%	-0.11%	0.21%
Denmark	7.2%	0.01%	-0.08%	0.21%
Estonia	5.7%	0.01%	-0.11%	0.21%
France	6.6%	0.02%	-0.07%	0.20%
Germany	5.5%	-0.01%	-0.10%	0.20%
Greece	6.1%	0.09%	0.00%	0.29%
Ireland	5.5%	-0.05%	-0.18%	0.15%
Italy	7.4%	0.09%	0.04%	0.31%
Luxembourg	1.5%	-0.05%	-0.16%	0.13%
Netherlands	6.1%	-0.02%	-0.12%	0.18%
Portugal	9.0%	0.02%	-0.06%	0.26%
Slovenia	6.6%	0.03%	-0.07%	0.26%
Spain	4.6%	0.01%	-0.12%	0.21%
Sweden	4.6%	-0.03%	-0.12%	0.16%
Switzerland	2.4%	-0.03%	-0.17%	0.20%
United Kingdom	6.0%	-0.02%	-0.19%	0.20%
United States	6.3%	0.02%	-0.12%	0.24%
Average	5.4%	0.00%	-0.10%	0.21%
Median	5.6%	-0.02%	-0.11%	0.20%

Data sources: see Appendix B for details.

The second column of Table 7 shows the increase in the immigrant stock from a shock that is as large as one percentage point of the labor force. The following columns show that welfare effects for the average native worker are very heterogeneous. Despite additional immigrants being all low skilled, in 9 out of our 20 countries average effects are positive, while they are negative in the

[38] This is comparable in magnitude to the labor force effect of the population of refugees to Germany in 2015.

[39] Because of data limitations, we are unable to investigate the case in which a certain fraction of high-skilled immigrants enters a segment of the labor market that outs them in competition with low-skilled natives rather than high-skilled natives, due to 'downgrading', which is a well-documented phenomenon in the migration literature, see Dustmann et al. (2013) among others. If some of the high-skilled immigrants 'downgrade' this effectively increases the share of low-skilled immigrants. We believe this exercise can then be informative on what such an intermediate scenario may look like.

remaining 11 countries. The average effect across all countries is very close to zero. The countries with positive effects include the United States (largely because of its relatively low taxation and low immigrant unemployment), France, Spain and Italy (because of the beneficial effects that immigration can have on labor markets where frictions are more severe). An additional inflow of low-skilled immigrants tends to hurt low-skilled natives and benefit high-skilled natives, showing that skill complementarity tends to be quantitatively more important than public transfers.

4.2.3 The total effects of immigration

In this section, instead of investigating the effects of a relatively small change in the immigrant share, we compare the status quo as of 2011 with a hypothetical autarky situation in which countries have no foreign-born workers. The left part of Table 8 presents the results. Countries that showed positive marginal effects in Table 6, such as Italy, Portugal, Greece and Ireland, are also among those exhibiting the largest gains in the status quo relative to the no immigration scenario. High native unemployment rates and large immigrant wage gaps lead to strong beneficial job creation effects. Moreover, the job creation effect has a much more important role when considering these substantial differences in immigration: we find positive overall effects in 19 out of our 20 countries, while only 13 countries show positive marginal effects. The median and average welfare effects of total immigration are both close to +1%, with magnitudes varying strongly across countries.

In 14 of our 20 countries there is no distributive conflict among natives. This highlights the importance of the job-creation effect over the simple complementarity effect, which is always positive for one and negative for the other group. Australia, Canada and Switzerland, whose immigrant composition is most skewed in favor of highly skilled, are the only countries showing negative effects on the welfare of high-skilled natives. In a model with complementarity effects only, we would find negative effects that are larger in absolute terms for highly skilled native workers. In our model, these negative complementarity effects are moderated by the fiscal effect and the job creation effect, which benefit high-skilled natives. Compared to a standard neoclassical model with skill complementarity, our model helps us understand why high-skilled natives may not oppose skill-biased immigration. In Germany, Slovenia and the United Kingdom there are negative (albeit very small) effects on welfare of the low skilled.

Table 8: Native welfare effects of observed migration flows

	Status quo vs. Autarky			2014 vs. 2011						
	Welfare effects			Migrant shares		High skilled		Welfare effects		
Countries	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$	2011	2014	2011	2014	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$
Australia	0.24%	1.26%	-1.72%	21.0%	22.0%	42.9%	43.7%	0.06%	0.18%	-0.16%
Austria	1.77%	1.74%	1.94%	18.3%	19.8%	16.8%	29.4%	0.34%	1.04%	-2.61%
Belgium	1.70%	1.37%	2.30%	17.8%	18.9%	27.5%	30.4%	0.14%	0.31%	-0.17%
Canada	1.19%	1.79%	-0.57%	19.9%	20.8%	32.2%	36.3%	0.28%	0.61%	-0.70%
Denmark	1.90%	2.39%	0.86%	12.0%	13.5%	46.8%	52.7%	0.23%	0.54%	-0.42%
Estonia	1.47%	1.47%	1.46%	14.7%	13.0%	36.3%	40.9%	-0.04%	0.14%	-0.36%
France	0.77%	0.52%	1.27%	13.0%	13.0%	22.8%	28.1%	0.11%	0.33%	-0.33%
Germany	0.31%	-0.07%	1.23%	15.3%	16.4%	18.7%	18.8%	0.02%	0.00%	0.07%
Greece	2.02%	1.40%	3.51%	14.0%	12.7%	13.2%	15.6%	-0.11%	0.05%	-0.48%
Ireland	1.77%	2.30%	0.95%	15.3%	16.3%	48.1%	50.1%	0.14%	0.31%	-0.12%
Italy	1.87%	1.64%	2.97%	11.8%	13.3%	11.0%	12.0%	0.22%	0.24%	0.15%
Luxembourg	0.72%	0.45%	1.15%	39.1%	40.5%	32.2%	45.8%	0.62%	2.41%	-2.09%
Netherlands	0.48%	0.23%	0.98%	14.0%	14.0%	25.2%	24.9%	-0.01%	-0.02%	0.02%
Portugal	1.27%	1.23%	1.41%	9.9%	10.3%	19.4%	24.9%	0.36%	0.57%	-0.37%
Slovenia	0.52%	-0.20%	2.30%	13.1%	13.3%	9.7%	7.7%	-0.03%	-0.16%	0.28%
Spain	1.90%	0.96%	3.43%	17.7%	15.9%	21.5%	24.3%	-0.03%	0.23%	-0.45%
Sweden	0.63%	0.77%	0.34%	17.8%	19.8%	32.6%	36.7%	0.09%	0.35%	-0.45%
Switzerland	-0.14%	0.04%	-0.46%	29.2%	30.6%	30.6%	35.9%	0.07%	0.80%	-1.18%
United Kingdom	0.35%	-0.22%	1.10%	14.2%	15.4%	31.3%	32.2%	0.09%	0.10%	0.07%
United States	0.80%	0.97%	0.53%	13.5%	13.8%	31.7%	33.1%	0.08%	0.17%	-0.05%
Average	1.08%	1.00%	1.25%	17.1%	17.7%	27.5%	31.2%	0.13%	0.41%	-0.47%
Median	0.99%	1.10%	1.19%	15.0%	15.7%	29.1%	31.3%	0.09%	0.27%	-0.35%

Data sources for 2014 data: EU LFS, ACS, Hilda and Census data. See Appendix B for details.

4.2.4 The effects of recent flows: 2014 versus 2011

The comparison of the status quo with a hypothetical autarky scenario reveals the total welfare gains from international mobility. The next exercise investigates the effects of changing the immigrant stocks and their skill compositions so as to account for the changes that took place between 2011 (our baseline year) and 2014, for each of the 20 countries we analyze. As shown on Table 8, Estonia, Greece and Spain are the only countries where the share of immigrants in the workforce fell noticeably from 2011 to 2014.[40] Except for the Netherlands and Slovenia, all countries experienced an increase in the share of high-skilled among immigrants. Our simulation finds that 15 of 20 countries experienced positive effects on aggregate native welfare, and in three of these countries both low- and high-skilled natives benefited.[41] Because migration has been relatively skilled in most countries, and because of fiscal transfers, the low skilled have benefited in 18 out of 20 countries. They experienced an average welfare increase of 0.41 percent, while high-skilled natives

[40] Shares in France and in the Netherlands fell very slightly.

[41] In three of the five countries in which the native welfare decreased, this resulted from a decrease in the share of immigrants in the workforce, and in the remaining two from a decrease in the share of high-skilled among immigrants.

have experienced an average welfare loss of 0.47 percent, with negative effects in 15 countries. The positive effects for the low skilled and the small positive effects on native welfare are consistent with the findings of Docquier et al. (2014), who look at earlier years.[42] The small magnitude of the wage effects are also consistent with Ottaviano and Peri (2012) for the US, Glitz (2014) for Germany and Dustmann et al. (2013) for the UK. The simulation of the welfare effects of immigration between 2011 and 2014 shows positive average effects on per capita income of natives.

4.2.5 A linear decomposition of welfare effects

Our simulations show that the effects of immigration on native welfare depend in complicated ways on labor market characteristics, composition of the immigrant inflow and redistributive institutions of the host countries. In this section, we use a parsimonious regression analysis based on Monte-Carlo-type simulations to investigate the relative importance of the channels at work in our model. We first create a sample of 10,000 artificial economies, each described by a 15-element vector of characteristics (initial labor force shares of natives and migrants, wage gaps, unemployment rates, GDP per capita, government shares, etc.).[43] We draw these 'moments' from a jointly distributed normal distribution $\mathcal{N}(\mu, \mathbf{\Sigma})$, where μ is a (15-dimensional) vector of means and $\mathbf{\Sigma}$ is the corresponding variance-covariance matrix, both generated from the observed data for our 20 OECD countries.[44] Then, we calibrate the model parameters of the artificial economies such that they match the drawn characteristics, following the same procedure as in the sections above. We next simulate the effects of an increase in migration equal to one percentage point of the labor force of our artificial countries. This exercise creates observations on 10,000 artificial economies, which by construction are characterized by the same summary statistics as the 20 real OECD economies. With these data we run a simple OLS regression (for all natives, and then separately by skill) where we explain welfare gains by various country characteristics (these are simple transformations of the 15 random variables). More precisely, we run the following regression:

[42] Those authors simulate the labor market effects of immigrants in a model featuring competitive labor markets. They focus on net immigration between 1990 and 2000 into OECD countries. Their study does not feature labor market frictions, the job creation channel or the income redistribution effects. However, it allows for potentially positive productive externalities from the concentration of high skilled.

