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ARTICLE

Immigration, skill acquisition, and fiscal redistribution in a search equilibrium model

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Abstract

As recent immigration flows are reshaping the host countries workforce composition, this paper aims to assess whether age composition and skill adjustment dynamics play a relevant role in the welfare impact of immigration. To this end, we build and simulate a search and matching model that allows for endogenous natives' skill acquisition and intergenerational transfers to analyze the welfare effects of immigration on a selected group of 19 OECD countries. The obtained results are then compared with those obtained under different assumptions on age composition and skill adjustment dynamics. Our comparative statics analysis shows that stronger job creation effects take place when natives adjust their skill in response to immigration. Moreover, taking into account age composition plays a key role in assessing the fiscal impact of immigration, which turns out to be positive when we include intergenerational transfers to retirees and immigration is high-skilled. Finally, we find that our model yields more optimistic welfare effects than standard search models that abstract from skill decision and intergenerational redistribution.

Keywords: Immigration; welfare; unemployment; skill acquisition; fiscal redistribution

1. Introduction

Over the past decades, several developed countries have begun to rise concerns over the continuous growth of international migration flows. Despite the academic literature has so far found limited effects of immigration on native citizens welfare, international migration is now at the heart of public debates and selective migration policies are proliferating worldwide in order to protect national employment and welfare.

Between 2000 and 2017, the increase in the foreign-born population accounted for almost three-quarters of the total population increase in EU/EFTA countries, and for more than one-third of the increase in the USA.[1] Such demographic changes are reshaping the host countries workforce composition and underline the importance of taking into account intergenerational aspects concerning young and older individuals when assessing for the effects of migration on the host countries. Indeed, as migration flows keep changing the host country labor force composition, younger natives may respond to immigration by upgrading their skills and specializing in different production tasks in the long run. Further, another interesting aspect which is often debated, but rarely taken into account when evaluating the immigration surplus, is that most developed countries are aging, while migration flows are usually characterized by young workers looking for new job opportunities. Given that intergenerational transfers in high-income countries are large, immigrant workers could play a considerable role in alleviating the fiscal burden that aging populations will face in the next decades.

As the stylized facts, described in Section 2, show that immigrants face higher unemployment rate, are on average younger, and are often characterized by different skill levels than natives, this paper aims to contribute to the limited but growing literature regarding the impact of immigration through search and matching models by introducing two major features that characterize the long-run equilibrium. First, we allow young natives that enter the labor market to endogenously adjust their skill in face of migration so that the skill composition of the migration flows affects natives education decisions in the long run. Second, we distinguish between young and retired workers, who receive different public transfers according to their age, skill, and origin. This feature allows us to better assess the fiscal impact of migration, as natives and immigrants are characterized by different shares of retirees and social welfare usage. It is also worth to point out that the choice of a search and matching model is instrumental for addressing these two key aspects. Indeed, natives' skill adjustment may play a relevant role in mitigating the unemployment risks deriving from a fiercer competition in the labor market. Moreover, the government spending on unemployment benefits is a relevant component of a country's fiscal balance, implying that differences in workers' unemployment risks affect the redistributive effect of immigration. To the best of our knowledge, no previous paper has developed a theoretical model able to analyze long-run effects of migration on native welfare by taking into account unemployment issues, endogenous skill acquirement, and fiscal redistribution among different generations.[2]

Focusing on a selected group of 19 Organization for Economic Cooperation and Development (OECD) countries, we calibrate and simulate the search model under 3 different scenarios: (a) an increase in low-skilled migration equal to 1% of the total labor force; (b) an increase of the same size of high-skilled migration; and (c) an increase of the same size of immigrants, keeping their skill composition constant. The obtained results are then compared to the cases in which the natives skill is exogenous and/or the retired population is not taken into account. Our quantitative analysis generates the following main results. First, we find that when skill acquisition is endogenous, skill-biased immigration generates stronger job creation effects in the sector that is not directly affected by the arrival of new immigrants. Second, taking into account the age composition of the population plays a key role in determining the fiscal impact of immigration. In particular, our simulations show that the fiscal impact of high-skilled immigration is positive for the aggregate group of the selected countries when we distinguish between active and retired workers in the economy. Conversely, when abstracting from retired individuals, the fiscal impact of immigration is found to be more pessimistic as well as negative for all of the three analyzed scenarios. Third, in almost all of the considered countries, incorporating endogenous natives skill acquisition and age composition yields more optimistic welfare results than a standard search model that neglects both of these features. In particular, under our model, we find that skill-balanced and high-skilled migration shocks increase the average native welfare on most countries, while low-skilled immigration is found to be beneficial to native welfare on 7 out of the 19 considered OECD countries.

This study is related to at least three strands of literature. First, it is related to the stream of literature that focuses on the effect of migration on the natives skill composition and specialization. While most of this literature is empirical and finds mixed results on the effects on natives high school completion rate [see, e.g., Betts (1998) and Hunt (2012)], a number of papers have recently focused on the immigration effects on natives task specialization. These latter studies include Peri and Sparber (2009, 2011) and D'Amuri and Peri (2014) who, by analyzing whether native workers move to more complex jobs as a consequence of immigration, find that natives may respond to immigration by changing their specialization. Cattaneo et al. (2013) find that native Europeans are more likely to upgrade to more skilled and better paid occupations when a larger number of immigrants enter their labor market. McHenry (2015) finds that low-skilled immigration induces natives to improve their performance in school, attain more years of schooling, and take jobs that involve communication-intensive tasks, potentially mitigating the negative effects of immigration on the labor market. Llull (2018) builds and estimates a labor market equilibrium dynamic model on USA and finds heterogeneous reactions to immigration, as some natives decide to switch to white-collar careers and increase education, whereas others reduce labor market attachment as well as their education. Similarly, Brunello et al. (2020) show that immigration in Italy has

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increased both the probability that young native high school graduates attain higher education and the probability that young natives with less than high school education stay out of further education or training.

Second, this paper is related to the recent stream of the migration literature that analyzes the impacts of immigration through a framework that allows for labor market search frictions. This literature includes Ortega (2000), Liu (2010), Chassamboulli and Palivos (2013, 2014), Chassamboulli and Peri (2015), Liu et al. (2017), Battisti et al. (2018), and Ikhenaode and Parello (2020). In particular, our paper is closely related to Battisti et al. (2018), who employ a setup with search and matching frictions in order to assess the welfare effects of immigration on 20 OECD countries. Their quantitative analysis suggests that immigration attenuates the effects of search frictions by boosting firms' profits and generating a job creation effect which, in turn, offsets the welfare costs of fiscal redistribution. However, as pointed out by these authors, their analysis abstracts from intergenerational transfers and population aging so that the fiscal effect of migration could differently impact the government balance and welfare. Moreover, they assume that all workers' skill level is exogenous so that their analysis does not allow natives to update their skill in response of skill-biased migration shocks.

Last, our paper also relates to that strand of the migration literature that focuses on the fiscal effects of immigration. Storesletten (2000, 2003) finds that new immigrants represent, on average, a positive gain for the fiscal balances of USA and Sweden. Dustmann and Frattini (2014) find a noticeable positive fiscal contribution from recent immigrants, especially those originating from European Economic Area countries. However, aside from Battisti et al. (2018), this literature mainly focuses on accounting approaches that involve in computing the net fiscal contribution of different population groups in greater detail, while usually abstracting from labor market interactions between migrant and native workers and the equilibrium responses of the economy.[3]

The remainder of this paper is organized as follows. Section 2 provides stylized facts on labor market characteristics and population composition of the 19 analyzed OECD countries. Section 3 introduces the benchmark version of the model and characterizes the search equilibrium. Section 4 describes the calibration procedure used to simulate the model and discusses the results. Finally, Section 5 offers some concluding remarks.

2. Stylized facts

In OECD countries, 127 million people were foreign-born in 2017, which represents an average of 13% of the total population compared with 9.5% in 2000.[4] To provide some key stylized facts, as well as to perform our simulation exercises later in the paper, we use the Database on Immigrants in OECD countries (DIOC) for the census round 2010 described by Arslan et al. (2014), which allows us to account for differences in demographic characteristics, level of education, and labor market status of the population of the 19 selected OECD countries. This database is a compilation of original data on migrant stocks from a large number of destination countries which provides detailed information on the country of origin, demographic characteristics, level of education, and labor market outcomes of the population of OECD member states. For the purpose of the analysis undertaken in the paper, we extract information about the country of origin (native- or foreign-born), age (25–64 or 65 years and over), educational attainment (college graduates or less educated), and labor market status (employed, unemployed, or inactive) of the individuals residing in each of the considered OECD countries (the 15 members of the European Union, Australia, Canada, Switzerland, and USA).

Figure 1 below shows age composition, labor market status, education level, and labor income of immigrant and native residents in the analyzed countries. Each of the presented stylized facts serves the purpose of underlining relevant differences between immigrants and natives in the demographics and labor market characteristics of the considered OECD countries. In turn, these

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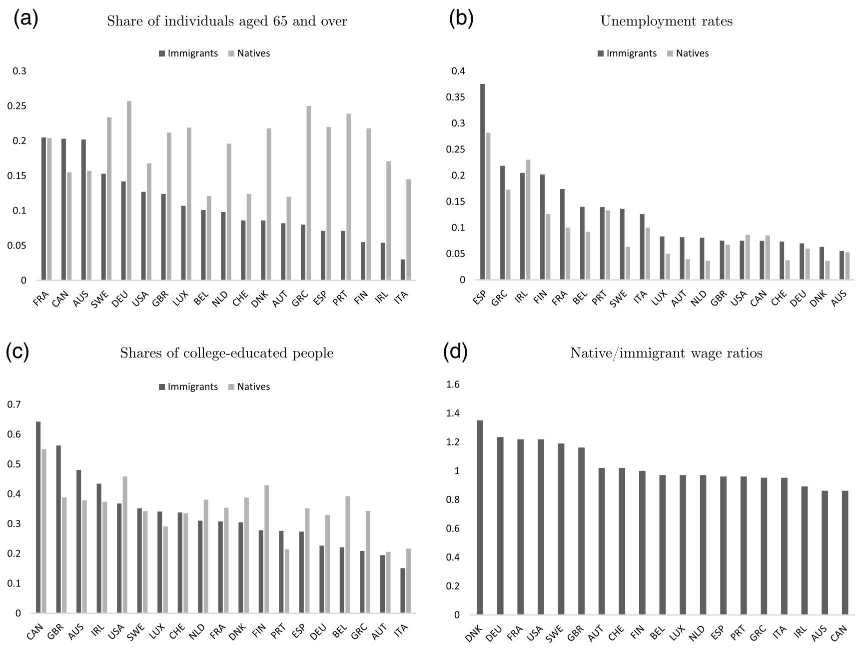

Figure 1. Labor market and population characteristics across countries.
Note: Figure 1 shows population characteristics for the 19 selected countries—reference year 2010.

differences rise questions related to the fiscal, labor market, and welfare effects of immigration and provide motivations for our model to take into account a number of key aspects.

Figure 1(a) compares the share of elderly natives (aged 65 years and over) in total native population with the share of elderly immigrants over the total immigrant population in each country. Coherently with the empirical evidence that immigrant flows are characterized by younger individuals [OECD (2014)], the average share of older natives in the considered 19 countries is almost twice as large as the share of older immigrants (19.1% for natives vs. 10.9% for immigrants). Countries with a long history of immigration flows, such as Canada and Australia, tend to have a narrower (and/or even negative) gap between the elderly shares of natives and immigrants. Conversely, in countries where immigration is a relatively new phenomenon, such as Italy and Spain, the difference in the two shares is quite large (e.g., in Italy the share of older natives is almost five times as large as the share of older immigrants). This represents a relevant aspect to underline, because the dependency ratio plays a key role in the fiscal effect of immigration which, in turn, affects natives' welfare.

Figure 1(b) shows that, on average, immigrants suffer from a higher unemployment rate (12.9% for immigrants vs. 9.7% for natives). In particular, 16 out of 19 countries (all but Ireland, USA, and Canada) are characterized by a higher unemployment rate for immigrant workers, though the correlation between immigrant and native unemployment is extremely high (91.3%). It is noteworthy that in some countries, the difference in unemployment rates is quite substantial. In Spain, immigrant workers face an unemployment rate almost 10% points higher than natives, while in Austria, Netherlands, and Sweden the migrant unemployment rate is more than twice as high as the native one. These figures are in line with the hypothesis that native workers may be able to avoid fiercer competition and face lower unemployment risks by upgrading their skill as a response to new immigrant workers in the labor market.

As far as skill composition is concerned, Figure 1(c) illustrates the share of immigrant and native workers with at least 1 year of college education or a bachelor's degree (ISCED 5). Despite the correlation between native- and foreign-born is high (65.7%) and, on average, immigrants and natives have a similar share of college-educated workers (33% for immigrants and 35.4% for natives), some countries still present a sharp difference in skill composition between the immigrant and native workers—particularly in Belgium, where the share of college-educated natives is almost twice as high as that of college-educated immigrants. These figures place further emphasis on the skill composition aspect and it shows that, even though the aggregate group of countries is characterized by a similar share of college-educated workers for immigrants and natives, the share of college-educated natives is much higher than that of college-educated immigrants in most European countries. This implies that immigration flows are far from skill-balanced for most countries and that, for this reason, new immigrants may indeed induce natives to upgrade their skill to mitigate the competition in the labor market.

