Immigration, Skill Acquisition and Fiscal Redistribution in a Search-Equilibrium Model

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Abstract: Focusing on a selected group of 19 OECD countries, we analyze the effects of immigration on natives welfare, labor market outcomes and fiscal redistribution. To this end, we build and simulate a search and matching model that allows for endogenous natives skill acquisition and intergenerational transfers. The obtained results are then compared with different variations of our benchmark model, allowing us to assess to what extent natives skill adjustment and age composition affect the impact of immigration. Our comparative statics analysis suggests that when natives adjust their skill in response to immigration, they successfully avoid, under most scenarios, any potential displacement effect in the labor market. 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 retired workers that receive intergenerational transfers. Finally, we find that, under any scenario, our model yields more optimistic welfare effects than a standard search model that abstracts from skill decision and intergenerational redistribution. These welfare effects are found to be overall particularly positive when the migration flows comprise high-skilled workers.

JEL classification: F22, J24, J61, J64.

Keywords: Immigration, Welfare, Unemployment, Skill Acquisition, Fiscal Redistribution.

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1 Introduction

Over the past decade, 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 United States.[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, in the long-run younger natives may respond to immigration by upgrading their skills and specializing in different production tasks. 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.

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 influence the 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 to better assess the fiscal impact of migration, as natives and immigrants are characterized by different age composition and social welfare usage. To the best of our knowledge, no previous paper has developed a theoretical model able to analyze long-run effects of migration on natives welfare by taking into account unemployment issues, endogenous skill acquirement, and fiscal redistribution among different generations.[2]

Focusing on a selected group of 19 OECD countries, we calibrate and simulate the search model under three different scenarios: (a) an increase in low-skilled migration equal to 1 percent of the total labor force; (b) an increase of the same size of high-skilled migration; (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, when skill acquisition is endogenous, young natives are effectively able to avoid any potential displacement effect under scenarios (b) and (c), in most of the analyzed countries. When the

[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.

immigration shock consists only of low-skilled workers (scenario (a)), native unemployment slightly increases in most countries, but native average wages noticeably increase in all of the 19 countries. Second, we find that taking into account the age composition of the population plays a key role in determining the fiscal impact of immigration. In particular, we find that the fiscal impact of skill-balanced and high-skilled immigration is positive for most 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 mostly 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 increse the average native welfare on almost most countries, while low-skilled immigration is found to be beneficial to natives welfare on 9 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; 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, analyzing whether natives 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.

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 (2014), Chassambouli and Peri (2015), Liu et al. (2017) and Battisti et al. (2018). 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 on government balance and welfare. Moreover, they assume that all workers' skill level is exogenous, so 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 U.S. and Sweden. Dustmann and Frattini (2014) find a noticeable positive fiscal contribution from recent immigrants, especially those originating from EEA countries. However, aside from Battisti et al. (2018), this literature mainly focuses on an account approach without considering labor market interactions between migrant and native workers.

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.[3] We use the Database on Immigrants in OECD countries (DIOC) described by Arslan et al. (2014) to account for differences in demographic characteristics, level of education, and labor market status of the population of the 19 selected OECD countries. In particular, we focus on the census round 2010, extracting information about the country of origin, age, educational attainment and labor market status of immigrants residing in 19 selected OECD countries (the 15 members of the European Union, Australia, Canada, Switzerland and US).

Figure 1 below compares labor market status, education level and age composition of immigrant and native residents in the analyzed countries.

Figure 1a displays the amount of immigrant workers of age 25–64 participating to the labor force, as a share of the total work force of the same age in the analyzed OECD countries. In 17 out of the 19 countries (all but Denmark and Finland), the share of immigrant workers is higher than 11%, with Luxembourg being the OECD country that relies the most on migrant workers (about 50% of its labor force is foreign-born). The average is 18% and the standard deviation is 10%.

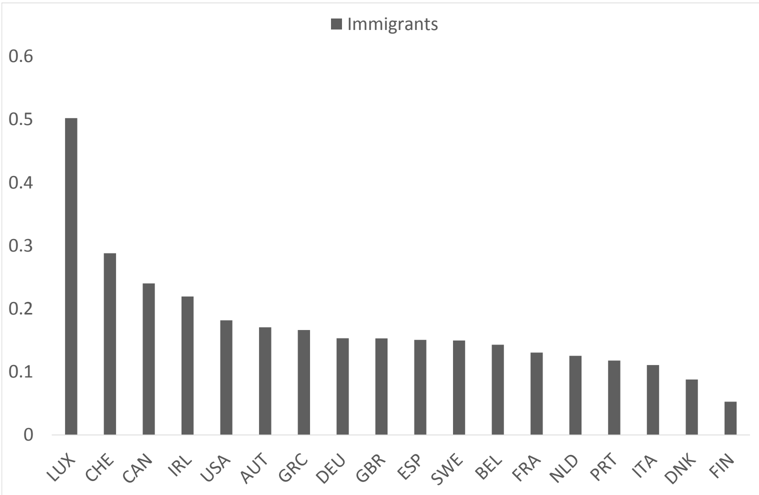
Figure 1b shows that, on average, immigrants suffer from a higher unemployment rate (12.9% for immigrants versus 9.7% for natives). In particular, 16 out of 19 countries (all but Ireland, US and Canada) are characterized by a higher unemployment rate for immigrant workers, though the correlation between immigrant and native unemployment is extremely high (91.3%). However, it is noteworthy that in some countries the difference in unemployment rates is quite substantial. In Spain, immigrant workers suffer an unemployment rate almost 10 percent points higher than natives, while in Austria, Netherlands and Sweden the migrant unemployment rate is more than twice as high as the native one.