[43] The country moments are those listed in the lower half of Table 2 and the nine moments that vary across countries in Table 3 (job duration has no country variation). This gives us a total of 15 moments.

[44] We truncate the distribution at $\mu_k \pm 2\sigma_k$ to avoid realizations that are ruled out by parameter restrictions.

$$\Delta \ln \mathcal{W}_{iN} = \sum_k \beta_k \ln X_{ik} + u_i \tag{16}$$

where $\Delta \ln \mathcal{W}_{iN}$ denotes the proportional welfare gain for natives in economy i, X_{ik} is an $i \times k$ matrix of country characteristics and u_i is an error term capturing specification error.[45] Regression (16) is a way of obtaining quantitative comparative statics results and by no means a test of the model. The standardized beta coefficients presented in Table 9 summarize the conditional correlation of a certain country characteristic with the native welfare effect of immigration.[46]

Table 9: Native welfare gains by skill, semi-log moment regression

Dependent variable: welfare gains of natives from a 1% point increase in immigrant stock			
	(1)	(2)	(3)
	All Natives	Low Skilled	High Skilled
Native-immigrant wage gap, skilled	0.086***	0.065***	0.124***
	[6.38]	[4.88]	[10.15]
Native-immigrant wage gap, unskilled	0.102***	0.066***	0.152***
	[6.75]	[4.44]	[11.11]
Native-immigrant unemployment gap, skilled	-0.016	-0.015	-0.017
	[-1.22]	[-1.18]	[-1.42]
Native-immigrant unemployment gap, unskilled	-0.096***	-0.081***	-0.114***
	[-5.64]	[-4.84]	[-7.41]
Share of immigrants in the labor force	-0.145***	-0.111***	-0.195***
	[-10.57]	[-8.17]	[-15.65]
Share of tertiary educated: Immigrant/native ratio	0.058***	0.176***	-0.347***
	[4.57]	[13.89]	[-29.96]
Share of tertiary educated among natives	0.007	0.001	0.019*
	[0.62]	[0.08]	[1.83]
Replacement rate	0.051***	0.058***	0.039***
	[3.06]	[3.49]	[2.61]
Government expenditures as share of GDP	-0.062***	-0.052***	-0.074***
	[-4.36]	[-3.69]	[-5.70]
Observations	10000	10000	10000
R^2	0.042	0.057	0.213

Notes: standardized beta coefficients; *t-stats* in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All regressors are in logs. Artificial economies obtained by sampling from a joint normal distribution.

Column (1) of Table 9 shows the native/immigrant wage gaps are the most important positive determinants of the overall native welfare gains from immigration. Increasing the high- and low-skilled wage gaps by one standard deviation leads to an increase in the welfare gains by 0.09 and 0.10 standard deviations, respectively. This result shows the strength of the job creation effect when the wage gap is mainly driven by different outside options. The second most important positive

[45] The log-linear specification of (16) is an approximation of the non-linear relationship implied by our model.

[46] Standardized beta coefficients measure the impact of an independent variable on the dependent variable in units of standard deviations, i.e., $\hat{\beta}_k \sigma(\ln X_k) / \sigma(\Delta \ln \mathcal{W}_N)$. Results from running the same regression on observational data for our 20 economies rather than on simulated data are in line with those of Table 9.

driver is the skill ratio between natives and immigrants: relatively highly educated immigrants are associated with larger gains.[47] The replacement rate ranks third: a higher replacement rate increases the gains as immigrants' job-creating effects are stronger if labor market frictions are initially more pronounced. This effect dwarfs the negative redistributive role of replacement rates.

The preexisting share of immigrants in the labor force turns out to be the most important negative determinant of the welfare gains (standardized beta of -0.15). This suggests that there may be an immigrant share at which the (usually) positive welfare effects of immigrants estimated in the previous section may turn negative. The logic for this result relates to infra-marginal effects: if additional immigration raises the wages of incumbent migrants, firms' incentives to create jobs fall and the marginal value of immigration for natives is diminishing. Immigrant/native unemployment gaps also reduce the welfare gains of immigration, as expected, because they hamper the job creating role of immigrants and increase transfers to immigrants. Government expenditures as share of GDP rank as the third most important negative determinant of welfare gains.

Results are qualitatively similar for welfare gains of low-skilled (column 2) and high-skilled natives (column 3), with the exception of the effects of immigrant skill composition, which are as expected because of complementarity effects. The relative skill composition of immigrants is the dominant determinant of welfare gains: the larger the share of immigrants with tertiary education, the higher the welfare gains for the low skilled and the smaller the gains for the high skilled. The associated standardized betas are large at 0.18 for low skilled and -0.35 for high skilled. The classical complementarity channel is still important for quantifying the distributive consequences of migration, but matters much less for overall native welfare gains. Larger wage gaps are associated with larger welfare gains, and the generosity of unemployment benefits matters more for low-skilled than for high-skilled natives because of the former group's higher unemployment risk.

4.3 Sensitivity analyses

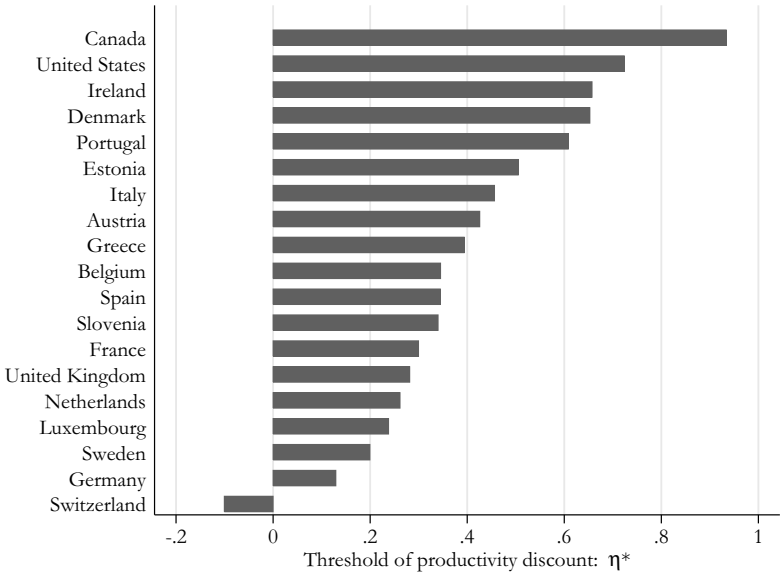
4.3.1 Immigrant-native productivity gaps

So far, we have assumed no productivity differences between immigrants and natives of the same skill level, setting $\pi_{ij} = 1$. In this robustness check, we introduce a parameter η, which makes

[47] On the other hand, the share of tertiary-educated among natives is unimportant once educational attainments of immigrants relative to natives are taken into account.

the immigrant-native productivity gap proportional to the observed wage gap between immigrants and natives: we posit $\pi_{iN}/\pi_{iI} - 1 = \eta\,(w_{iN}/w_{iI} - 1)$. Setting $\pi_{iN} = 1$, this implies $\pi_{iI} = [\eta\,(w_{iN}/w_{iI} - 1) + 1]^{-1} \leq 1$. In the absence of a wage gap (i.e., $w_{iN} = w_{iI}$) or with $\eta = 0$, one has $\pi_{iI} = 1$ (as assumed in our baseline). On the other hand, with $\eta = 1$, the entire wage gap is explained by a productivity gap. Previous research (e.g. LaLonde and Topel, 1991; Borjas and Friedberg, 2009; Kerr and Kerr, 2011) suggests that a significant part of the immigrant-native wage gap persists after controlling for skills and human capital. Hence, it seems plausible to expect η to lie closer to zero than to one.

Figure 1: Critical value of η at which immigration gain changes sign



Notes: we denote by η^* the level of η for which the overall native welfare gain resulting from the total observed stock of immigrants changes sign. Australia is excluded because no solution for η^* exists. Due to the fact that wage gaps are very small in Australia, no productivity difference consistent with those wage gaps can eliminate the gains we find. In other words, the gains for natives we find are unaffected by productivity differences as they enter our model specifications.

Figure 1 plots the level of η for which the overall native welfare gain due to immigrants, as shown in the second column of Table 8 for the case $\eta = 0$, changes sign. For example, in Canada, immigration would be beneficial for natives even if virtually the whole native-immigrant wage gap were due to productivity differences (within skill groups). In contrast, in Germany or Sweden, the gain would turn negative with an η larger than 0.13 or 0.20, respectively. Overall, Figure 1 indicates the assumption that $\pi_{ij} = 1$ is not essential in countries toward the top of the figure to obtain a positive welfare effect from immigration, while if immigrants' productivity is significantly

lower than that of comparable natives, countries toward the bottom may not experience the gains indicated by the model. The fact that the model is sensitive to an unidentified parameter calls for a cautious interpretation of some of our results. However, many of the considered countries (and notably Canada and the US) would still gain from immigration, even if half of the wage differential between natives and immigrants was due to productivity differences.

4.3.2 Non-rival public spending

So far, we have assumed public spending to be exclusively on rival goods. We find this defensible for scenarios that involve a long time span (e.g., the comparison between a hypothetical autarky situation with the observed *status quo*) and on basis of footnote 21. However, over shorter horizons and for small changes in immigrant shares, a fraction of public spending may be on non-rival public goods. To capture this possibility, we modify the government budget constraint to include spending on a non-rival (or "pure") public good $\bar{G}$, which is independent of the size of the labor force:

$$\sum_i \sum_j b_{ij} U_{ij} + \tilde{g} \sum_i \sum_j Q_{ij} + \bar{G} = t \sum_i \sum_j w_{ij} E_{ij}, \tag{17}$$

As pointed out by Dustmann and Frattini (2014) and others, separating public spending into rival and non-rival public goods is difficult in practice. However, most studies agree that military spending and the service of government debt do not vary with migration, at least in the short run. Using World Bank data and averaging over 2005-2011, in our 20 countries governments spend on average 2.0% of GDP for interest payments (Greece spends the most: 5.2%) and 1.6% of GDP for the military (the US spend the most: 4.2%).[48] Compared to our baseline specification, we keep the same total size of the government as share of GDP, but allow it to include "pure" public goods.