Finally, statistics on native/immigrant wage ratios are obtained from Docquier et al. (2014) and shown in Figure 1(d).[5] The average native/immigrant wage ratio in the 19 considered countries is 1.04, implying the presence of a slight native wage premium. Multiple determinants may influence the native wage premium, such as imperfect transferability of human capital [Poutvaara (2008)], discrimination [Bartolucci (2014)], different outside options [Chassamboulli and Palivos (2014) and Battisti et al. (2018)], or imperfect substituability in production [Manacorda et al. (2012) and Ottaviano and Peri (2012)]. In Section 3, we follow Ottaviano and Peri (2012) and use a standard nested Constant Elasticity of Substitution (CES) production function, thus interpreting this stylized fact as a result of imperfect substituability in production between immigrant and native workers.[6]

Before moving to the next section, it is interesting to point out that some puzzling aspects emerge by computing the correlations between some of the key indicators described in the stylized facts. First, the correlation between the unemployment rate of natives and the share of college-educated immigrants is negative, but rather close to zero (i.e., equal to −9.4%). This is at odds with the empirical findings that high-skilled migration raises native employment and reduces job destruction [see, e.g., Battisti et al. (2018) and Orrenius et al. (2020)]. Second, the correlation between the unemployment rate of natives and the share of immigrants aged 65 years and over turns out to be negative (−36.5%), which contradicts the economic intuition that the labor market outcomes of native workers improve when immigrants are younger, rather than older. Third, there is a negative correlation (−34.1%) between immigrant workers, as a share of total active population, and the native/immigrant wage ratio. This is also at odds with the literature, as migration is found to primarily reduce the wage of immigrant workers, with little to no effect on the wages of native workers [see, e.g., Manacorda et al. (2012), Ottaviano and Peri (2012), D'Amuri and Peri (2014), and Dustmann and Frattini (2014)]. Nonetheless, these correlations can hardly be used as a meaningful inference tool in this instance. Indeed, unemployment rates and wage rates across the different considered countries are influenced by a multitude of factors, including differences in the labor market structures and redistributive institutions. Because it is crucial to take into account the interplay between the different economic channels that take place in the economy, in the next section, we develop a theoretical model able to analyze the complex interaction among unemployment issues, wage setting dynamics, skill upgrade decision, and intergenerational fiscal redistribution. The model described in the next section will then be calibrated to match all of the described stylized facts as closely as possible and to shed some light on the different mechanisms at play in the considered economies.

3. The model

Consider a small open economy populated by a continuum of risk-neutral agents, who discount the future at a constant rate $r > 0$ and are heterogeneous under three respects. First, agents differ in their origin country so that they can either be native- or foeign-born individuals who immigrated in the domestic economy. Second, agents are characterized by different education

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attainments. Following the bulk of the literature that identifies education-based skills [e.g., Card (2009), Docquier et al. (2014), and Battisti et al. (2018)], throughout the paper we will refer to college graduates as high-skilled individuals, and to less educated as low-skilled individuals. Third, individuals of all origins are assumed to be either in their working age or retired. Young active individuals supply labor in order to be employed and earn a wage, while retirees are unable (or unwilling) to enter the labor market so that their only income derives from government transfers and capital market. For simplicity, all agents in the economy are assumed to be born and to die at the same rate ν, whereas the rate at which workers retire in the host country differs between native and immigrant individuals, so to reflect the stylized fact that immigrants and natives are characterized by different shares of retirees.[7]

As far as production is concerned, intermediate firms open vacancies in a frictional labor market in order to hire workers and produce intermediate goods. At the same time, retail firms buy these intermediate goods in order to produce and sell a homogeneous final good in a perfectly competitive market. Finally, the government taxes labor income to finance redistributive transfers, public consumption, and unemployment benefits. For easy of exposition, the time variable t is omitted where no confusion arises.

In Sections 3.1 and 3.2, we describe the production technology and the frictional labor market that characterizes the economy. We then illustrate the skill acquisition process and the government fiscal redistribution in Sections 3.3 and 3.4. Finally, the search equilibrium is characterized in Section 3.5.

3.1. Production

In the small open economy, retail firms employ physical capital K and a composite input good Z in order to produce a homogeneous final output Y, whose price is normalized to unity, according to the following Cobb–Douglas production function:

$$Y = AK^{\alpha} Z^{1-\alpha}, \tag{1}$$

where $A > 0$ is a given parameter capturing the level of Total Factor Productivity (TFP) and $\alpha \in (0, 1)$ is the share of capital income in total output.

At the same time, the composite input Z is produced by intermediate firms who employ young individuals of heterogeneous skill and origin country. Let E_{os} denote employed workers in the labor market, where the subscript $o = (n, m)$ refers to natives and immigrants, and the subscript $s = (h, l)$ refers to high- and low-skilled individuals. As standard in this strand of literature [see, e.g., Acemoglu (2002)], we assume that each intermediate firm employs at most one worker so that the number of intermediate goods, Y_{os}, and employed workers, E_{os}, coincide in each point in time t. Hence, following recent studies [such as Manacorda et al. (2012) and Ottaviano and Peri (2012)] that find imperfect substituability between native and migrant workers, the production technology used to assemble the composite input Z can be described by the following nested CES function:

$$\begin{aligned} Z &= \left[xY_h^{(\sigma_1-1)/\sigma_1} + (1-x)Y_l^{(\sigma_1-1)/\sigma_1} \right]^{\sigma_1/(\sigma_1-1)} \\ Y_s &= \left[\lambda Y_{ns}^{(\sigma_2-1)/\sigma_2} + (1-\lambda)Y_{ms}^{(\sigma_2-1)/\sigma_2} \right]^{\sigma_2/(\sigma_2-1)}, \ s = (h, l), \end{aligned} \tag{2}$$

where σ_1 and σ_2 are, respectively, the elasticity of substitution between skill groups and between origin groups, $x \in (0, 1)$ denotes the relative productivity of high-skilled compared to low-skilled, and $\lambda \in (0, 1)$ denotes the relative productivity of native workers compared to immigrants.

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Because intermediate goods are produced under perfect competition, their price p_{os} equals their marginal productivity:

$$p_{mh} = A(1-\alpha)x(1-\lambda)K^{\alpha}Z^{\frac{1-\alpha\sigma_1}{\sigma_1}}Y_h^{-\frac{1}{\sigma_1}}\left(\frac{Y_h}{Y_{mh}}\right)^{\frac{1}{\sigma_2}} \tag{3a}$$

$$p_{ml} = A(1-\alpha)(1-x)(1-\lambda)K^{\alpha}Z^{\frac{1-\alpha\sigma_1}{\sigma_1}}Y_l^{-\frac{1}{\sigma_1}}\left(\frac{Y_l}{Y_{ml}}\right)^{\frac{1}{\sigma_2}} \tag{3b}$$

$$p_{nh} = A(1-\alpha)x\lambda K^{\alpha}Z^{\frac{1-\alpha\sigma_1}{\sigma_1}}Y_h^{-\frac{1}{\sigma_1}}\left(\frac{Y_h}{Y_{nh}}\right)^{\frac{1}{\sigma_2}} \tag{3c}$$

$$p_{nl} = A(1-\alpha)(1-x)\lambda K^{\alpha}Z^{\frac{1-\alpha\sigma_1}{\sigma_1}}Y_l^{-\frac{1}{\sigma_1}}\left(\frac{Y_l}{Y_{nl}}\right)^{\frac{1}{\sigma_2}}. \tag{3d}$$

Finally, capital in the economy is free to be perfectly mobile and, because the domestic economy is assumed to be small compared to the outside world, the return on capital r is fixed by international markets. Hence, the total amount of physical capital in the economy will adjust so to satisfy the usual first-order condition:

$$r = A\alpha K^{\alpha-1}Z^{1-\alpha}. \tag{4}$$

3.2. Labor market

Each intermediate firm opens a vacancy for either high-skilled or low-skilled workers. Following Chassamboulli and Palivos (2014) and Battisti et al. (2018), the labor market is assumed perfectly segmented by skill level for simplicity[8] and firms are not able to discriminate between immigrant and native workers at the vacancy posting stage so that job vacancies V_s and unemployed individuals $U_s \equiv \sum_o U_{os}$ are randomly matched with each other according to the following Cobb–Douglas matching function:

$$M(U_s, V_s) = \xi U_s^{\epsilon} V_s^{1-\epsilon}, s = (h, l), \tag{5}$$

where M is the number of job matches, ξ is a constant matching efficiency parameter,[9] and $\epsilon \in (0, 1)$ is the elasticity parameter of the matching function.

Let $\theta_s \equiv V_s/U_s$ denote the labor market tightness in the skill sector s. The job-finding rate is given by $M_s/U_s = \xi\theta_s^{1-\epsilon} \equiv m(\theta_s)$, and the vacancy-filling rate is given by $M_s/V_s = \xi\theta_s^{-\epsilon} \equiv q(\theta_s)$. As easy to verify, $m(\theta_s)$ and $q(\theta_s)$ are, respectively, increasing and decreasing in θ_s, implying that a higher market tightness makes it more difficult for firms to fill a vacancy, but easier for unemployed workers to find a job.

3.2.1. Asset value functions

Let $\mathcal{J}_{os}^F$ and $\mathcal{J}_s^V$ denote the value associated with a filled and unfilled vacancy, respectively.[10] Then, their flow value in steady state is given by:

$$r\mathcal{J}_{os}^F = p_{os} - w_{os} - \left(\delta_{os} + g_o\right)\left[\mathcal{J}_{os}^F - \mathcal{J}_s^V\right] \tag{6}$$

$$r\mathcal{J}_s^V = -c_s + q(\theta_s)\left[(1-\phi_s)\,\mathcal{J}_{ns}^F + \phi_s\mathcal{J}_{ms}^F - \mathcal{J}_s^V\right], \tag{7}$$

where c_s is the fixed cost of an open vacancy for a worker of skill level s, $\phi_s \equiv U_{ms}/U_s$ is the share of unemployed immigrants among all searching individuals of skill type s, g_o is the retirement rate for individuals of origin o, and δ_{os} is the exogenous separation rate, which is allowed to differ for

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workers' skills and country origin. Equation (6) states that the asset value of a filled vacancy is given by the price at which the intermediate input is sold, minus the wage rate paid to employed workers, and the expected value of breaking up with an employed worker, multiplied by the probability that such an event occurs, $\delta_{os} + g_o$.[11] Equation (7) has a similar interpretation, as it states that the asset value of having an unfilled vacancy is given by the vacancy cost, $-c_s$, plus the expected value of filling a vacancy, which occurs at a probability $q(\theta_s)$.

For working-age individuals who supply labor, the steady-state discounted present value of employment, $\mathcal{J}_{os}^E$, and unemployment, $\mathcal{J}_{os}^U$, are given by:

$$r\mathcal{J}_{os}^E = (1-\tau)w_{os} + \delta_{os}\left[\mathcal{J}_{os}^U - \mathcal{J}_{os}^E\right] + g_o\left[\mathcal{J}_{os}^R - \mathcal{J}_{os}^E\right] + T_{os}^y + rk_{os}^y \tag{8}$$

$$r\mathcal{J}_{os}^U = b_{os} + m(\theta_s)\left[\mathcal{J}_{os}^E - \mathcal{J}_{os}^U\right] + g_o\left[\mathcal{J}_{os}^R - \mathcal{J}_{os}^U\right] + T_{os}^y + rk_{os}^y, \tag{9}$$

where τ is the labor income tax rate, T_{os}^y and rk_{os}^y are, respectively, redistributive transfers and capital income of young workers of origin o and skill s,[12] and $\mathcal{J}_{os}^R$ is the steady-state value of retirement which is defined later on in the paper. According to equation (8), the flow value of being employed equals the difference between the after-tax wage income and the expected loss from breaking up from the firm, plus transfers, T_{os}^y, capital income, rk_{os}^y, and the expected gain from becoming a retiree, $g_o[\mathcal{J}_{os}^R - \mathcal{J}_{os}^E]$. Likewise, equation (9) states that the flow value of unemployment equals its return, that is, the unemployment benefit b_{os}, plus the probability of finding a job, multiplied by the expected gain from such event, transfers, capital income, and the expected gain from retirement.

Finally, denoting with R_{os} the number of retired workers and Q_{os} the total amount of active workers of type (o, s), the flow value of being a retired worker in steady state, $\mathcal{J}_{os}^R$, can be written as:

$$r\mathcal{J}_{os}^R = T_{os}^R + rk_{os}^R - \nu\mathcal{J}_{os}^R, \tag{10}$$

where T_{os}^R are redistributive transfers paid to retired workers and k_{os}^R is the share of capital held by retired workers.