As far as skill composition is concerned, Figure 1c illustrates the share of immigrant and native workers with at least one year of college education or a bachelor degree (ISCED 5). Despite the correlation between native- and foreign-born is high (65.7%) and, on average, immigrants and

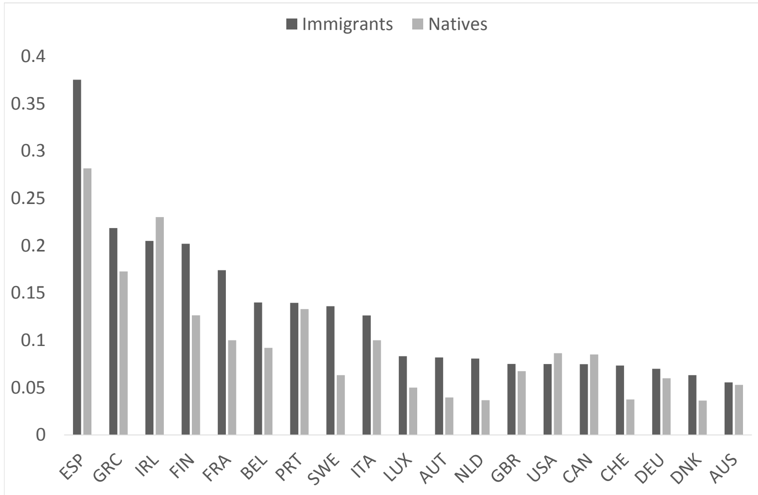
[3]Source: OECD (2018)

Figure 1: Labor market and population characteristics

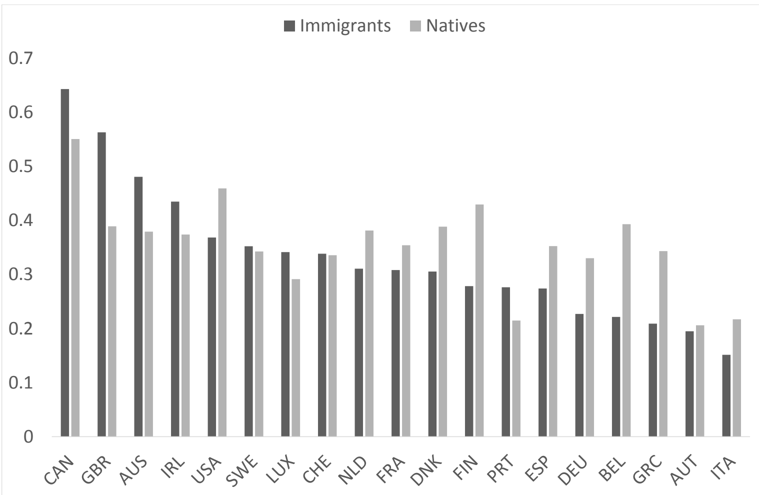
(a) Share of foreign-born labor force across countries



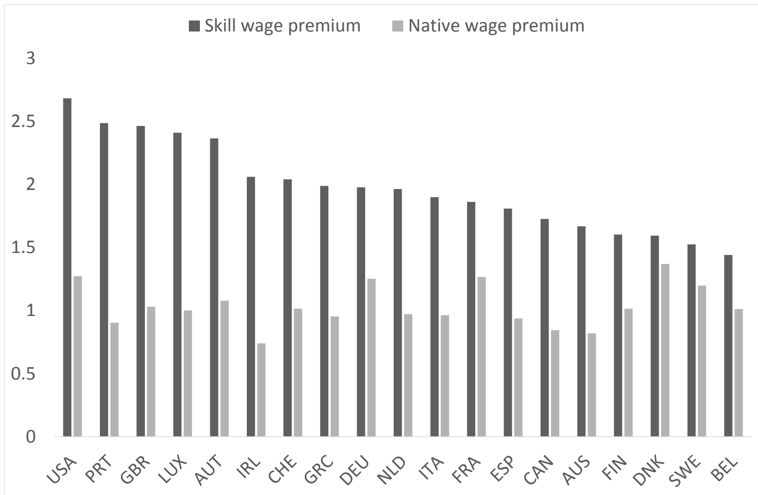
(b) Unemployment rates



(c) Shares of college-educated people



(d) Wage ratios



Note: Figure 1 shows population characteristics for 19 selected countries: the 15 members states of the European Union (EU15), Australia, Canada, Switzerland and US.

natives have a similar share of college educated workers (33% for immigrants, 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.

Heterogeneity in countries wage premiums are underlined in Figure 1d. Data on wage ratios between native and immigrant workers are obtained from Buchel and Frick (2005) and Docquier et al. (2014), while average returns to skill are taken from OECD (2012) data. In almost all countries, natives earn more than immigrant workers. In Section 3, we follow Ottaviano and Peri (2012) and interpret this stylized fact as a result of imperfect substituability in production between immigrant and native workers.[4] Finally, a consistent education wage premium is present in most countries, with college-educated workers earning more than twice as much as lesser-educated ones in 7 out of 19 countries.