Table 10 reports results from simulations equivalent to the first three columns of Table 6, the only difference being that Table 10 allows for non-rival public goods as described above. Because of the non-rival nature of "pure" public goods, per capita expenses on these goods decrease with the size of the labor force. Therefore, all welfare effects now turn out larger than in our baseline specification. On average, native welfare gains are now 0.06 percent, while the corresponding effects without "pure" public goods are 0.02 percent. Five of the seven countries with negative average

[48] Table C.1 reports the value of military spending and interest payments as share of GDP in each country.

effects in the baseline simulation of Table 6 now display a positive effect, with the two remaining negative numbers being very close to zero. While necessarily stylized, largely because we look at many countries, our exercise suggests that the composition of public spending may play an important role in shaping the native welfare effects of immigration.

Table 10: Native welfare effects from one p.p. increase, with non-rival public spending

Countries	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$
Australia	0.04%	0.09%	-0.05%
Austria	0.00%	0.00%	0.00%
Belgium	0.02%	0.01%	0.05%
Canada	0.07%	0.10%	-0.04%
Denmark	0.09%	0.14%	-0.02%
Estonia	0.07%	0.08%	0.04%
France	0.06%	0.04%	0.11%
Germany	0.02%	-0.01%	0.08%
Greece	0.15%	0.10%	0.29%
Ireland	0.07%	0.12%	-0.01%
Italy	0.13%	0.11%	0.22%
Luxembourg	-0.01%	-0.03%	0.00%
Netherlands	0.02%	0.00%	0.05%
Portugal	0.13%	0.13%	0.14%
Slovenia	0.05%	-0.01%	0.20%
Spain	0.07%	0.01%	0.15%
Sweden	0.01%	0.02%	-0.01%
Switzerland	-0.02%	-0.02%	-0.02%
United Kingdom	0.05%	0.01%	0.10%
United States	0.12%	0.12%	0.11%
Average	0.06%	0.05%	0.07%
Median	0.06%	0.03%	0.05%

Notes: 'p.p.' denotes 'percentage point'. We analyze a skill-neutral increase in immigration equal to one percentage point of the labor force, compared to 2011. Appendix B discusses data sources.

4.3.3 Utility from unemployment

In the baseline version of our model, we set utility effects of unemployment for native workers to zero: we assume $h_{LN} = 0$ and $h_{HN} = 0$, as in Chassamboulli and Palivos (2014). We now perform a sensitivity analysis where we investigate the extent to which our results are robust to changing this assumption. In particular, we set the values of h_{LN} and h_{HN} to around 10 percent and around 25 percent of unemployment benefits. We use both positive and negative values so that we can investigate the possible roles of utility gains and utility losses from unemployment. We then run the same exercise as in Section 4.2.1 (we investigate effects of an increase in migrant shares equal to one percentage point of the labor force) for each of the new values, and look at whether

estimated welfare effects for natives are different. Table C.5 in our Appendix presents the results of this sensitivity analysis on welfare gains for all natives, low-skilled natives and high-skilled natives separately. Even values of h_{LN} and h_{HN} as high as one-fourth of unemployment benefits hardly affect the welfare effects implied under our benchmark calibration.

5 Conclusions

The impact of immigration on wages, employment and welfare of natives depends on the characteristics of immigrants and on the institutions of the host country. Most research on the economic effects of immigration, however, assumes perfectly competitive labor markets, and abstracts from redistribution. In this paper, we propose a model that addresses these two issues. In most countries immigrants earn lower wages than natives and face higher unemployment risk, given similar observable skills. However, there is substantial heterogeneity across countries with regard to size and skill composition of the immigrant stock, their labor market performance, and institutional features, implying different impacts on natives.

We develop a sufficiently flexible model to capture these facts. Our point of departure is a search-and-matching model, inspired by Chassamboulli and Palivos (2014), where firms cannot discriminate between immigrants and natives ex ante. However, when a match is formed, wage bargaining accounts for immigrants' lower outside options and lower expected match duration. These two ingredients imply that the share of immigrants affects job creation, with consequences for wages and unemployment rates of native workers. We also add a redistributive government to the model. As stressed in the public finance literature, migration may generate a fiscal transfer from natives who typically hold higher-paying jobs and are less likely to be unemployed. Our model accounts for that. Indeed, time and again, surveys show that unemployment and fiscal transfers are very important determinants of native attitudes towards migration (Boeri, 2010).[49]

Introducing search frictions into a model with skill complementarity has quantitatively important implications for the welfare effects of immigration. When immigrant workers have inferior outside options, immigration boosts firms' incentives to create vacancies; this can benefit all workers (natives and incumbent immigrants) and can increase the immigration surplus. Part of this advan-

[49] In contrast, the same data from the European Social Survey indicate the wage effects of immigration are relatively unimportant, despite their prominent role in the economic literature.

tage is eroded by the fact that matches with immigrants typically have shorter duration. However, our quantitative exercise suggests that the net effect from the two channels is positive in virtually all countries in our sample, and sometimes substantial. Interestingly, this job creation effect seems more important in countries whose domestic labor market institutions are more conducive to native unemployment. The benefits from immigration deriving from labor market imperfections tend to be quantitatively more important than the classical complementarity channel.

In addition, in the presence of search frictions and wage bargaining, immigration need not create a distributional conflict between high- and low-skilled natives as in the classical model. Nonetheless, the composition of the immigrant workforce relative to natives is still the main predictor of skill-specific native welfare effects. We also find that the presence of a redistributive welfare state makes immigration less attractive to natives. Finally, accounting for all channels through which immigration affects natives, the latter are better off with the current migration stocks than in a hypothetical situation with no immigrants in 19 out of 20 countries.

Our 'macro' approach based on the structural calibration of a model on data from several countries complements previous reduced-form, one-country analyses of the effects of immigration. Still, there are many ways in which our analysis framework can be extended. For example, our analysis is silent on the role of inter-generational considerations. Given that inter-generational transfers are large, populations of OECD countries are aging and immigrants are young, immigration could play a considerable role in alleviating the burden that population aging places on OECD countries in the coming decades. The magnitude of such gains depends crucially on future return migration, on whether return migrants receive the accumulated pensions and on immigrants' future health care costs. It is important to point out that these mechanisms can be expected to strengthen our main result that OECD countries have gained from immigration. They might also turn some of the estimated negative effects to positive, for example in scenarios that analyze the effects of recent inflows or hypothetical future inflows. We have preferred to err on the side of caution and refrained from making speculative assumptions about future return migration, future developments in life expectancy and about the extent to which immigrants' potentially higher fertility rates could help to alleviate demographic challenges, so that our welfare effects hold also in the absence of such additional gains. We hope that further research will continue to combine micro and macro approaches to answer the relevant policy questions about the economic impact of migration.

Appendices

A Analytics of simplified models

A.1 Proposition 1

Before we can discuss this specific result, we need to derive a few equations, which are simplifications of the model we presented in the main text. Assuming separation rates are the same for immigrants and natives, the ratio of natives and immigrants among employed and unemployed is the same as their ratio in the labor force: immigrants and natives have the same chance of getting matched with a firm and the same probability of making a transition from employment to unemployment (because they have the same split rates). In this case ϕ_{iI} is equal to $Q_{iI}/(Q_{iI}+Q_{iN})$, i.e. the share of immigrants in the labor force. The ratio Y_H/Y_L that determines the marginal productivity of each type of workers can then be written as:

$$\frac{Y_H}{Y_L} = \frac{m(\theta_H)\left[s_L + m(\theta_L)\right]}{m(\theta_L)\left[s_H + m(\theta_H)\right]} * \frac{Q_{HN}+Q_{HI}}{Q_{LN}+Q_{LI}}. \tag{A.1}$$

In equilibrium, the vacancy/employment ratio is $s_i/q(\theta_i)$. Substituting (A.1) into (3) and (4), we can write the two equilibrium conditions for equilibrium market tightness, θ_H and θ_L explicitly:

$$\begin{aligned} p_L^{BE} &= xA\left[x + (1-x)\left(\Lambda(\theta_H,\theta_L)\Omega\right)^{\rho}\right]^{\frac{1-\rho}{\rho}} \\ &= \frac{\phi_{LI}h_{LI}}{1-t} + c_L\frac{(r+s_L)\left(1-t\left(1-\beta\right)\right)+\beta\xi\theta_L^{1-\varepsilon}}{\xi\theta_L^{-\varepsilon}\left(1-\beta\right)\left(1-t\right)} \end{aligned} \tag{A.2}$$

$$\begin{aligned} p_H^{BE} &= (1-x)\,A\left[x\left(\Lambda(\theta_H,\theta_L)\Omega\right)^{-\rho} + (1-x)\right]^{\frac{1-\rho}{\rho}} \\ &= \frac{\phi_{HI}h_{HI}}{1-t} + c_H\frac{(r+s_H)\left(1-t\left(1-\beta\right)\right)+\beta\xi\theta_H^{1-\varepsilon}}{\xi\theta_H^{-\varepsilon}\left(1-\beta\right)\left(1-t\right)}, \end{aligned} \tag{A.3}$$

where the term

$$\Lambda(\theta_H,\theta_L) = \frac{\xi\theta_H^{1-\varepsilon}\left[s_L+\xi\theta_L^{1-\varepsilon}\right]}{\xi\theta_L^{1-\varepsilon}\left[s_H+\xi\theta_H^{1-\varepsilon}\right]}$$

depends positively on the tightness of market H and negatively on the tightness of market L. The term $\Omega = \frac{Q_{HN}+Q_{HI}}{Q_{LN}+Q_{LI}}$ is the supply of highly educated relative to less educated workers. This term may also be affected by immigration if the skill-mix among immigrants differs from that of natives.