3.2.2. Job creation condition

As intermediate firms are in perfect competition and bare no costs of entry, they will find it profitable to enter the market as long as the value of posting a new vacancy is greater than zero. In steady state, the free entry condition is thus given by:

$$\mathcal{J}_s^V = 0. \tag{11}$$

Combining equations (6), (7), and (11), in steady state, the job creation condition reads:

$$\frac{c_s}{q(\theta_s)} = (1-\phi_s)\left[\frac{p_{ns} - w_{ns}}{r + g_n + \delta_{ns}}\right] + \phi_s\left[\frac{p_{ms} - w_{ms}}{r + g_m + \delta_{ms}}\right]. \tag{12}$$

Equation (12) states that the expected cost of creating a vacancy, $c_s/q(\theta_s)$, is equal to the expected benefit of filling a vacancy with either a native or immigrant worker, $p_{os} - w_{os}$, adjusted by the worker-type specific discount rate, $r + g_o + \delta_{os}$. Note that a higher market tightness θ_s translates to higher vacancy opening costs, since the waiting time for filling a vacancy is increasing in θ_s.

3.2.3. Wage determination

Following mainstream search and matching literature, wages are determined through a Nash-bargaining process. The surplus created when a job seeker U_{os} and a vacancy V_s meet leads to a negotiation over the wage rate w_{os}. For the worker accepting a job offer would generate a surplus of $\mathcal{J}_{os}^F - \mathcal{J}_s^V$, whereas for the firm hiring an additional worker would generate a gain of $\mathcal{J}_{os}^E - \mathcal{J}_{os}^U$.

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The outcome of the bargaining process is the wage rate w_{os} that solves the following maximization problem:

$$w_{os} = \text{argmax}\left(\mathcal{J}^E_{os} - \mathcal{J}^U_{os}\right)^{\beta} \left(\mathcal{J}^F_{os} - \mathcal{J}^V_{s}\right)^{1-\beta},$$

where $\beta \in (0, 1)$ denotes the worker bargaining power. The first-order maximization condition derived from the above equation satisfies:

$$(1-\beta)\left(\mathcal{J}^E_{os} - \mathcal{J}^U_{os}\right) = \beta\left(\mathcal{J}^F_{os} - \mathcal{J}^V_{s}\right). \tag{13}$$

Combining equation (13) with the asset value equations (6)–(9) and considering the free entry condition (11), the bargained wage rate paid to workers of type (o, s) is given by:

$$w_{os} = \frac{\beta\left[r + g_o + \delta_{os} + m(\theta_s)\right] p_{os}}{\left(r + g_o + \delta_{os}\right)\left[1 - (1-\beta)(\tau + \mu)\right] + \beta m(\theta_s)}, \tag{14}$$

where the unemployment benefit b_{os} has been endogenized and proportionally set to the wage rate, that is, $b_{os} \equiv \mu w_{os}$, with $\mu \in (0, 1)$ denoting the replacement rate. According to equation (14), higher worker bargaining power β translates to higher wage rates. It is also easy to check that the bargained wage rate w_{os} is increasing in the replacement rate μ. This is coherent with the intuition that higher values of replacement rate would increase the worker's outside option and, thus, the worker's surplus from hiring.

3.2.4. Employment and retirement

The dynamic law of employed workers of skill s and origin o is given by the difference between the amount of matches formed and the breakups that take place in a given instant of time t, that is:

$$\dot{E}_{os} = m(\theta_s)\, U_{os} - \left(\delta_{os} + g_o\right) E_{os}. \tag{15}$$

Similarly, the dynamic law of retired workers of skill s and origin o is given by the difference between the workers who retire and the retirees that die in a given instant of time t, that is:

$$\dot{R}_{os} = g_o Q_{os} - \nu R_{os}. \tag{16}$$

Recalling that $Q_{os} \equiv E_{os} + U_{os}$ is the total amount of active individuals of type (o, s), the number of employed, unemployed, and retired people in steady state can be written as:

$$E_{os} = \frac{m(\theta_s)\, Q_{os}}{\delta_{os} + g_o + m(\theta_s)} \tag{17}$$

$$U_{os} = \frac{\left(\delta_{os} + g_o\right) Q_{os}}{\delta_{os} + g_o + m(\theta_s)} \tag{18}$$

$$R_{os} = \frac{g_o}{\nu} Q_{os}. \tag{19}$$

Based on equations (17) and (18), for any given size of the active population Q_{os}, employment is increasing in the job-finding probability, $m(\theta_s)$, and decreasing in the separation rate, δ_{os}. Also note that, according to equation (19), an in increase in active population translates to more retirees in the steady state. It is worth pointing out that, because immigrants and natives have different retirement rates, a variation in the quantity of active workers type o is able to affect the host country dependency ratio $\sum_o \sum_s (R_{os}/Q_{os})$.

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3.3. Skill acquisition

Before entering the labor market, each young native individual decides whether to invest in education and become high-skilled or remain low-skilled.[13] Following Chassamboulli and Palivos (2014), agents differ in their cost of acquiring education and, in particular, older agents are assumed to face prohibitive costs that prevent them from investing in training. Let z denote the cost of acquiring training and assume for simplicity that it is distributed uniformly over the closed interval $[0, \bar{z}]$. A native young agent will invest in education if the benefit of looking for a job as high-skilled, rather than as low-skilled, exceeds the cost of acquiring training, that is,

$$\mathcal{J}^U_{nh} - \mathcal{J}^U_{nl} \geq z. \tag{20}$$

Setting (20) as an equality, there exists a threshold value for the training cost:

$$z^* = \mathcal{J}^U_{nh} - \mathcal{J}^U_{nl}, \tag{21}$$

such that agents will find it profitable to invest in education and become high-skilled. From equation (20), it follows that the fraction of native high-skilled workers, $\gamma \equiv Q_{nh}/(Q_{nh} + Q_{nl})$, is thus endogenously determined by the model and equals:

$$\gamma = \frac{z^*}{\bar{z}}. \tag{22}$$

Plugging equation (9) into (20), and then using equation (8), the steady-state share of native high-skilled workers γ reads:

$$\gamma = \frac{\mu(w_{nh} - w_{nl}) + T^y_{nh} - T^y_{nl} + m(\theta_h)\left[\dfrac{w_{nh}(1-\tau-\mu)}{r + g_n + \delta_{nh} + m(\theta_h)}\right] - m(\theta_l)\left[\dfrac{w_{nl}(1-\tau-\mu)}{r + g_n + \delta_{nl} + m(\theta_l)}\right]}{\bar{z}(r + g_n)}. \tag{23}$$

According to equation (23), the higher is the benefit of being a high-skilled worker, rather than low-skilled worker, the larger will be the share of young natives that decide to invest in education. It is worth noting that, since young individuals eventually age and become retired, a change in young natives skill composition implies a change in retired skill composition as well so that the ratio R_{nh}/R_{nl} always matches the ratio Q_{nh}/Q_{nl} in the steady state.

3.4. Government

The government imposes a fixed tax rate $\tau \in (0, 1)$ on labor income in order to finance unemployment benefits μw_{os}, and group-specific transfers T^a_{os}, where the superscript $a = (y, R)$ denotes young and retired individuals. Assuming that the government conducts a zero-profit policy, the government budget constraint writes

$$\tau \sum_o \sum_s E_{os} w_{os} = \mu \sum_o \sum_s U_{os} w_{os} + \sum_o \sum_s Q_{os} T^y_{os} + \sum_o \sum_s R_{os} T^R_{os}. \tag{24}$$

The left-hand side of equation (24) corresponds to the government revenues, whereas the right-hand side corresponds to the government expenditures. The income tax τ is assumed to endogenously adjust to balance the government budget so that when a temporary deficit (surplus) takes place, the government responses by raising (decreasing) τ. It is also worth pointing out that, since labor income is the only source of tax revenues for the government, both native and immigrant employed workers contribute to the fiscal balance as a percentage of their labor income, whereas retirees and unemployed workers do not contribute to the government revenues.

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3.5. Search equilibrium

Definition 1. A steady-state equilibrium is a set of equilibrium values $\{p_{os}, K, \theta_s, w_{os}, E_{os}, U_{os}, \gamma, \tau\}$, where $o = (n, m)$ and $s = (h, l)$, such that: (i) the intermediate inputs markets clear so that equations (3a)–(3d) are satisfied; (ii) capital markets clear so that equation (4) is satisfied; (iii) the job creation condition (12) for each skill type s is satisfied; (iv) the Nash-bargaining optimality condition (14) holds for each origin o and skill type s; (v) the numbers of employed, unemployed, and retired workers are given by equations (17), (18), and (19) for each origin o and skill type s; (vi) the skill acquisition condition (23) is satisfied; and (vii) the government sustains a no-deficit policy and its budget (24) is balanced.

Unfortunately, it is impossible to obtain closed-form equilibrium solutions and the complexity of the model makes it too burdensome to provide analytical results on the welfare effect of immigration. For this reason, in the next section we will perform a comparative statics analysis by first assigning specific values to the model parameters and then solving the model numerically.

4. Quantitative analysis

In this section, we assess the impact of immigration on welfare, labor market outcomes, and fiscal redistribution in 19 selected OECD countries through a comparative statics analysis. More specifically, we analyze both the cases of skill-biased and -unbiased migration shocks taking place in the described economy. Throughout the analysis, we will refer to the welfare level of natives by taking into account the following welfare index:[14]

$$\mathcal{W}_n \equiv \frac{(1-\tau)\sum_s E_{ns}w_{ns} + \mu\sum_s U_{ns}w_{ns} - \frac{z^*(r+g_n)}{2}Q_{nh} + \sum_s Q_{ns}T^y_{ns} + \sum_s R_{ns}T^R_{ns} + rK_n}{\sum_s (Q_{ns}+R_{ns})}, \tag{25}$$

where $K_n \equiv \sum_s \sum_a k^a_{ns}$ is the total amount of capital held by natives and $\frac{z^*}{2}$ is the discounted (endogenous) average cost of acquiring skill.[15] The welfare index $\mathcal{W}_n$ includes the flow values of native labor income, capital income, unemployment benefits, transfers, and cost for training.[16]

The remainder of this section is presented as follows. Section 4.1 explains the calibration strategy for the benchmark model. Section 4.2 shows the results obtained and compares them with different variations of the model. Finally, Section 4.3 provides a robustness check on the results to the parameters choice.

4.1. Parametrization

We parametrize the described model in order to match the economic and sociodemographic characteristics of 19 OECD countries (EU15 member states, Australia, Canada, Switzerland, and USA). The model includes a total of 33 exogenous parameters which need to be calibrated in order to perform a quantitative analysis. Most of these parameters vary across countries and are set to match moments taken from data, while some are assumed to be country-invariant and taken from the empirical literature.

4.1.1. Calibration of common parameters

Table 1 reports exogenous parameters without country variation. We set the capital share parameter $\alpha = 0.33$ to match the empirical evidence of Gollin (2002). Following Ottaviano and Peri (2012), we choose the elasticity of substitution between skill groups and origin groups of, respectively, $\sigma_1 = 2$ and $\sigma_2 = 20$. In line with Chassamboulli and Palivos (2014) and Battisti et al. (2018),

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Table 1. Parameters without country variation

Parameters	Description	Value	Source
α	Capital share	0.33	Gollin (2002)
σ_1	Elast. subst. between skills	2	Ottaviano and Peri (2012)
σ_2	Elast. subst. immig/natives	20	Ottaviano and Peri (2012)
c_l	Low-skilled vacancy cost	0.5	Battisti et al. (2018)
r	Interest rate (monthly)	0.004	Chassamboulli and Palivos (2014)
ϵ	Matching elasticity	0.5	Petrongolo and Pissarides (2001)
β	Worker bargaining power	0.5	Hosios (1990)

the monthly interest rate r is set to 0.4%. Further, we choose the matching elasticity parameter $\epsilon = 0.5$, which is within the range of estimates reported in Petrongolo and Pissarides (2001) and Mortensen and Nagypal (2007), and the bargaining power $\beta = 0.5$, so that the Hosios condition is met [see Hosios (1990)]. Finally, we normalize the low-skilled vacancy cost c_l to the same value adopted in Battisti et al. (2018).[17]

4.1.2. Calibration of country-specific parameters

Exogenous parameters varying across countries are listed in Table 2. The TFP parameter A is set to match the TFP levels at current PPPs from the Penn World Table 10 database for each of the considred OECD countries. The matching efficiency parameter ξ is instead set to match the monthly job-finding rates reported by Hobijn and Şahin (2009) for each country.[18] Further, the parameter x is calibrated to match the average return to skill w_h/w_l according to the *Education at Glance 2012* report of the OECD (2012), whereas λ is calibrated to match the average native wage premium w_n/w_m obtained from Docquier et al. (2014). The separation rates δ_{os} are set to match the unemployment rates observed in the DIOC data. Specifically, separation rates are calibrated to be, on average, larger for migrants than for natives, since migrant workers are generally characterized by a higher unemployment rate. The vacancy costs ratio c_h/c_l is set equal to the wage ratio w_h/w_l, implying that it is more costly to have a high-skilled unfilled vacancy, rather than a low-skilled one, proportionately to the education wage premium.[19] The upper bound parameter related to the cost of acquiring education, $\bar{z}$, is set in order to match the share of high-skilled natives provided by DIOC data.