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 foreign-born individuals who immigrated in the domestic economy. Second, agents are characterized by different education attainments. Following the bulk of the literature that identifies education based-skills (e.g. Card, 2009; Docquier et al., 2014; 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 born and retire at the same rate ν. Moreover, in each time period t, the number of deaths equal the number of births, so that the population sizes of young and retired agents are constant over time.

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 whereas no confusion arises.

In Section 3.1 and Section 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 Section 3.3 and Section 3.4. Finally, the search equilibrium is characterized in Section 3.5.

[4] Multiple determinants may also influence the native wage premium, such as imperfect transferability of human capital (Poutvaara, 2008), or discrimination (Bartolucci, 2014). We later perform a sensitive analysis to take into account the case in which immigrant and native workers are perfect substitutes in production.

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 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; 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

$$Z = \left[xY_h^{(\sigma_1-1)/\sigma_1} + (1-x)Y_l^{(\sigma_1-1)/\sigma_1}\right]^{\sigma_1/(\sigma_1-1)} \tag{2}$$

$$Y_s = \left[\lambda Y_{ns}^{(\sigma_2-1)/\sigma_2} + (1-\lambda)Y_{ms}^{(\sigma_2-1)/\sigma_2}\right]^{\sigma_2/(\sigma_2-1)}, \quad s = (h,l),$$

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.

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), we assume that 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

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

where M is the number of job matches, ξ is a constant matching efficiency parameter, 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 $M_s/U_s = \xi\theta^{1-\epsilon} \equiv m(\theta_s)$, and the vacancy filling rate is given by $M_s/V_s = \xi\theta^{-\epsilon} \equiv q(\theta_s)$. As it 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.

Asset value functions

Let $\mathcal{J}_s^{o,F}$ and $\mathcal{J}_s^{V}$ denote the value associated with a filled and unfilled vacancy, respectively.[5] Then, their flow value in steady-state is given by

$$r\mathcal{J}_s^{o,F} = p_{os} - w_{os} - (\delta_{os} + \nu)\left[\mathcal{J}_s^{o,F} - \mathcal{J}_s^{V}\right] \tag{6}$$
$$r\mathcal{J}_s^{V} = -c_s + q(\theta_s)\left[(1-\phi_s)\,\mathcal{J}_s^{n,F} + \phi_s \mathcal{J}_s^{m,F} - \mathcal{J}_s^{V}\right], \tag{7}$$

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, and δ_{os} is the exogenous separation rate, which is allowed to differ for 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, $\delta_{os} + \nu$.[6] 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

[5] 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.

[6] Remind that a worker will separate from a firm at a rate $\delta_{os} + \nu$, rather than δ_{os}, because he will not supply work after retirement.

vacancy, which occurs at a probability $q(\theta_s)$.

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

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

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

where τ is the labor income tax rate, T_{os}^{y} are redistributive transfers to young workers of origin o and skill s, rk is the per capita capital income, 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, and the expected gain from becoming a retiree, $\nu\left[\mathcal{J}_{os}^{R} - \mathcal{J}_{os}^{E}\right]$. Likewise, equation (9) states that the flow value of unemployment equals its return, i.e. 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, letting R_{os} denote the number of retired workers of type (o,s), the flow value of being a retired worker in steady-state, $\mathcal{J}_{os}^{R}$, can be written as

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

where T_{os}^{R} are redistributive transfers paid to retired workers and $g \equiv \nu Q_{os}/R_{os}$ is the share of retirees that die at each time period t.[7]

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

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

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, $r+\nu+\delta_{os}$. Note that a higher market tightness θ_s

[7]Note that, in each time period t, a mass of workers $\nu\sum_{o}\sum_{s} Q_{os}$ retire and, at the same time, the same number of retirees die. This implies that the total number of retirees is constant over time and the ratio $\nu Q_{os}/R_{os}$ is always within $(0,1)$.

translates to higher vacancy opening costs, since the waiting time for filling a vacancy is is increasing in θ_s.

Wage determination

Following mainstream search and matching literature, once a match between a worker and a vacancy has been formed, firms and workers bargain over wages. Let $\beta \in (0,1)$ denote the worker bargaining power. The solution of the bargaining problem is then given by the wage rate w_{os} that satisfies

$$(1-\beta)\left(\mathcal{J}_s^{o,E} - \mathcal{J}_s^{o,U}\right) = \beta\left(\mathcal{J}_s^{o,F} - \mathcal{J}_s^{V}\right).$$

Combining 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

$$w_{os} = \frac{\beta\left[r+\nu+\delta_{os}+m\left(\theta_s\right)\right]p_{os}}{\left(r+\nu+\delta_{os}\right)\left[1-\left(1-\beta\right)\left(\tau+\mu\right)\right]+\beta m\left(\theta_s\right)}, \tag{13}$$

where the unemployment benefit b_{os} has been endogenized and proportionally set to the wage rate, i.e. $b_{os} \equiv \mu w_{os}$, with $\mu \in (0,1)$ denoting the replacement rate. According to equation (13), 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.