(i) When the inflow of immigrants is balanced (the ratio of low to high skilled is the same as in the original native population) it will not affect Ω, and since immigrants of each type are as productive as natives, there is also no effect through $\Lambda(\theta_H, \theta_L)$. The left-hand side of equation (A.2) remains the same. The right-hand side of the same equation will need to adjust to the increase in ϕ_{LI}. Since this change has no first-order impact on the left-hand side of equation (A.2), we can write the partial derivative of θ_L with respect to ϕ_{LI} for the right-hand side of equation (A.2):

$$\frac{\partial \theta_L}{\partial \phi_{LI}} = -\frac{d/d\phi_{LI}}{d/d\theta_L} = \frac{\frac{h_{LI}}{1-t}}{c_L \frac{(1-\epsilon)\beta\xi\theta_L^{-\epsilon}(\xi\theta_L^{-\epsilon}(1-\beta)(1-t)) - [(r+s_L)(1-t(1-\beta)) + \beta\xi\theta_L^{1-\epsilon}][(1-\beta)(1-t)\xi(-\epsilon)\theta_L^{-\epsilon-1}]}{[\xi\theta_L^{-\epsilon}(1-\beta)(1-t)]^2}}. \tag{A.4}$$

The sign of this derivative will be driven by the sign of the term

$$\begin{aligned} &(1-\epsilon)\beta\xi\theta_L^{-\epsilon}(\xi\theta_L^{-\epsilon}(1-\beta)(1-t)) - [(r+s_L)(1-t(1-\beta)) \\ &+ \beta\xi\theta_L^{1-\epsilon}][(1-\beta)(1-t)\xi(-\epsilon)\theta_L^{-\epsilon-1}], \end{aligned} \tag{A.5}$$

which simplifies to

$$\begin{aligned} &[\beta(1-\beta)(1-\epsilon)\xi^2 + \beta\xi\epsilon(1-\beta)(1-t)]\theta_L^{-2\epsilon} \\ &+ \xi\epsilon(r+s_L)(1-t(1-\beta))(1-\beta)(1-t)\theta_L^{-\epsilon-1} > 0. \end{aligned} \tag{A.6}$$

Equivalently, using equation (A.3), we find

$$\frac{\partial \theta_H}{\partial \phi_{HI}} = -\frac{d/d\phi_{HI}}{d/d\theta_H} > 0. \tag{A.7}$$

This confirms the intuition that as the number of immigrants increases without changing the ratio between high- and low-skilled workers, the value of a vacancy goes up because immigrants leave a higher surplus to the firm. Since we have a free-entry condition ensuring the equilibrium value of a vacancy remains zero, more vacancies will be created compared to the total number of workers, thereby increasing market tightness in both markets. As market tightness increases in both markets, unemployment rates for natives will decrease, since

$$U_{iN} = \frac{s_i}{s_i + m(\theta_i)} Q_{iN} \quad \text{for } i = H, L. \tag{A.8}$$

In this equation, the arrival of new immigrants will only affect the unemployment rate through θ_i. As θ_i increases, $m(\theta_i)$ also increases (the probability to find a job is higher the tighter the market is), which reduces the unemployment rate of natives. Evaluating the effects on equilibrium wages is only slightly more complicated. We use our wage bargaining equation, observing the match surplus will be a positive function of market tightness, i.e. $\frac{\partial p_i}{\partial \theta_i} > 0$. We are interested in the effect of a change in market tightness on wages of natives:

$$\frac{\partial w_{iN}}{\partial \theta_i} = \beta p_i \frac{m'(\theta_i)[(r+s_i)(1-t(1-\beta)) + \beta m(\theta_i)] - [r+s_i+m(\theta_i)\beta m'(\theta_i)]}{[(r+s_i)\,(1-t\,(1-\beta)) + \beta m\,(\theta_i)]^2}. \tag{A.9}$$

After a few simple steps, this simplifies to

$$\frac{\partial w_{iN}}{\partial \theta_i} = \beta m'(\theta_i)[(1-\beta)(r+s_i)p_i(1-t)]. \tag{A.10}$$

Therefore

$$\frac{\partial w_{iN}}{\partial \theta_i} > 0 \text{ if and only if } p_i(1-t) > 0, \tag{A.11}$$

which is true in our model.

(ii) A change in the outside option of immigrants affects labor market tightness through the same channel discussed above, namely vacancy creation effects. If the outside option for immigrants worsens, unemployment of natives falls and wages of natives increase.

In particular, consider a decrease in h_{iI} (i.e. an increase in its absolute value). Note that h_{iI} only enters equations (A.2) and (A.3) when it is multiplied by ϕ_{iI}. Therefore, the effect of a change in h_{iI} is analytically equivalent to a change in ϕ_{iI}. Either having more immigrants or changing the outside option of current immigrants have the same qualitative effects. Therefore, the effects of labor market tightness on unemployment rates and wages of natives are equivalent to the analysis above. For clarity of exposition, let us consider an inflow of less-skilled immigrants, focusing on the effects on high-skilled natives. An increase in Q_{LI} will affect Ω in equation (A.3). By reducing the relative size of the high-skilled population, it will increase market tightness in the high-skilled

market. From equation (A.3) we can look at the effect of an increase in θ_H on p_H:

$$\frac{\partial p_H}{\partial \theta_H} = c_H \frac{\frac{(1-\epsilon)\beta\xi^2(1-\beta)(1-t)}{\theta_H^{2\epsilon}} + \epsilon[(r+s_H)(1-t(1-\beta)) + \frac{\beta\xi}{\theta_H^{\epsilon-1}}]\frac{\xi(1-\beta)(1-t)}{\theta_H^{\epsilon+1}}}{[\xi\theta_H^{-\epsilon}(1-\beta)(1-t)]^2} \geq 0, \tag{A.12}$$

so that higher labor market tightness of high-skilled workers is associated with a larger equilibrium surplus from the match, lower unemployment rates and higher wages for high-skilled natives.

(iii) The effect on natives of skill $i' \neq i$ is entirely driven by the complementarity channel, which is positive from the concavity of the production function, as in Borjas (1995).

A.2 Proposition 2

Results (i) and (ii) operate through identical mechanisms, as in the case of Proposition 1, with the fundamental difference that the effect of larger migration stocks on the expected surplus from a match is now negative. Given this equivalence, we focus on (iii).

For simplicity, consider a situation in which immigrants and natives have identical separation rates initially. We then increase split rates of immigrants of one type and look at the effects on natives. Naturally, the stronger effects will be on the immigrants themselves. However, our focus is primarily on natives, which means we are focusing on the indirect effect of separation rates, which operate through the job creation margin.

If immigrants have higher separation rates than natives, this means the surplus from being matched with an immigrant is lower because match duration is shorter on average. Note we are ruling out the firm targeting either natives or immigrants when it creates a vacancy. Therefore, from the free-entry condition,

$$rJ_i^V = -c_i + q(\theta_i)\left[\phi_{iN})J_{iN}^F + \phi_{iI}J_{iI}^F - J_i^V\right] = 0. \tag{A.13}$$

We see that as the value of a filled vacancy falls, equilibrium labor market tightness will have to fall in order for the equality to hold. Intuitively, in order for firms to break even in an environment where they get a lower surplus from the match, the market will have to adjust so the probability of filling a vacancy is larger for firms. In other words, at higher separation rates for immigrants, less vacancies get created and equilibrium market tightness is lower. The rest of the discussion in this

paragraph follows from the results on labor market tightness, which is the channel through which separation rates of immigrants affect labor markets of natives.[50] Below, we discuss the effects on wages and unemployment rates. These are generated by differences in separation rates, but since they operate though labor market tightness, they have been previously looked at in the context of search models. Higher separation rates for immigrants – which bring about lower equilibrium labor market tightness – generate higher unemployment rates for natives. Unemployment rates for natives of skill i are

$$u_{iN} = \frac{s_{iN}}{s_{iN} + m(\theta_i)}. \tag{A.14}$$

Since $m(\theta_i)$ is increasing in θ_i (in our model we use the functional form $m(\theta_i) = \xi\theta^{1-\varepsilon}$), the unemployment rate of natives will be higher when equilibrium market tightness is lower, even though the separation rates of natives are unchanged. We next discuss the effect of separation rates of immigrants on wages of natives, operating once again through market tightness. Let us write gross wages of natives as a function only of market tightness and exogenous parameters:

$$w_{iN} = \beta \frac{r + s_{iN} + \xi\theta^{1-\varepsilon}}{(r + s_{iN})\left(1 - t\left(1 - \beta\right)\right) + \beta\xi\theta^{1-\varepsilon}} p_i. \tag{A.15}$$

We want to investigate the sign of $\frac{\partial w_{iN}}{\partial \theta_i}$. It is straightforward to see the term on the right-hand side of equation (A.15) is increasing in θ_i. The price $p_i = p_i(\theta_i)$ is a positive function of labor market tightness, and it is easy to show the expression $\beta \frac{r+s_{iN}+\xi\theta^{1-\varepsilon}}{(r+s_{iN})(1-t(1-\beta))+\beta\xi\theta^{1-\varepsilon}}$ is also a positive function of θ_i. Therefore, an increase in the separation rates of immigrants, reducing labor market tightness, also lowers wages for natives. Within a wage bargaining framework, wages are a convex combination of the surplus from the match and the outside option of the worker. Lower labor market tightness also lowers the value of the outside option (because it is harder to find a job when unemployed), the price of the intermediate good is lower, and its weight is also lower (because the expected value of a match following the current match is lower).

Summarizing, through its negative effects on labor market tightness, higher separation rates for immigrants result in higher unemployment rates and lower wages for immigrants, but also for natives of the same skill class. These dynamics will also have second-order spillover effects of the

[50] We are abstracting from the fiscal channel here, which adds a further mechanism: if immigrants have higher separation rates, they will have higher equilibrium unemployment rates, which imply larger transfers from natives even in the absence of wage gaps.

same sign on native workers of a different skill class, operating through equations 3 and 4, governing prices of the intermediate goods. Lower employment of one skill level corresponds to a lower price in the other sector, due to complementarity. The mechanism feeds on itself and moves the system along a saddle path to a new steady state. Therefore, our model predicts that larger separation rates for immigrants in one sector will lower wages and increase unemployment of natives of the same skill level, as well as those of natives of a different skill level.

B Data sources

Our quantitative analysis uses data of population shares (skill shares of the labor force in each country, percentage of foreign-born individuals in each country, skill shares among immigrants), wages (skill premia and immigrant wage gaps by skill level), unemployment rates, generosity of the unemployment insurance scheme, GDP per capita and size of the public sector. For each of these, we list our data sources below. Following Chassamboulli and Palivos (2014) and Krusell et al. (2000), we define skilled workers as those workers who hold a Bachelor degree (or equivalent) or above.

Population shares. For all of the EU countries in our analysis, we have used information on population shares from the 2012 Eurostat Yearbook (data for 2011), restricting our sample to individuals between 15 and 64 years of age with skill information derived from the ISCED education classification system. From the Eurostat Yearbook we use data on the share of low-skilled among natives, the share of low-skilled among immigrants and the share of foreign born in the population. For the US, equivalent population shares are constructed using the Public Use Micro File dataset from the 2005 US Census. Similarly, for Canada we construct population shares using the Micro File version of the 2006 Canadian Census. In both cases, we then update the data using American Community Survey and Labor Force Survey. For Australia, we use the 2011 wave of the panel dataset Household, Income and Labor Dynamics in Australia (HILDA) representative survey.[51]

Unemployment rates. Figure C.1 presents descriptive figures for unemployment rates by skill class and by immigration status. For all EU countries and Switzerland we have used descriptive

[51] See Wooden and Watson (2007) and Breunig et al. (2013).

data from the EU Labour Force Survey. For Germany, there is no information on country of birth in the European Labour Force Survey so we used nationality, for 2005-2011. For the United States, we used the Current Population Survey for 2005-2011. For Canada, since the Labour Force Survey (LFS) does not include migration information, we constructed unemployment rates by skill level for 2005-2011, and then used the 2006 Census Microfiles to construct unemployment rates for immigrants and natives. We then constructed trends using the census data and the LFS data together. For Australia, we use data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey from 2005 to 2011 (Waves 5-11). For wage gaps and unemployment rates, we average data over this period to maximize comparability across countries and minimize the role of business cycle and short-term fluctuations, given that the focus of our study is on steady-state comparisons.