As far as fiscal parameters are concerned, the replacement rate μ matches the share of unemployment benefits in GDP obtained from the *Annual National Accounts* harmonized by the OECD. In line with Burzynski et al. (2018) and Aubry et al. (2016), we calibrate the level of public transfers to each cohort so to match the government expenditure to GDP, taken from the OECD *Annual National Accounts*, as well as the data on social protection expenditures included in the Social Expenditure Database (SOCX) of the OECD. More precisely, the SOCX database includes internationally comparable statistics on public social expenditures at the program level as well as net social spending indicators. We extract the data on expenditures linked to pension benefits, sickness and disability, family and children transfers as well as other transfers, as percentage of total social protection expenditures. Next, we disaggregate education expenditures and all social protection expenditures by education, age, and origin using the European Union Statistics on Income and Living Conditions (EU-SILC) provided by Eurostat for European countries, and the fiscal profiles used in Chojnicki et al. (2011) for the USA, Canada, and Australia. We then extract personal characteristics, data on social benefits, and the sampling weight of each individual. The amount of benefits received by each individual type (a, o, s) is then computed and rescaled to match the aggregate level obtained from the SOCX database.

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Table 2. Parameters varying across countries

Parameters	Description	Mean	S.d.	Moment matched
Production and labor market parameters				
A	TFP	0.877	0.099	TFP level (US = 1)
ξ	Matching efficiency	0.239	0.182	Avg. job-finding rate (monthly)
x	Firms' preference to HS	0.591	0.055	Avg. return to skill w_h/w_l
λ	Firms' preference to natives	0.523	0.038	Avg. wage ratio w_n/w_m
δ_{nh}	Break-up rate of HS natives	0.010	0.010	Unempl. rate U_{nh}/Q_{nh}
δ_{nl}	Break-up rate of LS natives	0.011	0.013	Unempl. rate U_{nl}/Q_{nl}
δ_{mh}	Break-up rate of HS immigrants	0.011	0.010	Unempl. rate U_{mh}/Q_{mh}
δ_{ml}	Break-up rate of LS immigrants	0.017	0.014	Unempl. rate U_{ml}/Q_{ml}
c_h/c_l	Vacancy costs ratio	1.922	0.356	Proportionality $c_h/c_l = w_h/w_l$
$\bar{z}$	Upper bound educ. cost (compared to USA)	0.638	0.323	Share of HS native workers γ
Fiscal parameters				
μ	Replacement rate	0.399	0.110	Share of unempl. benefits
T^y_{nh}	Transfers to natives HS	0.188	0.054	Gov. exp./GDP
T^y_{nl}/T^y_{nh}	Transfers ratio NL/NH	0.938	0.163	Social benef. ratio NL/NH
T^y_{mh}/T^y_{nh}	Transfers ratio MH/NH	1, 365	0.453	Social benef. ratio MH/NH
T^y_{ml}/T^y_{nh}	Transfers ratio ML/NH	1.276	0.438	Social benef. ratio ML/NH
T^r_{nh}/T^y_{nh}	Transfers ratio ret. NH/NH	2.486	0.984	Social benef. ratio ret. NH/NH
T^r_{nl}/T^y_{nh}	Transfers ratio ret. NL/NH	1.748	0.489	Social benef. ratio ret. NL/NH
T^r_{mh}/T^y_{nh}	Transfers ratio ret. MH/NH	2.367	0.889	Social benef. ratio ret. MH/NH
T^r_{ml}/T^y_{nh}	Transfers ratio ret. ML/NH	1.908	0.788	Social benef. ratio ret. ML/NH
Demografic parameters (native population aged 25–64 normalized to unity)				
Q_{mh}	Young migrants HS	0.090	0.0884	Immigrants HS aged 25–64 years
Q_{ml}	Young migrants LS	0.162	0.138	Immigrants LS aged 25–64 years
g_n	Native retirement rate	0.0004	0.0002	Natives aged 65+ years
g_m	Immigrant retirement rate	0.0002	0.0001	Immigrants aged 65+ years
ν	Population birth rate	0.001	0.0007	Labor force growth rate

Finally, we normalize the total young native workers population to one and parametrize the number of young immigrants by skill (Q_{mh} and Q_{ml}) according to the DIOC data on active individuals of age 25–64 years by origin. The retirement rates g_n and g_m are set in order to match the shares of total individuals of age 65 years and over by origin $\left(R_n \equiv \sum_s R_{ns} \text{ and } R_m \equiv \sum_s R_{ms}\right)$, while the birth rate ν is calibrated to match the monthly growth rate of the labor force during the period 2002–2010 in the analyzed OECD countries.

Using this calibration, in the following section, we simulate marginal increases in different types of migration flows taking as reference the described moments as the status quo.[20]

4.2. Sensitivity to different specifications

In this section, we simulate a 1% increase in the labor force due to an increase in the stock of immigrant workers.[21] As many developed countries are moving towards more selective migration policies in order to attract highly educated workers, and the skill composition of the migration flows plays a key role for determining welfare effects [Borjas (2003) and Ottaviano and Peri (2012)],

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Table 3. Immigration shock scenarios

Immigration scenario	Model's parameters variations
Low-skilled immigration	$\Delta Q_{ml} = 0.01 \sum_o \sum_s Q_{os}$
High-skilled immigration	$\Delta Q_{mh} = 0.01 \sum_o \sum_s Q_{os}$
Skill-balanced immigration	$\Delta Q_{ml} = 0.01 \left(\frac{Q_{ml}}{\sum_s Q_{ms}} \right) \sum_o \sum_s Q_{os}$ and $\Delta Q_{mh} = 0.01 \left(\frac{Q_{mh}}{\sum_s Q_{ms}} \right) \sum_o \sum_s Q_{os}$

in the analysis we consider three different types of one-off migration shocks: (a) a shock of low-skilled immigrant workers (Q_{ml}); (b) a shock of high-skilled immigrant workers (Q_{mh}); and (c) a shock of low- and high-skilled immigrant workers such that the immigrants' skill composition does not change in the post-shock scenario (henceforth, we will refer to this scenario as the "skill-balanced" migration shock). Table 3 summarizes the description of the three different immigration shocks taken into account in this subsection.

Our main goal is to analyze the effects of immigration on native welfare and to assess to what extent taking into account natives' endogenous skill and age composition matters in such analysis. For this reason, we also compare the results obtained by the benchmark version of the model described in Section 3 with those obtained in three other models that differ for the following elements: (i) the economy is composed of only working-age individuals, that is $R_{os} \equiv 0$ for each agent type (o, s) (henceforth referred as Model 2); (ii) young natives never adjust their skill in response to migration, that is γ is exogenous (henceforth referred as Model 3); and (iii) there are no retirees in the economy and young natives never adjust their skill, that is $R_{os} \equiv 0$ and γ is exogenous (henceforth referred as Model 4).

In what follows, we will first present the simulation results over the selected OECD countries and provide welfare comparisons across different model variations. Then, we will shed some light on the mechanisms in action by decomposing the observed welfare effects into different transmission channels.

4.2.1. The welfare effects of immigration

Figure 2 describes the effects of immigration on native welfare in the selected 19 OECD countries. In particular, Figure 2(a) shows the average welfare effects of low-skilled, high-skilled, and skill-balanced immigration on the aggregate group of the selected OECD countries, weighted for their native population size (which includes retirees for the benchmark model and Model 3, but only working-age active natives for Models 2 and 4) in order to account for the differences in countries size. The welfare effect on immigration is on average quite modest under the benchmark model, as it ranges from −0.08% (low-skilled immigration scenario) to 0.18% (high-skilled immigration scenario). The model versions abstracting from the presence of retirees (i.e., Model 2 and Model 4) are the most pessimistic ones under all of the three analyzed scenarios (especially Model 2, which ranges from −0.21% in the low-skilled immigration scenario to 0.06% in the high-skilled scenario). These are also the model versions that differ the most from the benchmark model, implying that taking into account the age structure of immigrants and natives plays an important role in the evaluation of the welfare effects of immigration. As far as the introduction of endogenous skill adjustment is concerned, the model version that differs from the benchmark for the only absence of native skill adjustment (i.e., Model 3) yields slightly more pessimistic results in the low-skilled scenario (average native welfare decreases by 0.12%), but more optimistic results in the high-skilled scenario (average native welfare increases by 0.25%) when compared with the benchmark model. In the skill-balanced scenario, both the benchmark model and Model 3 yield

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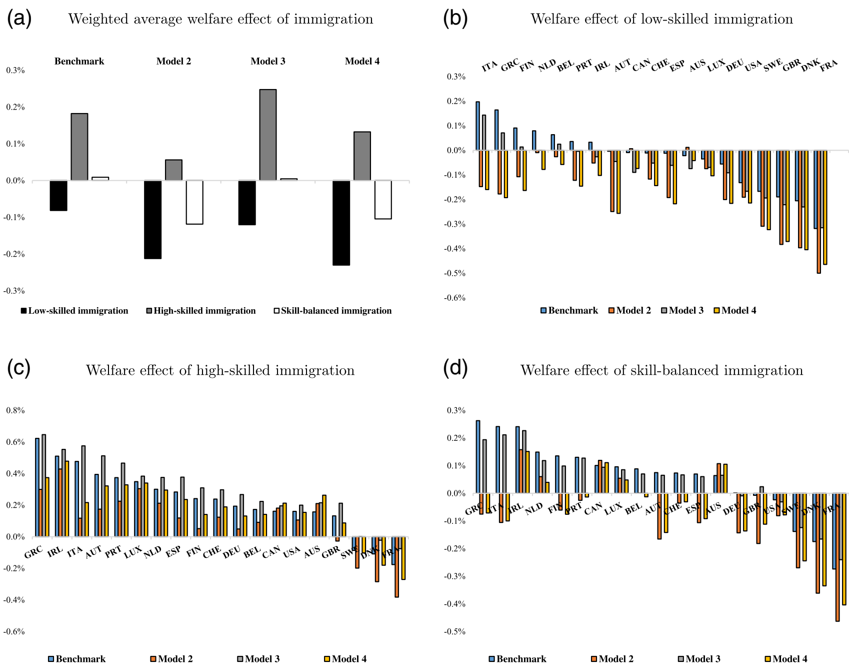

Figure 2. Effects of immigration (1% of the total labor force) on native welfare in the 19 selected OECD countries.
Note: Benchmark = Retirees & Endogenous Skill Acquisition; Model 2 = No Retirees; Model 3 = Exogenous Skill Acquisition; and Model 4 = No retirees & Exogenous Skill Acquisition. Countries are ranked in descending order according to the native welfare effect in the benchmark model. Variations are expressed in percentage points.

negligible effects on the average native welfare of the aggregate group of the considered OECD countries (average native welfare increases by less than 0.01% in both model versions).

Figure 2(b)–(d) show the effects of the three immigration shocks—low-skilled, high-skilled, and skill-balanced immigration—by country. According to our benchmark model, the countries that benefit the most from migration in all of the three scenarios are those characterized by a share of elderly immigrants that is much lower than the share of elderly natives (cfr. Figure 1(a) in Section 2). Unsurprisingly, the high-skilled immigration scenario is the more optimistic one for most countries (under the benchmark model, native welfare increases in all countries but Sweden, Denmark, and France). The skill-balanced immigration scenario also improves native welfare on most countries (14 out of 19 under the benchmark model). On the contrary, the low-skilled immigration scenario is the most pessimistic one for most countries (natives benefit from low-skilled immigration only in 7 out of 19 countries under the benchmark model).