Employment

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 break-ups that take place in a given instant of time t; that is

$$\dot{E}_{os} = m\left(\theta_s\right)U_{os} - \left(\delta_{os}+\nu\right)E_{os}. \tag{14}$$

Denoting with $Q_{os} \equiv E_{os} + U_{os}$ the total amount of active individuals of type (o,s), the total amount of employed and unemployed people in steady-state can be written as

$$E_{os} = \frac{m\left(\theta_s\right)Q_{os}}{\delta_{os}+\nu+m\left(\theta_s\right)} \tag{15}$$

$$U_{os} = \frac{\left(\delta_{os}+\nu\right)Q_{os}}{\delta_{os}+\nu+m\left(\theta_s\right)}. \tag{16}$$

Based on equations (15) and (16), for any given size of the active population Q_{os}, employment increases in the job finding probability, $m(\theta_s)$, and decreases in the separation rate, δ_{os}.

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. 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 make them prevent from investing in training. Let z denote the cost of acquiring training and assume 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

$$\mathcal{J}_{nh}^{U} - \mathcal{J}_{nl}^{U} \geq z. \tag{17}$$

Setting (17) as an equality, there exists a threshold value for the training cost

$$z^{*} = \mathcal{J}_{nh}^{U} - \mathcal{J}_{nl}^{U}, \tag{18}$$

such that agents will find it profitable to invest in education and become high-skilled. From equation (17), 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

$$\gamma = \frac{z^{*}}{\bar{z}}. \tag{19}$$

Plugging equation (9) into (17), and then using equation (8), the steady-state share of native high-skilled workers γ reads

$$\gamma = \frac{\mu\left(w_{nh} - w_{nl}\right) + T_{nh}^{y} - T_{nl}^{y} + m\left(\theta_{h}\right)\left[\frac{w_{nh}(1-\tau-\mu)}{r+\nu+\delta_{nh}+m(\theta_{h})}\right] - m\left(\theta_{l}\right)\left[\frac{w_{nl}(1-\tau-\mu)}{r+\nu+\delta_{nl}+m(\theta_{l})}\right]}{\bar{z}\left(r+\nu\right)}. \tag{20}$$

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, in steady-state, the ratio R_{nh}/R_{nl} always matches the ratio Q_{nh}/Q_{nl}.

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_{os}^{a}, where the superscript $a = (y, R)$ denotes young and retired individuals.[8] Assuming that the government conducts a zero profit policy, the government budget constraint writes

$$\tau \sum_{o} \sum_{s} w_{os} = \mu \sum_{o} \sum_{s} U_{os} w_{os} + \sum_{o} \sum_{s} Q_{os} T_{os}^{y} + \sum_{o} \sum_{s} R_{os} T_{os}^{R}. \tag{21}$$

[8] As in Burzynski et al. (2018), T_{os}^{a} includes redistributive transfers that vary across origin and skill types, as well as public consumption which is assumed to be identical across all individuals.

The left-hand side of equation (21) corresponds to the government revenues, whereas the right-hand side corresponds to the government expenditures. The income tax τ is assumed to endogenously adjusts to balance the government budget, so that when a temporary deficit (surplus) takes place, the government responses by raising (decreasing) τ.

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 market 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 (13) holds for each origin o and skill type s; (v) the numbers of employed and unemployed workers are given by equations (15) and (16) for each origin o and skill type s; (vi) the skill acquisition condition (20) is satisfied; (vii) the government sustains a no-deficit policy and its budget (21) is balanced.

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[9]

$$\mathcal{W}_n \equiv \frac{\sum\limits_s E_{ns}\mathcal{J}^E_{ns} + \sum\limits_s U_{ns}\mathcal{J}^U_{ns} - \frac{z^*}{2}Q_{nh} + \sum\limits_s R_{ns}\mathcal{J}^R_{ns}}{\sum\limits_s (Q_{ns} + R_{ns})}, \tag{22}$$

where $\frac{z^*}{2}$ is the (endogenous) average cost of acquiring skill.[10] The welfare index $\mathcal{W}_n$ includes the whole flows of native labor income, capital income, unemployment benefits, transfers and cost for training.

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.

[9]Using this welfare index is equivalent of using the welfare index proposed by Battisti et al. (2018) when the skill decision is exogenous and the population size is static. For the sake of exposition, in this section we will refer to the immigration effects on welfare only for the natives group. Appendix A shows the effects on immigrants welfare, as well as on specific workers groups.

[10]Recall that native workers are heterogenous with respect to their cost of training and that z in uniformly distributed. This implies that the average cost payed by natives to acquire skill is $\frac{z^*}{2}$, and the total training cost is $\frac{z^*}{2}Q_{nh}$.

4.1 Parametrization

We parametrize the described model in order to match the economic and socio-demographic characteristics of 19 OECD countries (EU15 member states, Australia, Canada, Switzerland and USA).

The described model includes a total of 32 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. Because the following analysis focuses on steady-state variations, all scale parameters which do not affect the results – namely, the TFP level A and the matching efficiency ξ – are, for simplicity, normalized to unity in all countries.