Wages. For EU countries, we constructed a measure of the wage gap between low- and high-skilled native workers, and of the gaps between immigrant and native workers (by skill) using the European Union Statistics on Income and Living Conditions (EU-SILC) for years 2005-2011 (2010 for Ireland).[52] For the US, Canada and Australia we use the same datasets that we used for population shares, see above.

Government expenditures. We take expenditures as share of GDP from the World Economic Outlook Database of the International Monetary Fund. For each country, we take an average for 2005-2011 to make sure that heterogeneity across countries is not driven by asymmetries in the respective business cycles.

Expenses on the military and on interests on government debt. We use the latest version of the World Development Indicators of the World Bank to get data on military spending and interest payments to service the government debt. We construct averages for all years between 2005 and 2011 to make sure that our results are not driven by current business cycle conditions. We use the sum of expenses for the military and payments to service the public debt as a conservative measure of the magnitude of "pure" public goods.

[52] We thank Eurostat for providing us with summary statistics based on the EU-SILC dataset.

Replacement rates. In order to parameterize the level of unemployment benefits for each country we use data on the average net replacement rates from the OECD Benefits and Wages Dataset, averaging net replacement rates (NRR)[53] for 2005-2011 to smooth out business cycle fluctuations.

Gross Domestic Product (GDP). We use data on 2011 Gross Domestic Product (PPP in international dollars) from the World Development Indicators of the World Bank.

Capital share. We calculate the capital share α for each country as one minus the annual labor income share, which is available from the "Unit Labour Costs - Annual Indicators" dataset of the OECD. We average capital shares over the period 2005-2011 again to get a measure that does not reflect a country's specific position along the business cycle.

Re-migration rates. We calculated monthly re-migration rates using data on the share of re-emigration rates five years after arrival from table III.1 from OECD (2008). Because of data limitations, we are unable to use different values for different countries, and also unable to make re-migration rates duration-dependent, which is likely to be the case in reality.

Stocks and skill compositions, 2011-2014. In order to perform this exercise, we need information on the stock of immigrants and on their skill composition in 2011. Our data sources are the EU Labour Force Survey for European countries, the American Community Survey for the United States (where we take account of the different sample characteristics between the sample and the US Census by equating growth rates rather than levels). For Australia, we need to use HILDA data from 2013 and impute data for 2014 using previous growth rates. For Canada, to the best of our knowledge there is no dataset that can be used for this purpose, which is more recent than the 2011 Census. We therefore use linear trends to extrapolate levels in 2014. Fortunately, both Australia and Canada are countries that have migration policies that have been very stable over longer periods of time, and we are therefore confident that our imputations do not deliver misleading results.

[53] We use the Net Replacement Rates summary measure provided by the OECD, and defined as the average of the net unemployment benefit replacement rates for two earnings levels, three family situations, averaged over 60 months of unemployment and excluding Social Assistance and Housing Benefits. Cross country differentials are similar for alternative calculations of replacement rates.

Table C.1: Summary statistics for country-specific moments

	(1) $\frac{Q_{LN}}{Q_N}$	(2) Q_I	(3) $\frac{Q_{LI}}{Q_I}$	(4) $\frac{w_{HN}}{w_{LN}}$	(5) $\frac{w_{LN}}{w_{LI}}$	(6) $\frac{w_{HN}}{w_{HI}}$	(7) u_{LN}	(8) u_{LI}	(9) u_{HN}	(10) u_{HI}	(11) $\frac{\bar{b}}{W(1-t)}$	(12) GDP	(13) $\frac{G+B}{GDP}$	(14) $\frac{rD}{GDP}$	(15) $\frac{M}{GDP}$
Countries															
Australia	0.70	0.21	0.57	1.40	1.01	1.00	0.04	0.05	0.01	0.03	0.43	39.7	0.36	0.010	0.019
Austria	0.83	0.18	0.83	1.35	1.34	1.18	0.04	0.10	0.02	0.06	0.52	42.2	0.50	0.025	0.008
Belgium	0.68	0.18	0.72	1.44	1.29	1.14	0.08	0.20	0.03	0.10	0.63	38.8	0.52	0.034	0.011
Canada	0.80	0.20	0.68	1.81	1.01	1.19	0.09	0.09	0.04	0.07	0.26	40.4	0.41	0.018	0.012
Denmark	0.71	0.12	0.53	1.37	1.18	1.16	0.06	0.12	0.03	0.08	0.57	40.9	0.55	0.016	0.014
Estonia	0.69	0.15	0.64	1.52	1.16	1.35	0.12	0.14	0.05	0.09	0.24	22.0	0.41	0.001	0.019
France	0.71	0.13	0.77	1.45	1.17	1.04	0.10	0.16	0.05	0.10	0.49	35.2	0.55	0.024	0.023
Germany	0.74	0.15	0.81	1.40	1.13	1.16	0.09	0.16	0.03	0.11	0.44	39.5	0.46	0.016	0.013
Greece	0.75	0.14	0.87	1.68	1.39	1.38	0.13	0.15	0.09	0.15	0.22	25.8	0.49	0.052	0.028
Ireland	0.66	0.15	0.52	1.61	1.07	1.24	0.11	0.16	0.04	0.08	0.54	41.7	0.44	0.020	0.006
Italy	0.86	0.12	0.89	1.56	1.34	1.57	0.08	0.11	0.05	0.08	0.23	32.6	0.49	0.044	0.017
Luxembourg	0.64	0.39	0.68	1.42	1.29	1.08	0.04	0.07	0.02	0.04	0.30	89.0	0.41	0.003	0.006
Netherlands	0.70	0.14	0.75	1.39	1.13	1.15	0.04	0.09	0.02	0.06	0.39	42.8	0.48	0.017	0.014
Portugal	0.83	0.10	0.81	2.08	1.09	1.22	0.10	0.14	0.08	0.09	0.52	25.4	0.47	0.029	0.019
Slovenia	0.76	0.13	0.90	1.49	1.12	1.06	0.07	0.08	0.04	0.05	0.26	27.0	0.44	0.014	0.014
Spain	0.67	0.18	0.79	1.55	1.30	1.34	0.17	0.23	0.08	0.16	0.42	32.0	0.43	0.015	0.011
Sweden	0.69	0.18	0.67	1.24	1.21	1.13	0.08	0.16	0.03	0.11	0.42	41.5	0.51	0.011	0.012
Switzerland	0.68	0.29	0.69	1.44	1.17	0.99	0.03	0.08	0.02	0.05	0.34	51.3	0.33	0.006	0.007
UK	0.62	0.14	0.69	1.52	1.04	1.15	0.08	0.10	0.03	0.06	0.29	35.7	0.43	0.023	0.023
USA	0.70	0.14	0.68	2.11	1.15	1.00	0.10	0.09	0.03	0.04	0.27	48.1	0.40	0.026	0.042
Statistics															
Mean	0.72	0.17	0.72	1.54	1.18	1.18	0.08	0.12	0.04	0.08	0.39	39.6	0.45	0.020	0.016
Median	0.70	0.15	0.71	1.47	1.16	1.15	0.08	0.11	0.03	0.08	0.40	39.6	0.45	0.018	0.014
S.d.	0.07	0.07	0.11	0.23	0.11	0.15	0.04	0.05	0.02	0.03	0.13	13.9	0.06	0.012	0.008
Min	0.62	0.10	0.52	1.24	1.01	0.99	0.03	0.05	0.01	0.03	0.22	22.0	0.33	0.001	0.006
Max	0.86	0.39	0.90	2.11	1.39	1.57	0.17	0.23	0.09	0.16	0.63	89.0	0.55	0.052	0.042
S.d./mean	0.09	0.39	0.15	0.15	0.09	0.12	0.43	0.37	0.55	0.33	0.40	0.40	0.13	0.61	0.53

Notes: Q_{LN}/Q_N is the share of low-skilled among natives. $Q_I = Q_{LI} + Q_{HI}$ is the number of immigrants in the labor force relative to the number of natives. Q_{LI}/Q_I is the share of low-skilled among immigrants. $\frac{w_{HN}}{w_{LN}}$ is the skill premium among natives. $\frac{w_{LN}}{w_{LI}}$ is the native/immigrant wage ratio for low skilled. $\frac{w_{HN}}{w_{HI}}$ is the native/immigrant wage ratio for high skilled. u_{ij} are unemployment rates for each skill level for immigrants and natives. $\frac{\bar{b}}{W(1-t)}$ denotes the average replacement rate: ratio between benefits and average wages (OECD data). In column 11, we use OECD data for net replacement rates. GDP is per capita GDP PPP for year 2011 in current international dollars (in 1000s). In column 13, B denotes total expenditures on unemployment benefits, and therefore our implied empirical measure of G denotes a public good in an inclusive sense, including all transfers and public expenses apart from unemployment insurance schemes. $\frac{rD}{GDP}$ denotes interest payment on public debt as share of GDP, on average between 2005 and 2011. $\frac{M}{GDP}$ denotes public spending on the military as share of GDP, on average between 2005 and 2011. These two measures are also included in our measure of G in column 13. For the USA, data from IPUMS 2005 Census. For Canada, data from the 2006 Census and 2005-2012 LFS (with data referring to 2011). For EU countries: Eurostat data for population shares, EU-SILC and EU-LFS for wage gaps.