4.2.2. Welfare effect decomposition

To shed light on the mechanisms at work behind the simulations results we presented, we decompose the average welfare effect into different transmission channels: employment, gross wage, fiscal, capital, education cost, and residual effect channels. Indeed, using equation (25), variations in native welfare can be decomposed as:

$$\Delta\mathcal{W}_n = \sum_s \Delta\mathcal{W}_n|_{\text{empl}_s} + \sum_s \Delta\mathcal{W}_n|_{\text{wage}_s} + \Delta\mathcal{W}_n|_{\text{fiscal}} + \Delta\mathcal{W}_n|_{\text{capital}} + \Delta\mathcal{W}_n|_{\text{educ}} + \Delta\mathcal{W}_n|_{\text{resid}},$$

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where

$$\Delta\mathcal{W}_n|_{\text{empl}_s} \equiv \frac{(1-\tau)\,(\Delta E_{ns})\,w_{ns} + \mu(\Delta U_{ns})\,w_{ns}}{\sum_s (Q_{ns}+R_{ns})}$$

$$\Delta\mathcal{W}_n|_{\text{wage}_s} \equiv \frac{(1-\tau)\,(\Delta w_{ns})\,E_{ns} + \mu(\Delta w_{ns})\,U_{ns}}{\sum_s (Q_{ns}+R_{ns})}$$

$$\Delta\mathcal{W}_n|_{\text{fiscal}} \equiv -\frac{\Delta\tau \sum_s E_{ns}w_{ns}}{\sum_s (Q_{ns}+R_{ns})}$$

$$\Delta\mathcal{W}_n|_{\text{capital}} \equiv \frac{r\sum_s\sum_a \Delta k^a_{ns}}{\sum_s (Q_{ns}+R_{ns})}$$

$$\Delta\mathcal{W}_n|_{\text{educ}} \equiv -\frac{\left(r+g_n\right)\,[(\Delta z^*)\,Q_{nh} + (\Delta Q_{nh})\,z^*]}{2\sum_s (Q_{ns}+R_{ns})}$$

$$\Delta\mathcal{W}_n|_{\text{resid}} \equiv \frac{\sum_s (\Delta Q_{ns})\,T^y_{ns} + \sum_s (\Delta R_{ns})\,T^R_{ns}}{\sum_s (Q_{ns}+R_{ns})}.$$

Figure 3 gives the weighted mean averages of the labor market-related welfare components (employment and wage transmission channels by skill), whereas Figure 4 gives the weighted mean averages of the other transmission channels (fiscal, capital, education, and residual).[22] For the sake of comparability, in all of these figures, we use the same vertical scale.

Figure 3(a) and (b) show that when natives endogenously decide whether to invest in education (i.e., in Benchmark and Model 2), the employment transmission channel contributes to welfare variations in a meaningful way only in case of skill-biased immigration. In particular, endogenous skill adjustment asymmetrically amplify the job creation effects for low- and high-skilled jobs so that there is a positive job creation effect for natives employed in the skill sector that is not directly affected by the immigration shock, but a negative job creation effect for those natives working in the same skill sector of the new immigrants. This is because, in case of low-skilled (high-skilled) immigration, more natives will find it profitable to (to not) invest in education and apply for high-skilled (low-skilled) positions, so to avoid a fiercer competition from the new immigrants in the low-skilled (high-skilled) sector. As a result, the welfare effect contribution due to the presence of high-skilled (low-skilled) workers increases, whereas that of low-skilled (high-skilled) workers decreases. This same mechanism does not operate in those model versions where natives are not allowed to upgrade their skill in face of migration. Indeed, in Models 3 and 4, the employment effect only depends on the market tightness, which results to not be particularly sensible to immigration shocks. As a consequence, the employment transmission channel does not significantly contribute to variations in native welfare under Models 3 and 4.

Figure 3(c) and (d) illustrate the contribution of the wage transmission channel on the obtained welfare results. Interestingly, this channel is not particularly sensitive to differences in the model versions. Indeed, wage variations are mainly driven by complementarity effects in production between low- and high-skilled workers: an increase of low-skilled (high-skilled) migrant employment makes marginal productivity of high-skilled (low-skilled) workers increase, leading to a higher high-skilled (low-skilled) labor income. This holds true regardless of the considered model version, as they all share the same production function structure.

As far as the direct fiscal contribution of the immigration shocks is concerned, Figure 4(a) gives noticeably less pessimistic results when retired workers are included in the model (i.e., in

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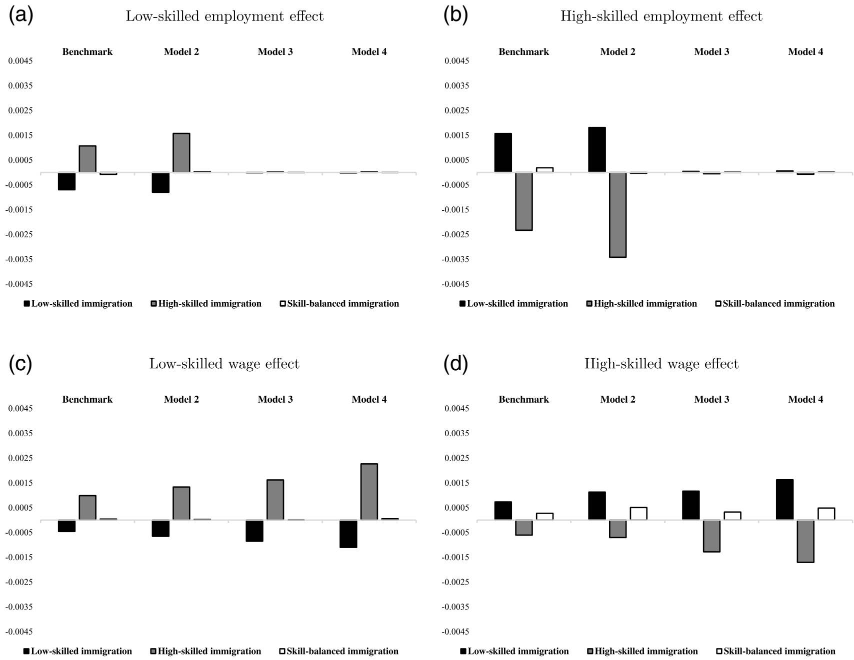

Figure 3. Decomposition of the average welfare effect of immigration (1% of the total labor force) — employment and wage channels.
Note: Benchmark = Retirees & Endogenous Skill Acquisition; Model 2 = No Retirees; Model 3 = Exogenous Skill Acquisition; and Model 4 = No retirees & Exogenous Skill Acquisition.

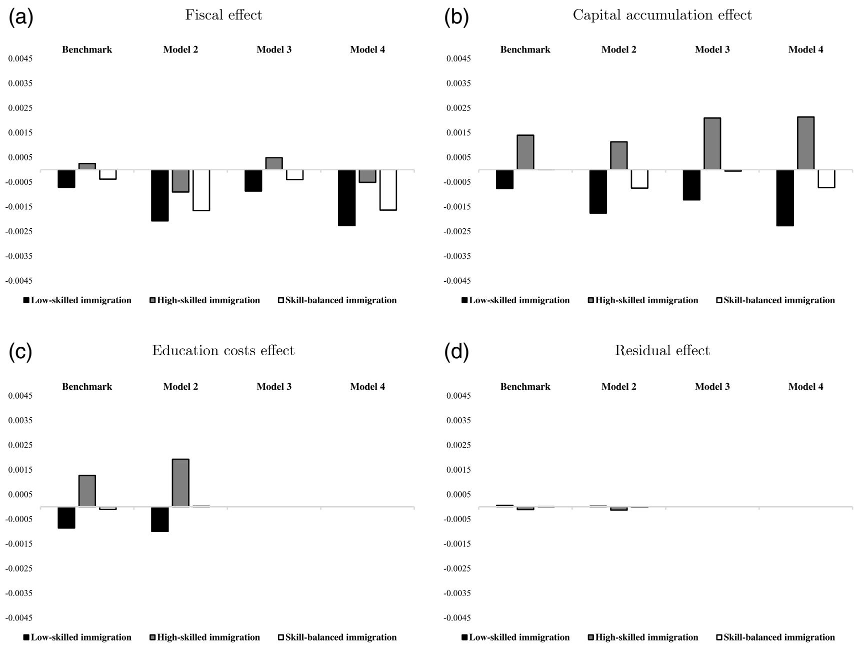

Figure 4. Decomposition of the average welfare effect of immigration (1% of the total labor force) — fiscal, capital, education, and residual channels.
Note: Benchmark = Retirees & Endogenous Skill Acquisition; Model 2 = No Retirees; Model 3 = Exogenous Skill Acquisition; and Model 4 = No retirees & Exogenous Skill Acquisition.

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Benchmark and Model 3). In particular, the fiscal contribution in the high-skilled immigration scenario turns positive, while the negative fiscal effect of low-skilled and skill-balanced immigration shrinks with the introduction of retirees in the model. This is because retirees tend to be a weighty fiscal burden (retired workers have access to pension benefits and stop contributing to the fiscal revenues as they leave the labor market) and, at the same time, immigrants in the host countries are, on average, characterized by a lower share of retirees. Furthermore, the result that high-skilled and low-skilled immigration have different fiscal impacts is given by the differences in their unemployment rates (high-skilled workers are characterized by a lower unemployment rate, which translates to a lower government expenditure on unemployment benefits) and welfare usage.

Figure 4(b) displays the welfare effect of immigration that takes place through the capital accumulation channel. High-skilled immigration stimulates native capital accumulation, whereas low-skilled immigration hampers native capital accumulation in per capita terms (i.e., the capital dilution effect takes place) across all model variants. Indeed, recalling that the capital accumulation transmission channel takes into account native capital in per capita terms, $\sum_s \sum_a k^a_{ns} \equiv \left(\sum_s Q_{ns} + \sum_s R_{ns} \right) K / \left(\sum_o \sum_s Q_{os} + \sum_o \sum_s R_{os} \right)$, the resulting effect depends on whether the increase in aggregate capital K is able to offset the increase in the total population $\left(\sum_o \sum_s Q_{os} + \sum_o \sum_s R_{os} \right)$ due to the inflow of new immigrants. As in almost all of the considered countries, the share of low-skilled workers is much higher than that of high-skilled workers, increasing the number of the scarcer and more productive input, that is, the high-skilled workers, leads to a positive complementary effect that is stronger than any capital dilution effect that may take place in the host economy. On the contrary, the complementary effect taking place in response to low-skilled immigration turns out to be unable to counteract the capital dilution effect.

Finally, Figure 4(c) and (d) show the education cost and residual transmission channels, respectively. Both channels are necessarily equal to 0 in the models where natives skill distribution cannot change in response to immigration shocks (Models 3 and 4), as education cost is exogenous and the residual channel depends on the changes on natives skill distribution. Focusing our attention on the benchmark model and Model 2, the results on the education cost channel are quite intuitive: when new low-skilled immigrants enter the labor market, more natives find it profitable to invest in education, making both total and average cost in education increase. In the case of high-skilled immigration, a specularly symmetric scenario takes place, that is, a lower number of natives invest in education, making the education cost decrease. The residual effect is still negligible under both the benchmark model and Model 2, as natives skill adjustment does not noticeably affect the weight of the redistributive transfers on the average native welfare.

4.3. Sensitivity to parameters

As there is empirical disagreement on the degree of substitutability between workers of different skill and origin [see Borjas et al. (2012)] and these parameters play a key role for correctly assessing the impact of migration on the host country labor market, here we perform a ceteris paribus sensitivity analysis on the elasticities of substitution between high- and low-skilled workers, σ_1, and between native and immigrant workers, σ_2. In the benchmark parametrization, following Ottaviano and Peri (2012), we chose $\sigma_1 = 2$ and $\sigma_2 = 20$. In what follows, we set $\sigma_1 = 1.5$ and $\sigma_2 = 10,000$ to check how robust our benchmark model is when high- and low-skilled workers are more complementary, and when native and immigrant workers can be considered as perfect substitutes (i.e., $\sigma_2 \to \infty$). We vary each parameter each time and perform the same skill-biased and skill-balanced immigration shocks we have discussed in the previous sections.

Figure 5 illustrates the sensitivity of the immigration effects on native welfare under different calibrations of the benchmark model. Qualitatively, our results countries are robust to the choice

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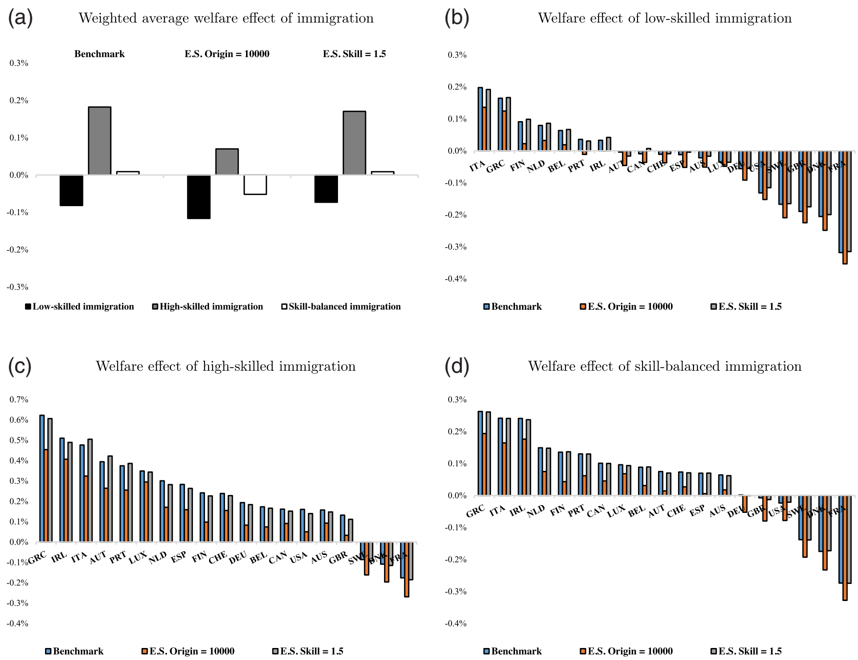

Figure 5. Effects of immigration (1% of the total labor force) on 19 selected OECD countries — sensitivity to parameters. Note: Countries are ranked in descending order according to the native welfare effect in the benchmark model. Variations are expressed in percentage points.

of elasticity parameters when we consider the aggregate group of the selected OECD countries [see Figure 5(a)]. Quantitatively, however, we find that our results are highly robust to σ_1, but rather sensitive to σ_2. In particular, smaller welfare gains are obtained when immigrants are closer substitutes for native workers. Nonetheless, the countries ranking is barely affected by these parameters choice the all of the three different immigration shock scenarios [see Figure 5(b)–(d)].