Data sources used to calibrate country specific variables. As anticipated in Section 2, we use the DIOC data to account for different demographic characteristics over the 19 OECD countries. These data cover the census round 2010 and document the structure of the population by country of origin, age, education level, and labor market status. As in Aubry et al. (2016), we consider the share of population aged 65 and over as retired and out of the labor force, while individuals aged 25 to 64, or that did not report their age, as the working aged group.[11] Further, individuals that have at least one year of college education or a bachelor degree are regarded as high-skilled, whereas those with no education, with pre-primary, primary or secondary education completed, or that did not report their education level, are defined as the less-educated. Following Burzynski et al. (2018), data on the wage ratio between college-educated and less educated workers are taken from the *Education at Glance 2012* report of the OECD, and used as a proxy for the average return to skill w_h/w_l. Data on the wage ratio between native and immigrant workers are instead obtained from Buchel and Frick (2005) and from Docquier et al. (2014).

As far as the fiscal characteristics of the 19 OECD countries are concerned, comparable aggregate data on public finances are obtained from the *Annual National Accounts* harmonized by the OECD. In line with Burzynski et al. (2018), we use it to identify the redistributive transfers T^a_{os} and the ratio of public expenditure to GDP. We also identify the amount of public consumption and treat it as a homogeneous transfer to all residents (as a part of T^a_{os}). As in Aubry et al. (2016), we also use the Social Expenditure Database (SOCX) of the OECD to decompose social protection expenditures, and the European Union Statistics on Income and Living Conditions (EU-SILC, provided by Eurostat) to disaggregate education and social protection transfers received by the natives; transfers to natives are then identified by education level and by age group.

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

[11] Note that the DIOC data do not distinguish retirees by origin country. Following Burzynski et al. (2018), we assume that retirees origin distribution follows the same proportion of the younger individuals, i.e. $R_n/R_m \equiv \sum_s Q_{ns}/\sum_s Q_{ms}$.

Chassamboulli and Palivos (2014) and Battisti et al. (2018), 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 vancancy cost κ_l to the same value adopted in Battisti et al. (2018).[12]

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)
κ_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)

Calibration of country-specific parameters. Exogenous parameters varying across countries are listed in Table 2. The parameters x and λ are calibrated to match, respectively, the average return to skill w_h/w_l and the average native wage premium w_n/w_m. 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 ratio κ_h/κ_l is parameterized to match 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. 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 observed share of unemployment benefits in GDP. Further, we calibrate the level of public transfers so to match the government expenditure to GDP as well as transfers by different cohorts taken from the OECD *Annual National Accounts* database.

Finally, we normalize the total young workers population to one and parametrize the shares of total retirees by origin ($R_m \equiv \sum_s R_{ms}$ and $R_n \equiv \sum_s R_{ns}$) and young immigrants by skill (Q_{mh} and Q_{ml}) according to DIOC data.[13]

Using this parameters 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.[14]

[12]As pointed out in Battisti et al. (2018), this is a normalization that does not affect the obtained results.

[13]Note that the total number of retirees by origin is exogenous, but the number of retirees by origin and skill is endogenous (e.g. $R_{nh} \equiv R_n\gamma$).

[14]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 the considered countries for the benchmark model.

Table 2: Parameters varying across countries

Parameters	Description	Mean	S.d.	Moment matched
Labor market parameters				
x	Firms' preference to HS	0.521	0.038	Avg. return to skill w_h/w_l
λ	Firms' preference to natives	0.592	0.054	Avg. wage ratio w_n/w_m
δ_{nh}	Break-up rate of HS natives	0.064	0.044	Unempl. rate U_{nh}/Q_{nh}
δ_{nl}	Break-up rate of LS natives	0.072	0.052	Unempl. rate U_{nl}/Q_{nl}
δ_{mh}	Break-up rate of HS immigrants	0.07	0.046	Unempl. rate U_{mh}/Q_{mh}
δ_{ml}	Break-up rate of LS immigrants	0.113	0.075	Unempl. rate U_{ml}/Q_{ml}
κ_h/κ_l	Vacancy costs ratio	1.98	0.36	Avg. return to skill w_h/w_l
$\bar{z}$	Training cost (compared to US)	0.835	0.442	Share of HS native workers γ
Fiscal parameters				
μ	Replacement rate	0.4	0.11	OECD data
T^y_{nh}	Transfers to natives HS	0.194	0.047	Gov. exp./GDP
T^y_{nl}/T^y_{nh}	Transfers ratio NL/NH	0.938	0.163	OECD data
T^y_{mh}/T^y_{nh}	Transfers ratio MH/NH	1,365	0.453	OECD data
T^y_{ml}/T^y_{nh}	Transfers ratio ML/NH	1.276	0.438	OECD data
T^r_{nh}/T^y_{nh}	Transfers ratio ret. NH/NH	2.486	0.984	OECD data
T^r_{nl}/T^y_{nh}	Transfers ratio ret. NL/NH	1.748	0.489	OECD data
T^r_{mh}/T^y_{nh}	Transfers ratio ret. MH/NH	2.367	0.889	OECD data
T^r_{ml}/T^y_{nh}	Transfers ratio ret. ML/NH	1.908	0.788	OECD data
Demografic sizes (native workers population normalized to unity)				
Q^y_{mh}	Young migrants HS	0.09	0.088	OECD data
Q^y_{ml}	Young migrants LS	0.162	0.138	OECD data
R_m	Retired migrants HS	0.077	0.049	OECD data
R_n	Retired migrants LS	0.353	0.085	OECD data

4.2 Sensitivity to different specifications

In this section, we simulate a 1 percent increase in the labor force due to immigration under four different versions of the benchmark model described in Section 3. Our main goal is to analyze the effects of immigration on natives welfare, and to assess to what extent taking into account natives endogenous skill and age composition matters in such analysis.[15] To this end, we compare the results obtained by the benchmark version of the model with those obtained in models that differ for the following elements: (a) the economy is composed of only working-age individuals, i.e $R_{os} \equiv 0$ for each agent type (o, s) (henceforth referred as Model 2); (b) young natives never adjust their skill in response to migration, i.e. γ is exogenous (henceforth referred as Model 3); (c) there are no retirees in the economy and young natives never adjust their skill, i.e. $R_{os} \equiv 0$ and γ is exogenous (henceforth referred as Model 4).