Table C.2: Welfare effects for natives of a one percentage point increase in immigration

Countries	Model 1			Model 2			Model 3			Model 4			Model 5		
	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$
Australia	0.01%	0.08%	-0.13%	0.01%	0.09%	-0.12%	0.00%	0.08%	-0.13%	0.00%	0.08%	-0.13%	0.01%	0.06%	-0.08%
Austria	0.00%	0.00%	0.01%	0.08%	0.09%	0.07%	0.05%	0.05%	0.04%	0.04%	0.04%	0.04%	-0.03%	-0.03%	-0.03%
Belgium	0.00%	-0.04%	0.06%	0.09%	0.07%	0.12%	0.03%	0.01%	0.06%	0.03%	0.01%	0.07%	-0.02%	-0.03%	-0.01%
Canada	0.01%	0.09%	-0.20%	0.04%	0.11%	-0.13%	0.03%	0.10%	-0.14%	0.03%	0.10%	-0.14%	0.04%	0.08%	-0.08%
Denmark	0.01%	0.14%	-0.22%	0.09%	0.21%	-0.13%	0.05%	0.17%	-0.17%	0.07%	0.19%	-0.16%	0.06%	0.11%	-0.05%
Estonia	0.00%	0.04%	-0.06%	0.09%	0.12%	0.05%	0.07%	0.10%	0.03%	0.08%	0.11%	0.03%	0.05%	0.07%	0.02%
France	0.00%	-0.05%	0.09%	0.07%	0.04%	0.12%	0.03%	-0.01%	0.08%	0.04%	0.00%	0.10%	0.02%	0.00%	0.05%
Germany	0.00%	-0.05%	0.11%	0.07%	0.03%	0.17%	0.02%	-0.03%	0.12%	0.02%	-0.02%	0.12%	-0.01%	-0.03%	0.04%
Greece	0.01%	-0.09%	0.19%	0.15%	0.07%	0.31%	0.13%	0.05%	0.29%	0.15%	0.06%	0.31%	0.07%	0.02%	0.18%
Ireland	0.01%	0.11%	-0.13%	0.07%	0.15%	-0.04%	0.04%	0.13%	-0.07%	0.05%	0.15%	-0.08%	0.05%	0.10%	-0.03%
Italy	0.00%	-0.02%	0.10%	0.14%	0.12%	0.25%	0.13%	0.10%	0.23%	0.13%	0.11%	0.24%	0.07%	0.05%	0.14%
Luxembourg	0.00%	-0.02%	0.04%	0.03%	0.02%	0.06%	0.02%	0.00%	0.05%	0.02%	0.00%	0.05%	-0.02%	-0.03%	-0.01%
Netherlands	0.00%	-0.04%	0.06%	0.06%	0.03%	0.12%	0.03%	0.00%	0.09%	0.03%	0.00%	0.09%	-0.01%	-0.03%	0.02%
Portugal	0.00%	0.02%	-0.06%	0.08%	0.08%	0.06%	0.05%	0.06%	0.04%	0.08%	0.09%	0.04%	0.08%	0.09%	0.07%
Slovenia	0.01%	-0.11%	0.27%	0.07%	-0.04%	0.30%	0.06%	-0.05%	0.29%	0.06%	-0.05%	0.30%	0.02%	-0.04%	0.17%
Spain	0.01%	-0.09%	0.13%	0.13%	0.04%	0.25%	0.08%	-0.01%	0.19%	0.09%	0.01%	0.21%	0.04%	-0.01%	0.12%
Sweden	0.00%	0.01%	-0.02%	0.08%	0.10%	0.04%	0.02%	0.04%	-0.01%	0.02%	0.04%	-0.01%	-0.02%	-0.01%	-0.04%
Switzerland	0.00%	-0.01%	0.02%	0.02%	0.03%	0.02%	0.00%	0.01%	0.00%	-0.01%	-0.01%	-0.01%	-0.04%	-0.03%	-0.04%
UK	0.00%	-0.06%	0.07%	0.05%	-0.02%	0.12%	0.03%	-0.04%	0.11%	0.03%	-0.03%	0.11%	0.00%	-0.03%	0.05%
USA	0.00%	0.01%	-0.02%	0.04%	0.08%	0.00%	0.04%	0.08%	0.00%	0.05%	0.08%	0.01%	0.05%	0.06%	0.03%
Average	0.00%	0.00%	0.01%	0.07%	0.07%	0.08%	0.05%	0.04%	0.05%	0.05%	0.05%	0.06%	0.02%	0.02%	0.03%
Median	0.00%	-0.02%	0.03%	0.07%	0.08%	0.06%	0.04%	0.05%	0.04%	0.04%	0.04%	0.04%	0.02%	0.00%	0.02%

Notes: models are defined as in Table 5.

Table C.3: Sensitivity analysis: t fixed, g adjusts

	Autarky vs. status quo welfare effects					
What adjusts:	**Tax rate t (baseline)**			**Govt. expenditures g**		
Countries	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$
Australia	0.24%	1.26%	-1.72%	0.24%	1.28%	-1.76%
Austria	1.77%	1.74%	1.94%	1.74%	1.74%	1.74%
Belgium	1.70%	1.37%	2.30%	1.64%	1.41%	2.06%
Canada	1.19%	1.79%	-0.57%	1.17%	1.86%	-0.88%
Denmark	1.90%	2.39%	0.86%	1.82%	2.46%	0.46%
Estonia	1.47%	1.47%	1.46%	1.45%	1.51%	1.36%
France	0.77%	0.52%	1.27%	0.75%	0.53%	1.20%
Germany	0.31%	-0.07%	1.23%	0.33%	-0.08%	1.33%
Greece	2.02%	1.40%	3.51%	1.99%	1.42%	3.36%
Ireland	1.77%	2.30%	0.95%	1.71%	2.44%	0.57%
Italy	1.87%	1.64%	2.97%	1.84%	1.65%	2.77%
Luxembourg	0.72%	0.45%	1.15%	0.74%	0.37%	1.30%
Netherlands	0.48%	0.23%	0.98%	0.49%	0.22%	1.01%
Portugal	1.27%	1.23%	1.41%	1.22%	1.30%	0.95%
Slovenia	0.52%	-0.20%	2.30%	0.52%	-0.21%	2.33%
Spain	1.90%	0.96%	3.43%	1.87%	0.98%	3.31%
Sweden	0.63%	0.77%	0.34%	0.64%	0.77%	0.38%
Switzerland	-0.14%	0.04%	-0.46%	-0.13%	-0.04%	-0.28%
United Kingdom	0.35%	-0.22%	1.10%	0.36%	-0.24%	1.14%
United States	0.80%	0.97%	0.53%	0.79%	1.05%	0.37%
Average	1.08%	1.00%	1.25%	1.06%	1.02%	1.14%
Median	0.99%	1.10%	1.19%	0.98%	1.17%	1.17%

Notes: results are equivalent to those in the first three of Table 8.

Table C.4: Sensitivity analysis: average separation rates from German data

	Autarky vs. status quo welfare effects		
Countries	$\mathcal{W}_N$	$\mathcal{W}_{LN}$	$\mathcal{W}_{HN}$
Australia	0.24%	1.26%	-1.72%
Austria	1.77%	1.74%	1.92%
Belgium	1.71%	1.38%	2.30%
Canada	1.20%	1.79%	-0.57%
Denmark	1.91%	2.40%	0.86%
Estonia	1.47%	1.48%	1.45%
France	0.77%	0.52%	1.27%
Germany	0.31%	-0.06%	1.22%
Greece	2.03%	1.41%	3.51%
Ireland	1.79%	2.32%	0.96%
Italy	1.87%	1.64%	2.97%
Luxembourg	0.73%	0.45%	1.14%
Netherlands	0.48%	0.24%	0.97%
Portugal	1.30%	1.26%	1.44%
Slovenia	0.52%	-0.20%	2.30%
Spain	1.91%	0.97%	3.43%
Sweden	0.63%	0.78%	0.33%
Switzerland	-0.14%	0.04%	-0.46%
United Kingdom	0.36%	-0.21%	1.10%
United States	0.79%	0.96%	0.53%
Average	1.08%	1.01%	1.25%
Median	1.00%	1.11%	1.18%

Notes: results are equivalent to those in the first three columns of Table 8, with average separation rates from SIAB microdata for Germany.

Table C.5: Sensitivity analysis: effects of one p.p. increase in migration when unemployment has non-monetary utility costs for natives

	All Natives					**Low Skilled Natives**					**High Skilled Natives**				
h_N	0	-0.02	0.02	-0.05	0.05	0	-0.02	0.02	-0.05	0.05	0	-0.02	0.02	-0.05	0.05
Australia	0.012%	0.012%	0.012%	0.011%	0.013%	0.059%	0.059%	0.059%	0.058%	0.060%	-0.079%	-0.080%	-0.078%	-0.081%	-0.077%
Austria	-0.030%	-0.030%	-0.030%	-0.029%	-0.030%	-0.028%	-0.028%	-0.029%	-0.028%	-0.029%	-0.034%	-0.036%	-0.033%	-0.037%	-0.032%
Belgium	-0.024%	-0.027%	-0.021%	-0.031%	-0.016%	-0.034%	-0.036%	-0.032%	-0.038%	-0.030%	-0.005%	-0.011%	0.000%	-0.018%	0.010%
Canada	0.036%	0.036%	0.037%	0.036%	0.037%	0.075%	0.075%	0.075%	0.075%	0.076%	-0.079%	-0.079%	-0.079%	-0.079%	-0.078%
Denmark	0.057%	0.054%	0.061%	0.050%	0.066%	0.108%	0.106%	0.111%	0.103%	0.115%	-0.052%	-0.056%	-0.047%	-0.062%	-0.038%
Estonia	0.049%	0.048%	0.050%	0.046%	0.053%	0.066%	0.065%	0.067%	0.064%	0.068%	0.019%	0.017%	0.021%	0.015%	0.026%
France	0.015%	0.010%	0.021%	0.003%	0.031%	-0.003%	-0.007%	0.001%	-0.012%	0.008%	0.053%	0.045%	0.062%	0.034%	0.079%
Germany	-0.012%	-0.015%	-0.009%	-0.019%	-0.004%	-0.035%	-0.037%	-0.032%	-0.041%	-0.028%	0.043%	0.040%	0.048%	0.035%	0.055%
Greece	0.068%	0.067%	0.070%	0.064%	0.074%	0.023%	0.022%	0.024%	0.021%	0.024%	0.178%	0.173%	0.183%	0.167%	0.193%
Ireland	0.047%	0.045%	0.049%	0.042%	0.054%	0.098%	0.096%	0.100%	0.094%	0.103%	-0.033%	-0.035%	-0.029%	-0.039%	-0.023%
Italy	0.067%	0.066%	0.067%	0.065%	0.069%	0.052%	0.052%	0.053%	0.051%	0.053%	0.135%	0.133%	0.138%	0.130%	0.142%
Luxembourg	-0.024%	-0.024%	-0.024%	-0.024%	-0.024%	-0.034%	-0.034%	-0.034%	-0.033%	-0.034%	-0.008%	-0.008%	-0.008%	-0.009%	-0.008%
Netherlands	-0.010%	-0.011%	-0.009%	-0.012%	-0.008%	-0.025%	-0.026%	-0.024%	-0.027%	-0.023%	0.020%	0.018%	0.021%	0.016%	0.024%
Portugal	0.083%	0.076%	0.091%	0.068%	0.108%	0.085%	0.079%	0.093%	0.072%	0.107%	0.073%	0.064%	0.085%	0.054%	0.113%
Slovenia	0.020%	0.018%	0.021%	0.016%	0.023%	-0.040%	-0.041%	-0.039%	-0.042%	-0.037%	0.167%	0.165%	0.170%	0.161%	0.175%
Spain	0.040%	0.037%	0.044%	0.033%	0.050%	-0.010%	-0.012%	-0.007%	-0.016%	-0.004%	0.121%	0.116%	0.127%	0.110%	0.136%
Sweden	-0.017%	-0.018%	-0.015%	-0.021%	-0.011%	-0.006%	-0.008%	-0.005%	-0.010%	-0.003%	-0.037%	-0.040%	-0.034%	-0.044%	-0.029%
Switzerland	-0.036%	-0.035%	-0.036%	-0.035%	-0.037%	-0.034%	-0.033%	-0.035%	-0.033%	-0.036%	-0.038%	-0.038%	-0.038%	-0.038%	-0.038%
UK	0.005%	0.004%	0.006%	0.002%	0.007%	-0.029%	-0.030%	-0.028%	-0.032%	-0.026%	0.049%	0.048%	0.049%	0.047%	0.051%
USA	0.045%	0.045%	0.046%	0.044%	0.046%	0.057%	0.058%	0.057%	0.059%	0.056%	0.027%	0.025%	0.029%	0.023%	0.032%
Average	0.020%	0.018%	0.022%	0.015%	0.025%	0.017%	0.016%	0.019%	0.014%	0.021%	0.026%	0.023%	0.029%	0.019%	0.036%
Median	0.017%	0.015%	0.021%	0.014%	0.027%	-0.005%	-0.007%	-0.002%	-0.011%	0.003%	0.019%	0.018%	0.021%	0.016%	0.025%