5. Concluding remarks

This paper investigates the effects of immigration on the native welfare by introducing two key features that have been so far mostly neglected in the growing literature of search models. The first feature is related to the recent empirical findings that natives tend to adjust their task specialization in response to immigration. The second feature regards individuals age composition and allows us to assess whether immigrant workers are able to alleviate the fiscal burden of aging populations. Both of these features are taken into account in our search model by endogenizing natives education decisions and by including different generations of workers. We focus our analysis on a selected group of 19 OECD countries (EU15 member states, Australia, Canada, Switzerland, and USA) and perform a comparative statics analysis under different variations of immigration shocks and model versions in order to assess to what extent the introduced features affect welfare results.

Despite the heterogeneity in population and labor market characteristics across countries, our analysis finds the following results for the aggregate group of considered OECD countries. First, the introduction of young natives' endogenous skill acquisition asymmetrically amplifies any job creation effect generated by skill-biased immigration shocks. This is because young natives decide to specialize and apply in the sector which is less affected by the immigration shock so to avoid a fiercer competition from new immigrants. Second, high-skilled immigration has positive fiscal effects when age composition is taken into account. On the contrary, model variants that abstract

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from retired workers find negative fiscal effects under all immigration shock scenarios. Third, the features introduced in our benchmark model allow for an overall more optimistic prediction of the impact of immigration on natives' welfare. In particular, according to our benchmark model simulation, average native welfare increases in 14 out of the selected 19 OECD countries in response to a immigration shock that does not affect the observed immigrants education composition. However, these results change when the influx of migration is composed of only low-skilled workers, as only 7 of the analyzed 19 countries experience an increase in average welfare after the shock. Qualitatively, our results are mostly robust to different choices on the degrees of substitution between workers of different skill and origin.

Our paper departs from a search model inspired by Battisti et al. (2018), in which we introduced intergenerational features. However, our analysis can still be extended to address several issues for future research. For example, one significant issue to be pursued in future work may be to allow for immigrants assimilation. Indeed, our model accounts for population dynamics regarding skill and age composition but totally abstracts from immigrants assimilation. Long-term immigrants, and especially their offspring, may successfully integrate in the host country and eventually be considered the same as native workers under all respects. Another interesting avenue would be to take into account a more detailed fiscal block of the model that abstracts from the simplifying assumption of a fixed-benefit scheme and includes different types of income taxes. This is particularly relevant, as immigrants also contribute to the host country government revenues through consumption and capital taxes and, thus, the fiscal effects of immigration might be even greater than those obtained in the presented analysis.

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Notes

1 Source: OECD (2018).
2 Chassamboulli and Palivos (2014), in one of their extensions, analyze the case in which natives endogenously adjust their skill, but they completely abstract from the presence of a public sector.
3 See Preston (2014) for an extensive survey on the advantages and disadvantages of accounting approaches.
4 Source: OECD (2018).
5 Note that, because of the lack in immigrants wages data availability, the wage ratios presented in Docquier et al. (2014) derive from different sources and refer to different years.
6 In a technical appendix, available upon request, we show that assuming native and immigrant as workers perfect substitutes in production different outside options, as in Chassamboulli and Palivos (2014) and Battisti et al. (2018), does not affect the main results of the paper.
7 Indeed, many immigrants who remain in their host country during their working life still prefer to return to their home country at retirement [Coulon (2016)]. For instance, Klinthall (2006) finds that the probability of return migration increases when reaching the age of 65 years in Sweden. Similarly, Jensen and Pedersen (2007) estimate that the probability of leaving the country declines in the first 15 years of residence in Denmark but significantly increases upon retirement. Cobb-Clark and Stillman (2013) also find similar results in Australia.
8 See Liu et al. (2017) for a search and matching framework with international immigration that allows for cross-skill matching.
9 Note that, following Chassamboulli and Palivos (2014) and Battisti et al. (2018), we postulate that the matching processes of low- and high-skilled workers are characterized by a common efficiency parameter so that cross-skill differences in the job-finding rates only depend on the sector-specific market tightness.
10 Note that the value of an open vacancy, $\mathcal{J}_s^V$, has no origin index o because firms are unable to direct their search towards different types of workers who hold the same skill level.
11 Remind that a worker will separate from a firm at a rate $\delta_{os} + g_o$, rather than δ_{os}, because he will not supply labor after retirement.
12 Followig Aubry et al. (2016) and Burzynski et al. (2018), redistributive transfers include public consumption as well as public health expenditures, family allowances, pension benefits, and other welfare payments. As it is debated that immigrants may

use welfare more intensively than natives (see, e.g., Barrett and McCarthy (2008) for a review on the literature of immigrants and their welfare usage), these transfers are allowed to vary across age, origin, and skill types.
13 We abstract from endogenizing education decisions of immigrants individuals, as analyzing the effects of immigration on the welfare of previous immigrant workers is beyond the scope of this paper. In Section 4, we will assess the effects of immigration under different skill composition scenarios.
14 Using this welfare index is equivalent of using the welfare index proposed by Battisti et al. (2018) when the skill decision is exogenous and no retirement takes place. In Appendix A, we consider an alternative welfare index that can be interpreted as a consumption-equivalent measure.
15 Recall that native workers are heterogeneous with respect to their cost of training and that z in uniformly distributed. This implies that the average cost paid by natives to acquire skill is $\frac{z^*}{2}$, and the total flow value of training cost is $\frac{z^*(r+g_n)}{2}Q_{nh}$.
16 For the sake of exposition, in this section, we will only refer to the immigration effects on the average native welfare. The online Appendix shows the effects of immigration on specific workers groups.
17 As pointed out by Battisti et al. (2018), this is a normalization that does not affect the obtained results.
18 In a technical appendix, available upon request, we perform a sensitivity analysis on ξ and show that the proposed results are robust to the choice of a matching efficiency parameter which is twice as large as that considered in the benchmark calibration.
19 This is in line with the empirical evidence that hiring costs generally increase with skill requirements for job applicants [see Blatter et al. (2012)] as well as with the common practice of measuring vacancy costs as a percentage of labor costs [see Manning (2011), for a recent survey on hiring costs].
20 Although we cannot obtain a closed-form solution for our model, we find that, under the described parametrization, a unique economically meaningful equilibrium exists in all of the considered countries for the benchmark model.
21 Battisti et al. (2018) simulate a shock of the same magnitude. In a technical appendix, available upon request, we show that considering a larger percentage change of immigration only proportionally affects the scale of the welfare effects. Moreover, in Appendix B, we also take into account the actual changes in immigration stocks that took place between the two most recent DIOC census rounds and show that the models results of this exercise are very close to those obtained under the skill-balanced scenario.
22 In Figure 12 of the Appendix C, we also show component bar charts for the decomposed average welfare effects under each of the three different immigration scenarios.
23 Note that considering each agent group as a different household and then computing the weighted average steady-state native consumption yields exactly the same level of average steady-state native consumption. Moreover, the introduction of a fixed positive rate of depreciation for capital is straightforward, but it does not change the results of the comparative statics analysis.
24 Note that all of the other transmission channels described in Section 4.2.2 are still in place, as including native firms' profits π_n to the welfare index does not affect the other welfare components studied in the welfare decomposition analysis.
25 Note that, at the time of this writing, the DIOC census round 2015 is the most recent database undertaken by the OECD that accounts for differences in demographic characteristics, level of education, and labor market status of the population of OECD member states.
26 See Appendix A for an extensive description of this alternative welfare index.

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Appendix A. Alternative welfare index: native consumption

In the main text of the paper, we follow Battisti et al. (2018) and consider $\mathcal{W}_n$ as the benchmark index for the presented welfare analysis. However, this index cannot be directly interpreted as a consumption-equivalent measure. For this reason, in what follows we provide an alternative welfare index that represents the steady-state value of average native consumption.

Let us assume, for ease of exposition, that all native agents can be considered as a single household and that capital does not depreciate over time.[23] Under such assumptions, the flow budget constraint of the native household is

$$\dot{k}_n = \frac{(1-\tau)\sum_s E_{ns}w_{ns} + \mu\sum_s U_{ns}w_{ns} - \frac{z^*(r+g_n)}{2}Q_{nh} + \sum_s Q_{ns}T^y_{ns} + \sum_s R_{ns}T^R_{ns} + rK_n + \pi_n}{\sum_s (Q_{ns}+R_{ns})} - \tilde{c}_n,$$

where $k_n \equiv K_n / \sum_s (Q_{ns}+R_{ns})$ is the capital held by each native, $\tilde{c}_n \equiv \tilde{C}_n / \sum_s (Q_{ns}+R_{ns})$ is the per capita amount of native consumption $\tilde{C}_n$, and

$$\pi_n \equiv \frac{\sum_s (Q_{ns}+R_{ns})}{\sum_s\sum_o (Q_{os}+R_{os})}\left[Y - \sum_s\sum_o E_{os}w_{os} - rK - \sum_s c_s V_s\right],$$

denotes the native firms' profits under the assumption that all individuals can hold intermediate and final goods firms regardless of their age, skill, or origin. Note that, in the presented model, we have that final goods firms' profits are given by:

$$\pi^f \equiv Y - \sum_s\sum_o Y_{os}p_{os} - rK,$$

whereas intermediate goods firms' profits amount to

$$\pi^i \equiv \sum_s\sum_o Y_{os}p_{os} - \sum_s\sum_o E_{os}w_{os} - \sum_s c_s V_s,$$

thus the aggregate amount of profits in the economy is

$$\pi \equiv \pi^f + \pi^i = Y - \sum_s\sum_o E_{os}w_{os} - rK - \sum_s c_s V_s.$$

In the steady state, we have that $\dot{k}_n = 0$ and thus that the steady-state native consumption can be written as:

$$\tilde{c}_n = \frac{(1-\tau)\sum_s E_{ns}w_{ns} + \mu\sum_s U_{ns}w_{ns} - \frac{z^*(r+g_n)}{2}Q_{nh} + \sum_s Q_{ns}T^y_{ns} + \sum_s R_{ns}T^R_{ns} + rK_n + \pi_n}{\sum_s (Q_{ns}+R_{ns})}.$$

Making use of equation (25), it is straightforward to check that $\tilde{c}_n = \mathcal{W}_n + \pi_n / \sum_s (Q_{ns}+R_{ns})$. This implies that, to obtain a welfare index which represents a measure of native consumption,

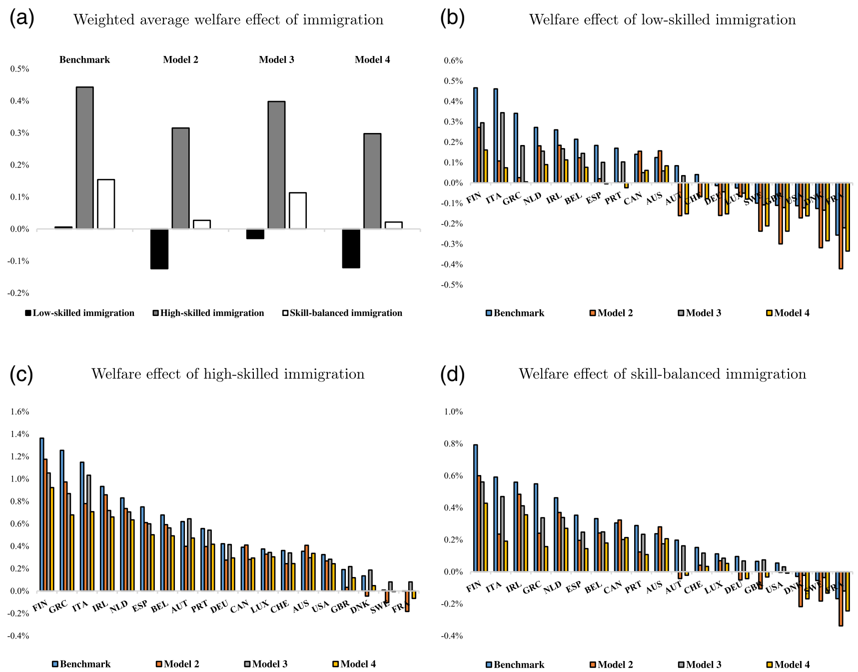

Figure 6. Effects of immigration (1% of the total labor force) on native welfare in the 19 selected OECD countries using W_n^* as welfare index.
Note: Benchmark = Retirees & Endogenous Skill Acquisition; Model 2 = No Retirees; Model 3 = Exogenous Skill Acquisition; and Model 4 = No retirees & Exogenous Skill Acquisition. Countries are ranked in descending order according to the native welfare effect in the benchmark model. Variations are expressed in percentage points.