Since 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; Ottaviano and Peri, 2012), in the analysis we consider three different types of one-off migration shocks: (i) a shock of low-skilled immigrant workers (Q_{ml}); (ii) a shock of high-skilled immigrant workers (Q_{mh}); (iii) a shock of low- and high-skilled immigrant workers such that the immigrant skill composition does not change in the post-shock scenario. Henceforth we will refer to this latter scenario as the "skill-balanced" migration shock.

[15] Battisti et al. (2018) simulate a shock of the same magnitude.

Moreover, as the impact of immigration on native welfare crucially depends on how the new influx of foreign-born workers affect the labor market and the fiscal balance of the domestic economy, we also analyze three main channels through which migration impacts native welfare: the average labor income of native workers ($w_n \equiv \sum_s E_{ns} w_{ns} / \sum_s E_{ns}$), the native unemployment rate ($u_n \equiv \sum_s U_{ns} / \sum_s Q_{ns}$), and the fiscal effect on the income tax rate (τ).[16]

4.2.1 The effects of low-skilled immigration

Figure 2 shows the effect of low-skilled immigration on the labor market, fiscal balance and native welfare of the 19 selected OECD countries.

Under the benchmark version of the model, 8 out of 19 countries experience a decrease in native unemployment rate (see Figure 2a). A similar result is obtained for Model 3, whereas Model 2 and Model 4 find a decrease in the native unemployment rate only for Belgium. Moreover, native wages positively respond to low-skilled immigration under all specifications, but the benchmark model and Model 2 are noticeably more optimistic than the other models (see Figure 2b). This underlines the importance of taking into account natives skill acquisition: in the long-run, young natives decide to upgrade their skill and invest more in education in order to avoid the fiercer competition of the new influx of low-skilled migrants. As a consequence, in models with endogenous native skill a higher share of natives will be high-skilled in the post-shock scenario, making average wages raise and, on some countries, native unemployment rates decrease.[17]

As far as the fiscal impact is concerned, Figure 2c shows that the benchmark model is more optimistic than the others on all countries but Belgium. In particular, low-skilled immigration has a positive effect on government income in in 9 countries out of 19 under the benchmark model. Model 4 is the more pessimistic, as it finds a positive fiscal impact only for Belgium, whereas Model 2 and Model 3 find positive effects for 4 and 7 countries, respectively. This underlines that including both endogenous skill acquisition and age composition matters for assessing the fiscal impact of low-skilled immigration.

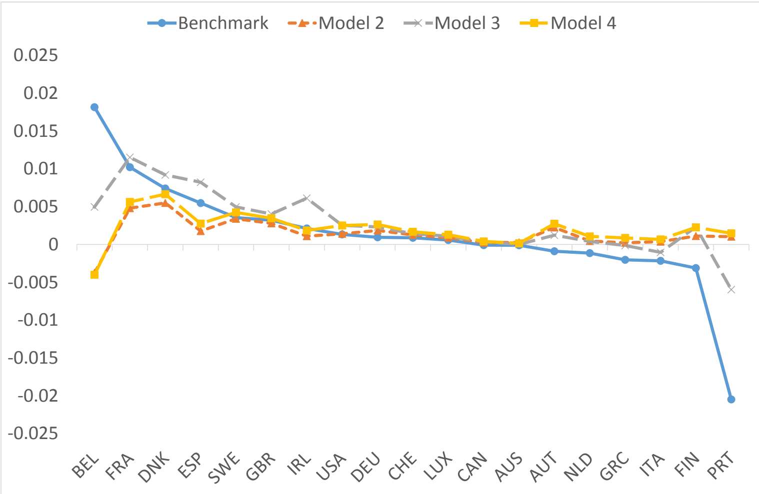
These results lead to an average native welfare effect which is positive only for a sub-group of OECD countries (see Figure 2d). Under the benchmark model, the average native welfare increases for 9 out of the 19 OECD countries. Table 3 shows average results for the aggregate group of the 19 selected 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 Model 2 and Model 4) in order to account for the differences in country size. Interestingly, Model 2 turns out to be the more optimistic model when assessing the native welfare average effect of the whole group of countries, though the benchmark model is still less pessimistic than Model 3 and Model 4.

[16] As described in Section 3, the tax rate on labor income τ is assumed to always adjust to balance the government budget (21). This implies that, after a shock, if the domestic economy experiences an increase in income (expenditures), the government will set a lower (higher) tax rate until its budget balances again.