Notes: in all exercises, $h_{LN} = h_{HN}$, so we simply denote them by h_N. A negative value of h_N means that we are introducing a utility, since h_N enters the value of being unemployed positively. The values of 0.02 and 0.05 are around 10 and 25 percent of average unemployment benefits received by natives in our 20 countries, respectively.

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Online Appendix for "Immigration, Search, and Redistribution: A Quantitative Assessment of Native Welfare"

Michele Battisti, Gabriel Felbermayr, Giovanni Peri and Panu Poutvaara

A Notes on equilibrium existence and uniqueness

Below, we present some additional analysis regarding existence and uniqueness of equilibrium in our model. As noted in the paper, the absence of closed form solutions of the model make it impossible to come up with precise necessary and sufficient conditions. However, it is possible to gain a good qualitative understanding of the model mechanics by a closer discussion of the equilibrium conditions. More precisely, we briefly discuss sufficient conditions for existence by separately analyzing the job creation curve and the wage curve of our model. Showing the conditions for existence (i.e. that these two curves intersect) is easier than discussing the conditions for uniqueness (only one such intersection), as we mention below. We then briefly discuss a simple exercise that we believe is reassuring concerning uniqueness. Summarizing, as long as we are in parameter constellations (including the level of public goods provision G) that permit a strictly positive surplus of matches, both existence and uniqueness appear unproblematic.

A.1 Base case: p_i, ϕ_{ij}, t treated as parameters

Job Creation Curve (JC-Curve). We start with the case where p_i is exogenous and where $d\phi_{ij}/d\theta_i = 0$ (which is the case when $s_{iI} = s_{iN}$). Then, the JC curve is given by

$$\sum\nolimits_j \phi_{ij} \frac{\pi_{ij} p_i - w_{ij}}{r + s_{ij}} = \frac{c_i}{q(\theta_i)}.$$

Clearly, for this equality to hold we need that the left-hand-side is non-negative. A sufficient but clearly not necessary condition for the left-hand side to be non-negative is $\pi_{ij} p_i > w_{ij}$ for all j. We define

$$W_i = \sum\nolimits_j \frac{\phi_{ij}}{r + s_{ij}} w_{ij}, \Pi_i = \sum\nolimits_j \frac{\phi_{ij}}{r + s_{ij}} \pi_{ij} p_i$$

so that the JC-curve can be simply written as

$$W_i = \Pi_i - \frac{c_i}{q(\theta_i)}.$$

Clearly, as $\theta_i \to 0$, we have that $c_i/q(\theta_i)$ goes to zero as the job fill rate $q(\theta_i) = \xi\theta^{-\varepsilon}$ diverges to infinity. Hence, the intercept of the JC curve is Π_i. As $\theta_i \to \infty$, $c_i/q(\theta_i)$ diverges to infinity, and W_i would have to tend to $-\infty$.

Wage Curve. The wage curve for a specific labor market cell is given by

$$w_{ij}(t, p_i, \theta_i) = \frac{\beta \pi_{ij} p_i [r + s_{ij} + m(\theta_i)] + (1 - \beta)(b_{ij} + h_{ij})(r + s_{ij})}{(r + s_{ij})[1 - t(1 - \beta)] + \beta m(\theta_i)}.$$

As defined above

$$W_i = \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} w_{ij}.$$

Treating t and p_i as parameters, we have $w_{ij}(t, p_i, 0) = \frac{\beta\pi_{ij}p_i + (1-\beta)(b_{ij}+h_{ij})}{1-t(1-\beta)}$ since $\lim_{\theta_i \to 0} m(\theta_i) = 0$, and $\lim_{\theta_i \to \infty} w_{ij}(\theta_i) = \frac{\beta\pi_{ij}p_i m'(\theta_i)}{\beta m'(\theta_i)} = \pi_{ij}p_i$ by the rule of de l'Hopital. Hence, $\lim_{\theta_i \to 0} W_i = \sum_j \frac{\phi_{ij}}{r+s_{ij}} \frac{\beta\pi_{ij}p_i + (1-\beta)(b_{ij}+h_{ij})}{1-t(1-\beta)} = \Xi_i$ and $\lim_{\theta_i \to \infty} W_i = \sum_j \frac{\phi_{ij}}{r+s_{ij}} \pi_{ij}p_i = \Pi_i$. To pin down the slope, we look at cell-specific wages. To simplify notation, let $k_{ij} \equiv (1-\beta)(b_{ij}+h_{ij}) r_{ij}$ and $r_{ij} = r + s_{ij}$. Below, we define $m_i \equiv m(\theta_i)$ for simplicity.

$$\begin{aligned}
\frac{\partial w_{ij}}{\partial \theta_i} &= \frac{\beta\pi_{ij}p_i m_i' (r_{ij}[1-t(1-\beta)] + bm_i) - \beta m_i' (\beta\pi_{ij}p_i [r_{ij}+m_i] + k_{ij})}{(r_{ij}[1-t(1-\beta)] + \beta m_i)^2} \\
&= \frac{\beta m_i'}{(r_{ij}[1-t(1-\beta)] + bm_i)^2} \{\pi_{ij}p_i (r_{ij}[1-t(1-\beta)] + \beta m_i) - \beta\pi_{ij}p_i [r_{ij}+m_i] - k_{ij}\} \\
&= \frac{\beta m_i'}{(r_{ij}[1-t(1-\beta)] + bm_i)^2} \{\pi_{ij}p_i r_{ij} - \pi_{ij}p_i r_{ij} t(1-\beta) - \beta\pi_{ij}p_i r_{ij} - k_{ij}\} \\
&= \frac{(1-\beta)\beta m_i' r_{ij}}{(r_{ij}[1-t(1-\beta)] + bm_i)^2} \{\pi_{ij}p_i (1-t) - (b_{ij}+h_{ij})\}.
\end{aligned}$$

Using this in the definition of W_i, we have

$$\begin{aligned}
\frac{\partial W_i}{\partial \theta_i} &= \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \frac{\partial w_{ij}}{\partial \theta_i} \\
&= \sum\nolimits_j \phi_{ij} \frac{(1-\beta)\beta m_i' r_{ij}}{(r_{ij}[1-t(1-\beta)] + bm_i)^2} \{\pi_{ij}p_i (1-t) - (b_{ij}+h_{ij})\}.
\end{aligned}$$

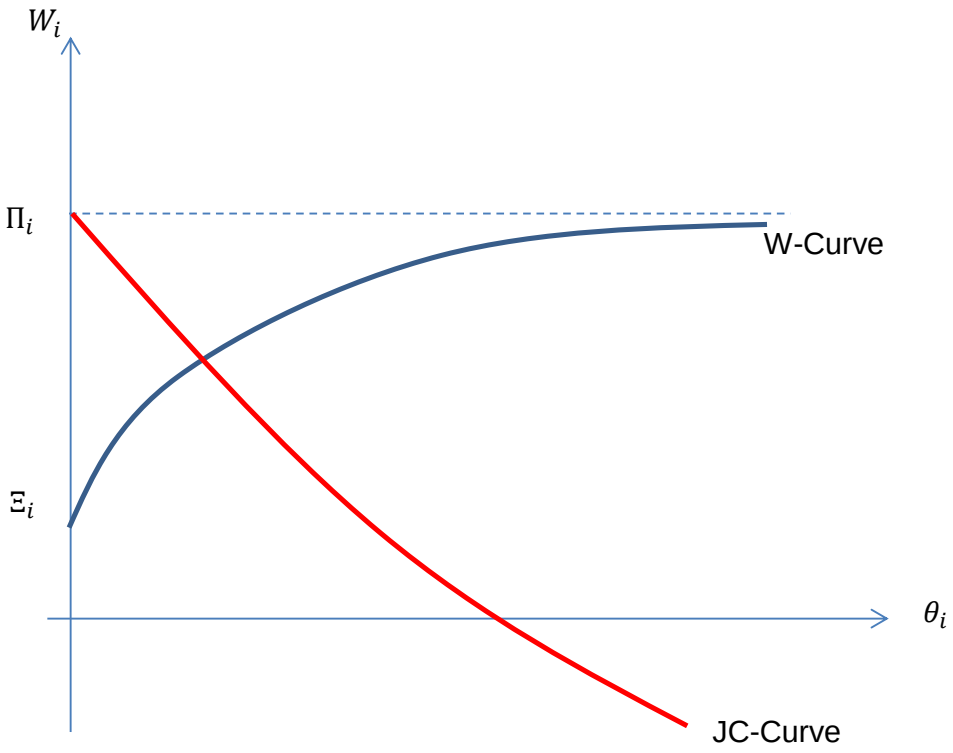
Therefore, since $m_i' > 0$ the sufficient condition $\pi_{ij}p_i(1-t) - (b_{ij}+h_{ij}) > 0$ makes sure that $\frac{\partial W_i}{\partial \theta_i} > 0$.