profits' income need to be added on the right-hand side of equation (25) so that the alternative welfare index can be defined as:

$$\mathcal{W}_n^* = \mathcal{W}_n + \pi_n / \sum_s (Q_{ns} + R_{ns}) .$$

Replicating the same comparative statics analysis that we performed in Section 4.2.1, using $\mathcal{W}_n^*$ in place of $\mathcal{W}_n$, we find that the obtained welfare effects under the alternative index (see Figure 6) are overall slightly more optimistic than those obtained in the main text of the paper (cf. Figure 2), though the main conclusions of the analysis hold mostly unaffected. In particular, Figure 6(a) shows that the welfare effect on immigration is still, on average, quite modest under the benchmark model, as it ranges from 0.01% (low-skilled immigration scenario) to 0.44% (high-skilled immigration scenario). Moreover, the model versions abstracting from the presence of retirees (i.e., Model 2 and Model 4) are still the most pessimistic ones under all of the three analyzed scenarios, while the model version that differs from the benchmark for the only absence of native skill adjustment (i.e., Model 3) yields very slightly more pessimistic results when compared with the benchmark model. Interestingly, the welfare effects in the skill-balanced scenario turn slightly positive for both Model 2 and Model 4, though such effects are still very small (average native welfare increases by roughly 0.03% and 0.02% for Model 2 and Model 4, respectively). Finally, Figure 6(b)–(d) show that a slightly higher number of countries benefit from the different immigration shocks under the alternative welfare index $\mathcal{W}_n^*$ (the native welfare effect is indeed positive for 11 countries under the low-skilled migration scenario, for 16 countries under the skill-balanced scenario, and for 18 under the high-skilled scenario), though the ranking of the welfare effect by country is mostly unaffected when compared with Figure 2(b)–(d).

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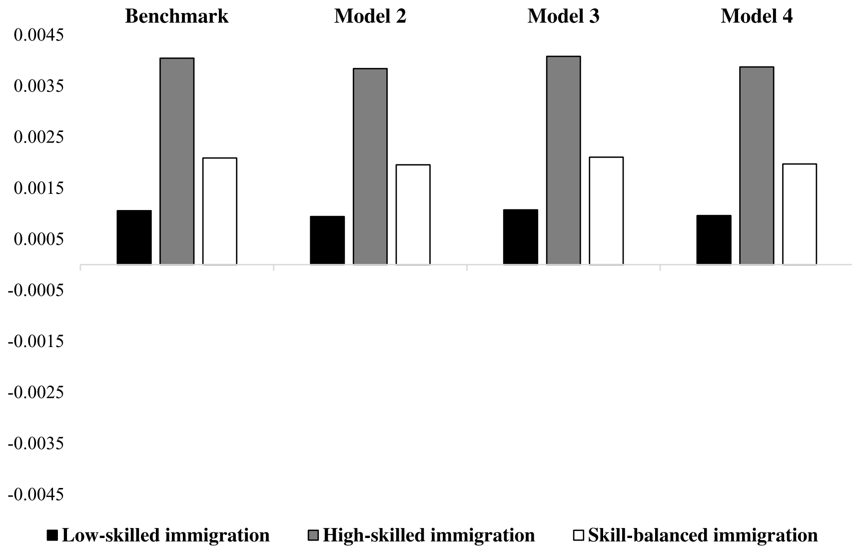

Figure 7. Decomposition of the average welfare effect of immigration (1% of the total labor force)—profitability channel. Note: Benchmark = Retirees & Endogenous Skill Acquisition; Model 2 = No Retirees; Model 3 = Exogenous Skill Acquisition; and Model 4 = No retirees & Exogenous Skill Acquisition.

The reason for such results lies in the addition of the profitability effect, which is included in the alternative welfare index $\mathcal{W}_n^*$, but not in the benchmark welfare measure $\mathcal{W}_n$. This additional transmission channel can be defined as:[24]

$$\Delta \mathcal{W}_n^*\big|_{\text{profit}} \equiv \frac{\Delta \pi_n}{\sum_s (Q_{ns} + R_{ns})}.$$

Figure 7 gives the weighted mean averages of the profitability effect. According to this figure, such effect appears to be extremely robust under all of the four model variations, though sensible to the different immigration shock scenario. We can thus conclude that the differences in the welfare effects obtained across the four different model variants are robust to the choice of the welfare index.

Appendix B. Actual immigration scenario

In the main text of the paper, we have focused our attention on analyzing the effects of a 1% increase in the labor force due to three different types of migration shocks: an increase of only low-skilled immigrant workers; an increase of only high-skilled immigrant workers; and an increase of both low- and high-skilled immigrant workers such that the immigrants' skill composition does not change in the post-shock scenario. In this Appendix, we instead consider the actual changes in immigration stocks that took place during the period 2010–2015. To do so, we simulate all of the presented model variants under an "actual immigration shock" scenario, where we use the DIOC census round 2015 to extract information in the stock of immigrant workers by skill, age, and market status for the year 2015.[25]

According to Figure 8(a), where the changes in the stock of immigrants are computed as percentage of the total labor force in the year 2010, the actual immigration shock during the period 2010–2015 appears to be much higher than 1% of the total labor force for the most of the considered countries. In particular, Switzerland is the country who faces the largest shock of immigrants in the considered period, as the increase in immigration amounts to 13.4% of the total labor force population of the year 2010. Sweden and Luxembourg also face large inflows of immigrants

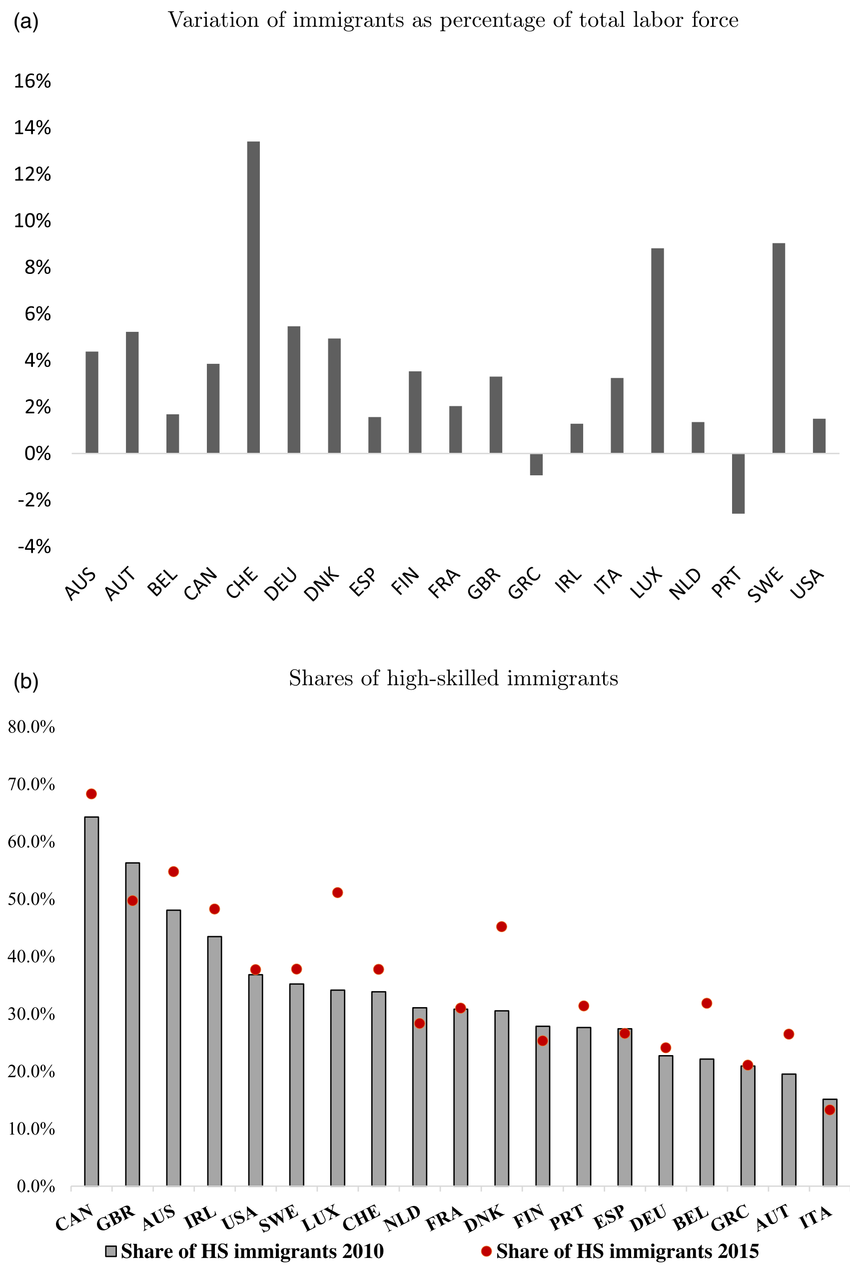

Figure 8. The actual changes in the stock of immigrants between the two census rounds in terms of total labor force and skill composition.
Note: Countries are ranked in descending order according to the native welfare effect in the benchmark model. Variations are expressed in percentage points.

(their increase in immigration amounts to about 9% and 8.8% of the total labor force, respectively), while the other countries are characterized by relatively lower, or even negative, variations in the stock of immigrant stocks (in particular, the stock of immigrant workers in Greece and Portugal reduce by 0.9% and 2.5%, respectively, of the total labor force). As far as the skill composition of the immigrant workers is concerned, Figure 8(b) shows that the actual immigration

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variation appears to be roughly skill-balanced for most countries, though some countries experienced a relevant increase in the share of high-skilled immigrants in 2015 (in particular, the share of high-skilled immigrants in Luxembourg rises from 34.1% in 2010 to 51.1% in 2015; similarly, the share of high-skilled immigrants in Denmark rises from 30.5% in 2010 to 45.2% in 2015).

In what follows, we will first present the simulation results under the actual immigration scenario by taking into account all of the considered model variants. Then, we will test the endogenous skill acquisition mechanism described in Section 3 by comparing the share of high-skilled natives implied by the benchmark model with the actual changes in natives' skill composition observed in DIOC 2015 census round data.

B.1. The effects of the actual immigration during the period 2010–2015

To determine the actual impact of immigration on native welfare over the period 2010–2015, we use the same welfare index $\mathcal{W}_n$ described by equation (25) that we considered in the previous simulation exercises. The model is then calibrated according to the parametrization strategy described in Tables 1 and 2. Figure 9 shows the effects of the actual immigration shock on the average native welfare in the selected group of OECD countries according to the four considered model versions.

According to Figure 9(a), the average welfare effect of the actual change in the stock of migrant workers is quantitatively negligible for the benchmark model and Model 3, and slightly negative under Model 2 and 4. Such welfare impacts are similar to those obtained in Section 4.2 under the skill-balanced scenario, coherently with the empirical fact that the actual immigration shock is roughly a skill-balanced shock for most countries [cf. Figure 8(b)]. Nonetheless, the benchmark model and Model 3 produce welfare effects that are less pessimistic than those obtained under Models 2 and 4, implying that taking into account age composition still affects the quantitative evaluation of the welfare effects under the actual immigration shock. As for the welfare effect by country depicted in Figure 9(b), the country ranking is also mostly in line with the ranking obtained under the skill-balanced shock depicted in Section 4.2 [cf. Figure 2(d)]. The greatest variations in the country ranking are mainly due to differences in the skill composition of the immigration shock (see, e.g., Luxembourg, which faced a very large inflow of high-skilled workers in the 2010–2015 period) or in the magnitude of the shock (see, e.g., Greece and Portugal, that faced a decrease in the stock of immigrants, rather than an increase).

Interestingly, the results are slightly sensible to the choice of the welfare index that we take into account in the simulation exercise. Indeed, if we consider the alternative welfare index:[26]

$$\mathcal{W}_n^* = \mathcal{W}_n + \pi_n / \sum_s (Q_{ns} + R_{ns}) \,,$$

where π_n denotes the native firms' profits, the average welfare effects of the actual immigration shock turns positive under the benchmark model and Model 3 (cf. Figure 10), so that the inclusion of retirees in the model does not only quantitatively impact the results, but it is also able to affect the sign of the average welfare effect. Nonetheless, the average welfare effects depicted in Figure 10(a) are still in line with those obtained when the welfare index $\mathcal{W}_n^*$ is taken into account under the skill-balanced scenario shown in Appendix A [cf. Figure 6(a)], implying that the skill-balanced scenario gives a good approximation of the actual immigration scenario regardless of the considered welfare index.