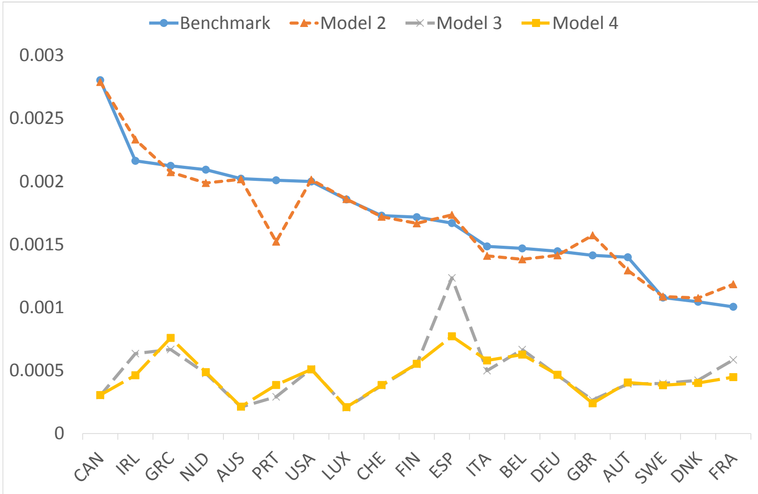
[17] Note that, as pointed out in Battisti et al. (2018), it is possible for unemployment rates to decrease after immigration, as firms may increase their profit after the shock and open more vacancies for both native and immigrant workers.

Figure 2: Effects of low-skilled immigration (1% of the total labor force) on 19 selected OECD countries

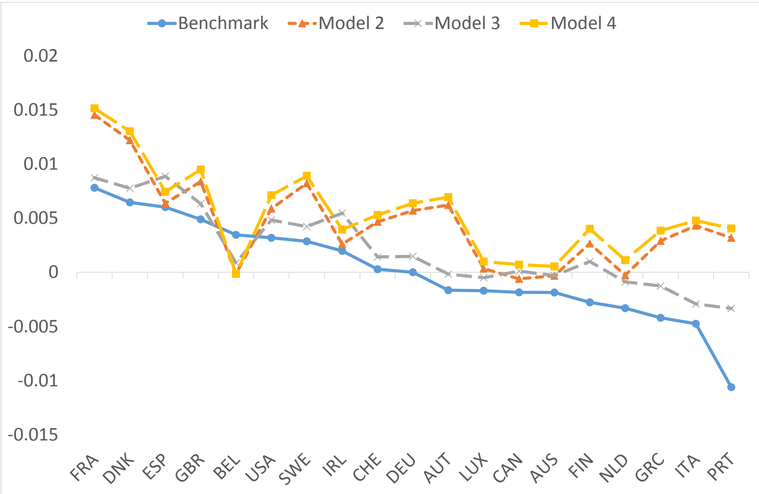
(a) Effect on avg. native unemployment rate



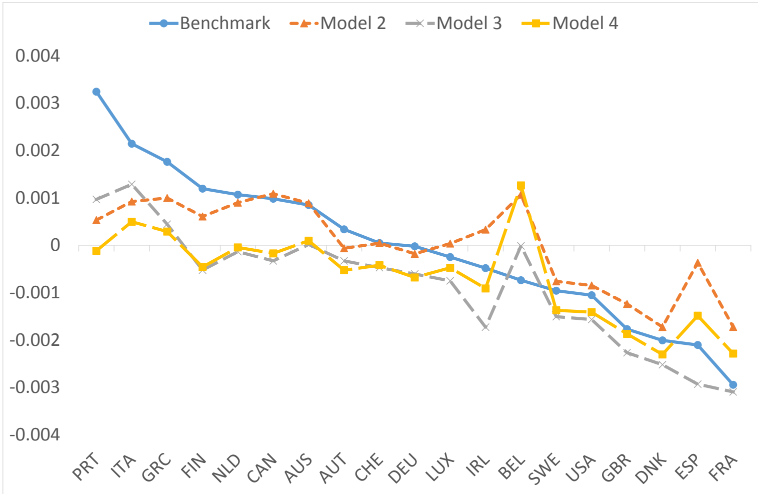
(b) Effect on avg. native wage



(c) Effect on labor income tax



(d) Effect on avg. native welfare



Note: Solid lines represent the benchmark model, whereas square-dotted, short-dashed and long-dashed lines represent Model 2, Model 3 and Model 4, respectively.

Table 3: Weighted average effects of low-skilled immigration

Variable	Benchmark	Model 2	Model 3	Model 4
u_n	0.193	0.173	0.327	0.248
w_n	0.173	0.175	0.052	0.048
τ	0.2	0.603	0.373	0.702
$\mathcal{W}_n$	-0.064	-0.044	-0.127	-0.108

Note: all values indicate variations in percentage points. Each country is weighted according to its native population size. Appendix B provides results for unweighted averages.

4.2.2 The effects of high-skilled immigration

The steady-state variations of increasing the number of high-skilled immigrant by 1 percent of the total labor force population over the 19 OECD countries are illustrated in Figure 3.