Existence and uniqueness with p_i, ϕ_{ij}, t treated as parameters. To ensure the existence of a unique equilibrium, we require $\Pi_i > \Xi_i$.

$$\begin{aligned}
\sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \pi_{ij}p_i &> \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \frac{\beta\pi_{ij}p_i + (1-\beta)(b_{ij}+h_{ij})}{1-t(1-\beta)} \\
\sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \pi_{ij}p_i &> \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \frac{\beta\pi_{ij}p_i}{1-t(1-\beta)} + \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \frac{(1-\beta)(b_{ij}+h_{ij})}{1-t(1-\beta)} \\
\sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \pi_{ij}p_i - t(1-\beta) \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \pi_{ij}p_i &> \beta \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} \pi_{ij}p_i + (1-\beta) \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} (b_{ij}+h_{ij}) \\
\sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} (1-t) \pi_{ij}p_i &> \sum\nolimits_j \frac{\phi_{ij}}{r+s_{ij}} (b_{ij}+h_{ij}).
\end{aligned}$$

Hence, a sufficient condition for existence and uniqueness is that $\pi_{ij}p_i(1-t) - (b_{ij}+h_{ij}) > 0$ for all i, j : The downward-sloping $JC-$curve and the upward-sloping $W-$curve pin down the equilibrium values for θ_i and W_i. Knowing θ_i, one can use the cell-specific wage curves to find w_{ij}.

Figure A.1: Equilibrium with parametric goods prices and taxes



A.2 General case: p_i and t treated as endogenous

We now take account of the fact that p_i and t depend on θ_i. JC-curve does not depend on the tax rate, as it is defined in terms of gross wage rate. As higher labor market tightness in a given labor market segment is associated with larger output of the intermediate good it produces, accounting for the endogeneity of p_i should make the JC-curve slope downwards even more strongly. As for the wage curve, we have

$$\frac{dW_i(\theta_i, p_i(\theta_i), t(\theta_i))}{d\theta_i} = \frac{\partial W_i(\theta_i, p_i(\theta_i), t(\theta_i))}{\partial \theta_i} + \frac{\partial W_i(\theta_i, p_i(\theta_i), t(\theta_i))}{\partial p_i}\frac{dp_i}{d\theta_i} + \frac{\partial W_i(\theta_i, p_i(\theta_i), t(\theta_i))}{\partial t}\frac{dt}{d\theta_i}.$$

If $JC-$curve is downward-sloping and $W-$curve upward-sloping, then the equilibrium is unique provided that it exists; in all search models, an equilibrium with positive employment exists only if search costs and unemployment benefits are not prohibitively high. In our model, unemployment benefits do not pose a problem as they are linked to net wages through replacement rate. The first term on the right-hand side is positive, just as in the baseline case above. Therefore, any equilibrium is unique as long as the direct effect from the first term is not cancelled by the indirect effect from the two latter terms. Although we have not been able to prove generally that wage curve would be always upward-sloping, the whole matching literature has a strong focus on upward-sloping wage curves. Pissarides (2000) only discusses the case of upward-sloping wage curve, noting that in a standard search model the wage curve slopes up since "at higher market tightness the relative bargaining strength of market participants shifts in favor of workers" (p. 19). An upward-sloping $W-$curve is a sufficient but not a necessary condition for an equilibrium to exist. Even if $W-$curve were downward-sloping, an equilibrium would still exist, if the $JC-$curve declined more steeply.

A.3 Uniqueness: a quantitative exercise

An alternative way to investigate whether, for parameter values that are relatively similar to those of the 20 countries we analyze, numerical simulations suggests that multiplicity of equilibria may be of concern. We experiment with extreme admissible values of endogenous variables as starting points and see whether the system always converges to the same equilibrium. In particular, we tested whether different extreme choices of initial values of endogenous variables (the tightness variables and the tax rate) always lead to the same equilibrium. For 1,000 vastly different economies (which are calibrated to replicate the moments drawn from a distribution with restrictions based on logic, such as requiring unemployment rates to be non-negative, like in Section 4.2.5), for each of the three endogenous variables we let initial values be (very) high or low; this gives 2^3 possibilities. In none of the 8,000 runs does the system converge to a different equilibrium. Instead, in every single case it converges to the same equilibrium. For this reason, we are confident that the system admits a unique equilibrium, and that this not only holds for a special configuration of parameters but more generally.

One could also be worried about existence and uniqueness of our calibration algorithm. We choose 11 exogenous model parameters such that we match a set of empirical moments. To make sure that this approach makes sense, we set each of the 11 parameters of Table 4 to either the lower bound or the upper bound within their feasible range. We then generate a matrix (with $2^{11} = 2,048$ rows and 11 columns) where each row is one of the possible combinations of elements from the 'low end' and the 'high end' 11-element vector of parameters. We then let find a solution of our system for each of these combinations of parameters, and for each of the 20 countries of our study. We find that the system converges to the very same solution in each of the 20 countries irrespective of which of the 2,048 different vectors of initial values of parameters we use.

B Re-migration

In our baseline model, re-migration does not enter our Bellman equations as a separate state. This means that we are implicitly assuming that the value of such event is the same as that of unemployment in the host country. In the case of international migration, this appears to be a strong assumption. Below, we analyze a case in which there is a certain chance that immigrants return home (or move to a third country), and the value associated with that move is allowed to be different from the value of unemployment in the host country. In particular, we look at the effects of including a return state that can materialise with the same probability whether immigrants are employed or unemployed. In the analysis below, we focus on immigrants only, and therefore drop the j subscript for simplicity. Below, we show that the value of re-migration plays no role, and therefore that our baseline assumption is not restrictive.

If re-migration may be associated with a different value compared to unemployment in the host country[54] the value of unemployment can be written as

$$rJ_i^U = g + rk_i + b_i + h_i + m(\theta_i)[J_i^E - J_i^U] - \psi(J_i^U - J^R). \tag{B.1}$$

Correspondigly, the value of employment is

$$rJ_i^E = g + rk_i + (1-t)w_i - \bar{s}_i[J_i^E - J_i^U] - \psi(J_i^E - J^R), \tag{B.2}$$

where J^R denotes the value associated with re-migration. In our baseline analysis, since our data on return migration are not reliable, we decided to abstract from that to offer more conservative estimates by assuming that $J_i^U - J^R = 0$. We instead decided to let wag gaps simply discipline h_{ij}. The value of a filled vacancy for the firm, incorporating the free-entry condition dictating that $J^V = 0$ is

$$rJ_i^F = \pi_i p_i - w_i - \bar{s}_i J_i^F - \psi J_i^F \tag{B.3}$$

and therefore

$$J_i^F = \frac{\pi_i p_i - w_i}{r + \bar{s} + \psi}, \tag{B.4}$$

which does not directly depend on the value that immigrants get when they (exogenously) re-migrate.[55] The Nash bargaining equation, written under the free-entry equilibrium condition $J_i^V = 0$ can be written as

$$(1-\beta)(J_i^E - J_i^U) = \beta J_i^F. \tag{B.5}$$

This clarifies that the Nash bargaining outcome depends (only) on the difference between the value of employment and that of unemployment. Using Equations (B.1) and (B.2) above

$$r(J_i^E - J_i^U) = g + rk_i + (1-t)w_i - \bar{s}_i(J_i^E - J_i^U) - \psi(J_i^E - J^R) - g - rk_i - b_i - h_i - m(\theta)(J_i^E - J_i^U) + \psi(J_i^U - J^R) \tag{B.6}$$

which simplifies to

$$J_i^E - J_i^U = \frac{(1-t)w_i - b_i - h_i}{r + \bar{s}_i + \psi + m(\theta)}. \tag{B.7}$$

Equation (B.7) is unaffected by the level of J^R. Since the possibility of re-migration is assumed to happen at the same rate for employed and unemployed individuals, it does not play any role here. Separation rates $\bar{s}_i$ and ψ do play a role, but only their sum s_i matters.

[54] By revealed preferences, we expect that value to be lower, but do not need to make that assumption below.
[55] The dependence may come through other endogenous variables, however.

It is also possible to derive wage rates directly. In this case as well, J^R cancels out from the equation, such that the wage rate for group i can be written as:

$$w_i = \frac{\beta\pi_i p_i(r + \bar{s}_i + \psi + m(\theta)) + (1-\beta)(b_i + h_i)(r + \bar{s}_i + \psi)}{(r + \bar{s}_i + \psi)\left[1 - t\left(1-\beta\right)\right] + \beta m\left(\theta_i\right)}. \tag{B.8}$$

Again, the value associated with re-migration plays no role. The probability of re-migration matters for wages, since it is part of separation rates. From equation (B.8) above we can calculate how wages depend on re-migration probabilities

$$\frac{\partial w_i}{\partial \psi} = \frac{m(\theta)\beta(1-\beta)(b_i + h_i - \pi_i p_i)}{\left\{(r + \bar{s}_i + \psi)\left[1 - t\left(1-\beta\right)\right] + \beta m\left(\theta_i\right)\right\}^2}. \tag{B.9}$$

A non-negative match surplus is a sufficient condition for the expression above to be negative, since prices need to be strictly larger than unemployment benefits in that case. This is the very same derivative as that with respect to $\bar{s}_i$ showing once again that the possibility of re-migration behaves in the very same way as a separation rate, and the value obtained after return migration is immaterial. This means that the fact that we simply assume it to be the same as the value of unemployment in the host country is not a knife-edge assumption but rather a notational simplification that does not affect the generality of our setup.[56]

On the other hand, the important assumption is that the stock of unemployed immigrants is unaffected by ψ. We believe, however, that this is a natural assumption given that ours is a steady-state analysis, in which we observe net migration flows (changed in migration stocks over time) rather than gross flows. In other words, since we use unemployment rates of immigrants in the data, it is natural to assume that those are the results of some immigrants leaving the country and others joining the pool of the unemployed.

[56] This is true under the assumptions of our model. In particular, relaxing the assumptions of additive linear utility, risk aversion would affect this. Working in finite, discrete time would also affect this.