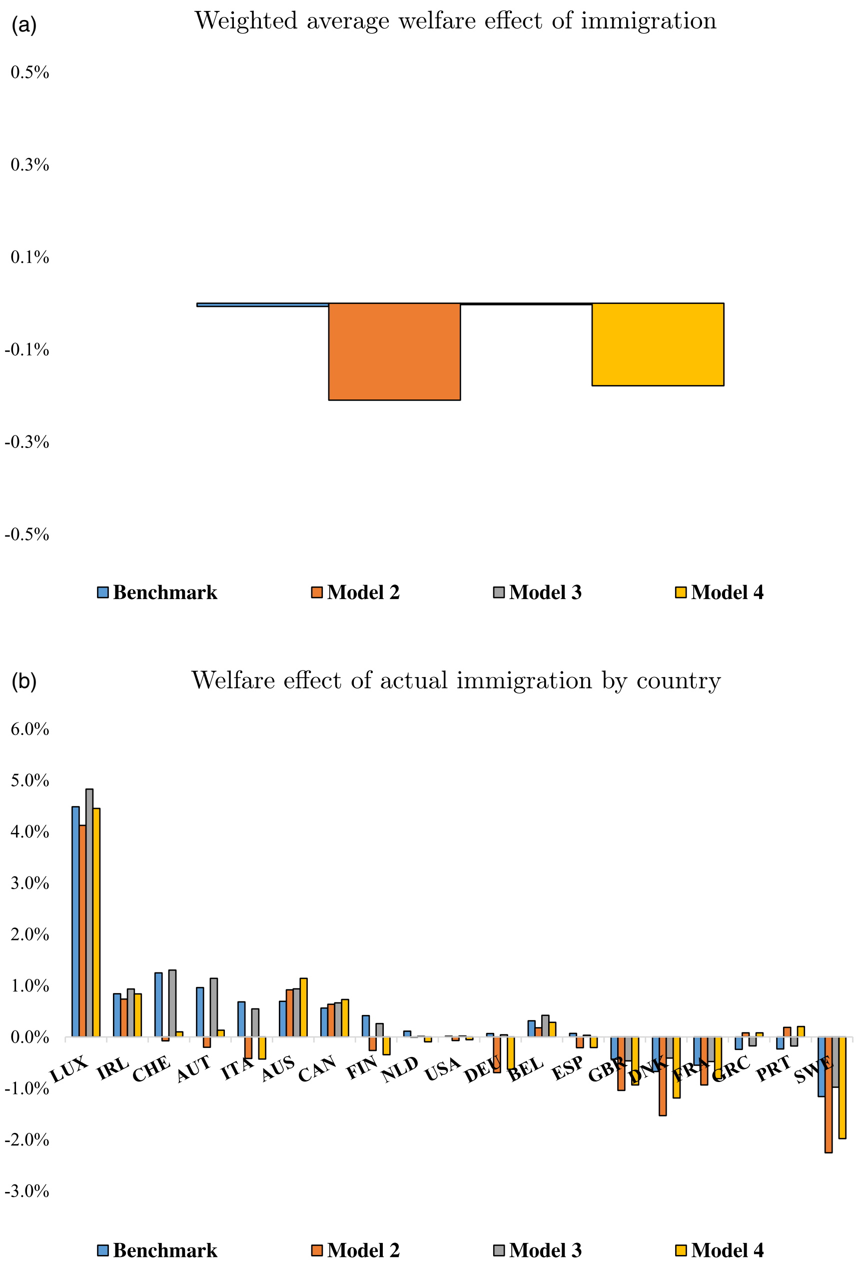

Figure 9. Effects of immigration for the period 2010–2015 on native welfare in the 19 selected OECD countries.
Note: Benchmark = Retirees & Endogenous Skill Acquisition; Model 2 = No Retirees; Model 3 = Exogenous Skill Acquisition; and Model 4 = No retirees & Exogenous Skill Acquisition. Countries are ranked in descending order according to the native welfare effect in the benchmark model. Variations are expressed in percentage points.

B.2. Testing the endogenous skill acquisition mechanism

One of the main features of the benchmark model presented in Section 3 is the inclusion of an endogenous decision for natives to acquire education. This feature allows young natives to adjust their skill in face of migration, as the skill composition of the migration flows affects natives

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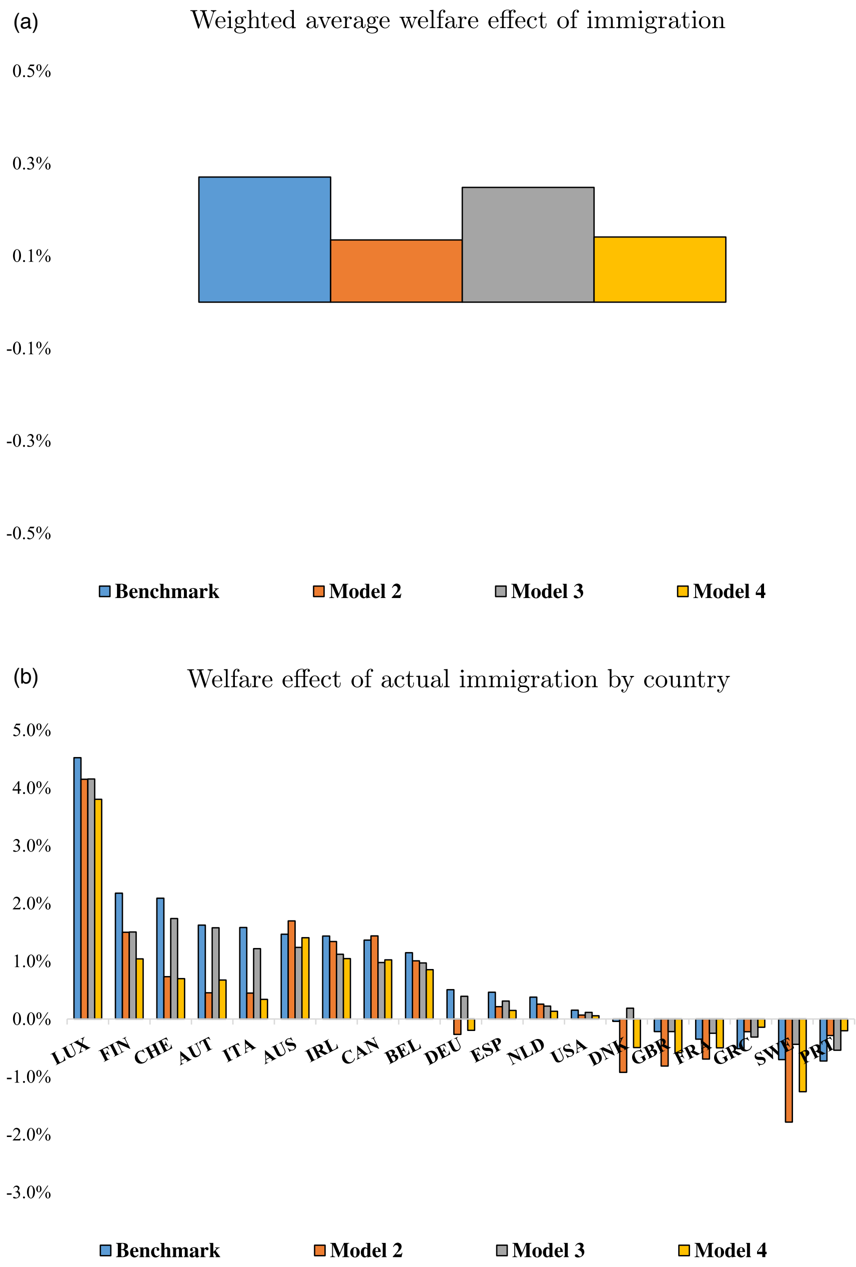

Figure 10. Effects of immigration for the period 2010–2015 on native welfare in the 19 selected OECD countries using W_n^* as welfare index.
Note: Benchmark = Retirees & Endogenous Skill Acquisition; Model 2 = No Retirees; Model 3 = Exogenous Skill Acquisition; and Model 4 = No retirees & Exogenous Skill Acquisition. Countries are ranked in descending order according to the native welfare effect in the benchmark model. Variations are expressed in percentage points.

education decisions in the long run. Because the DIOC census rounds provide information on the level of education, age, and labor market status for both natives and immigrants, it is possible to check to what extent the skill acquisition mechanism described in Section 3 is able to reflect the actual native skill composition changes observed in the data.

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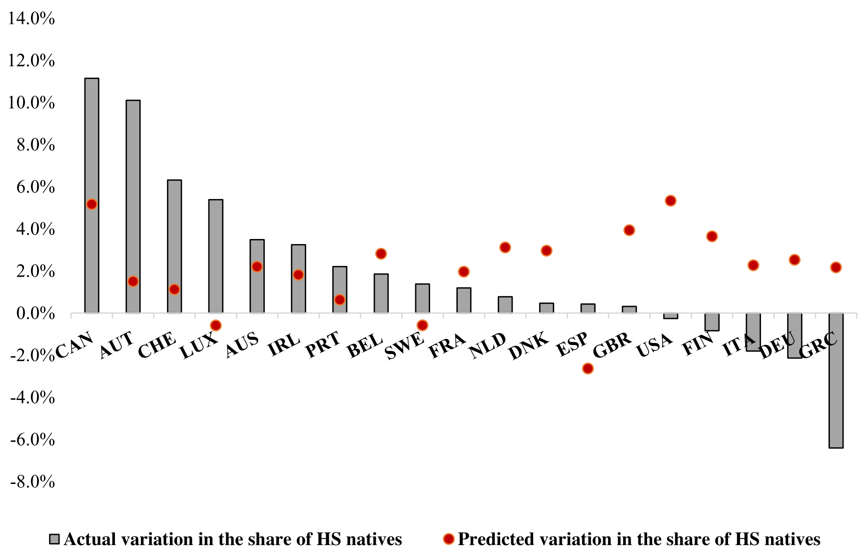

Figure 11. QNH

Figure 11 shows the comparison between the change in the share of high-skilled natives implied by the benchmark model, under the actual immigration shock, with the actual changes observed in DIOC 2015 census round data. On the average, the actual share of high-skilled natives rises by 1.9% in the 2010–2015 period. The average predicted variation in the share of high-skilled natives is 2%, which is extremely close to the actual variation of 1.9%. Nonetheless, the predicted variation by country is close to the actual variation only for very few countries (namely Austria, Ireland, Portugal, Belgium, and France) and the correlation between the two variations is close to zero (−1.3%).

Different reasons might explain such a poor result of this test. First, the changes in the native skill composition implied by the model are related to the long-run equilibrium, as the adjustment process only ceases when the economy reaches its steady state. On the contrary, the actual changes are related to what we observed after only a 5-year period. Second, for the sake of simplicity, the model completely abstracts from other sources that might affect the education decision, such as the government investments in education or the presence of a technological innovation process able to spur investments in human capital.

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Appendix C. Decomposed average welfare effects—component bar charts

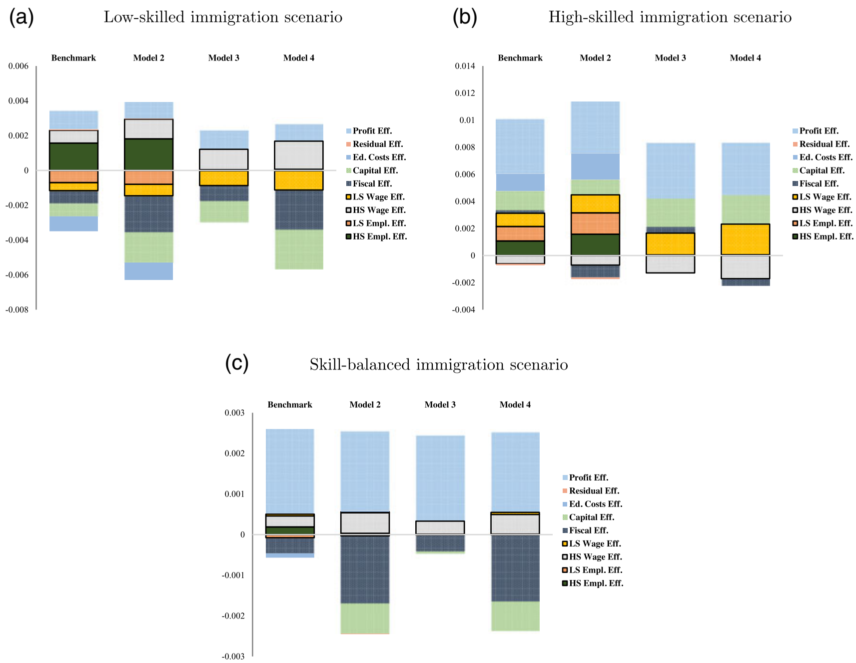

Figure 12. Average welfare effects of immigration (1% of the total labor force) decomposed for each transmission mechanism.
Note: Benchmark = Retirees & Endogenous Skill Acquisition; Model 2 = No Retirees; Model 3 = Exogenous Skill Acquisition; and Model 4 = No retirees & Exogenous Skill Acquisition.

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