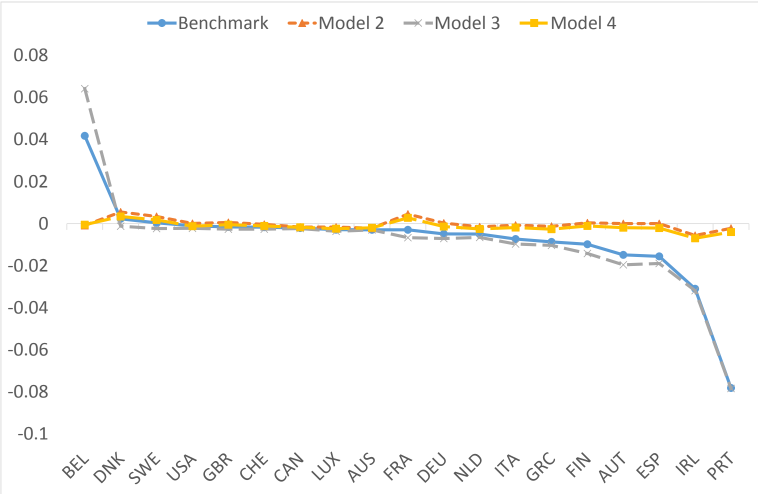
Regarding the effects on the labor market outcomes, simulations of high-skilled immigration yield contrastant results that depend on the assumption on natives skill acquisition. In models in which natives skill acquisition is exogenous (Model 3 and Model 4), the higher competition in the high-skill sector makes, on average, native unemployment rate to slightly increase, though native wage rates increase as well (see Table 4). On the contrary, in models in which young natives are allowed to endogenously adjust their skill (Benchmark and Model 2), young natives avoid the increasing competition in the high-skill sector by supplying low-skill labor. As a result, native unemployment rates, on average, decrease (Figure 3a shows that native unemployment rate decreases in all countries but Belgium, Denmark and Sweden for the benchmark model), but at the expense of average lower wage rates as, after the shock, more native people are now working in the low-skilled sector, which pays for a lower wage rate.

Figure 3c shows that when age composition is taken into account, the labor income tax rate decreases in almost all countries. In particular, under the benchmark model, high-skilled immigration has positive fiscal effects for all countries but Belgium and Denmark. Simulations on Model 2 and Model 4 produce similar results, which find an average negative effect of high-skilled migration on the domestic country fiscal balance. These results underline that endogenizing skill acquisition does not noticeably affect the fiscal impact of immigration on the OECD countries, whereas age composition plays a bigger role on assessing the fiscal effect of high-skilled immigration.

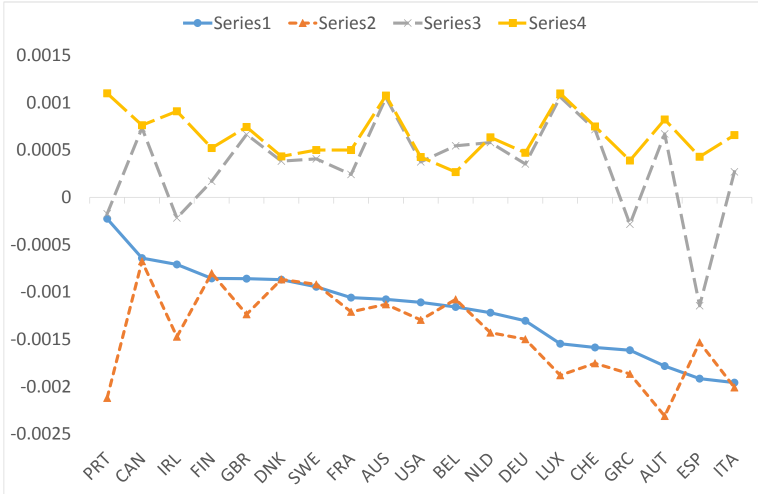
Native welfare effects are depicted in Figure 3d. The simulations yield positive native welfare impacts on most countries under all model variations. Interestengly, Model 3 is found to be the more optimistic model, underlining the fact that, when age composition is considered, high-skilled immigrants greatly alleviate the fiscal burden in the host country. Conversely, Model 2 and Model 4, which do not account for age composition, are the least optimistic. Finally, The benchmark model finds positive native welfare effect on all countries but Belgium and Denmark, which are the same countries for which simulations generate negative labor market outcomes in the post-shock scenario.

Figure 3: Effects of high-skilled immigration (1% of the total labor force) on 19 selected OECD countries

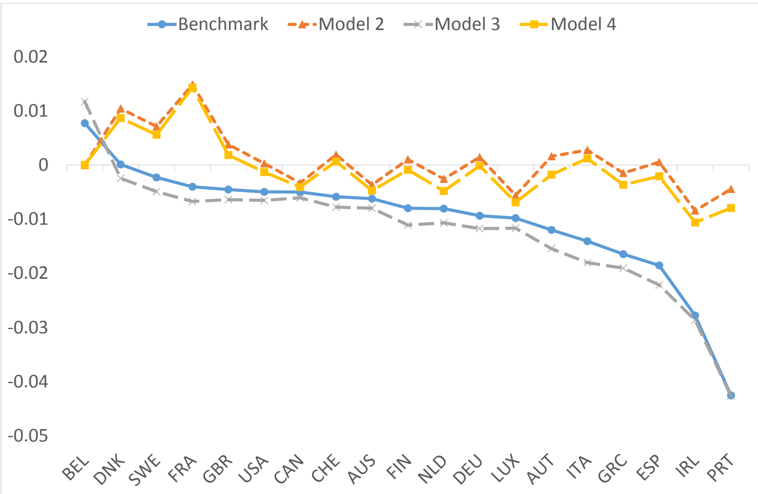
(a) Effect on avg. native unemployment rate



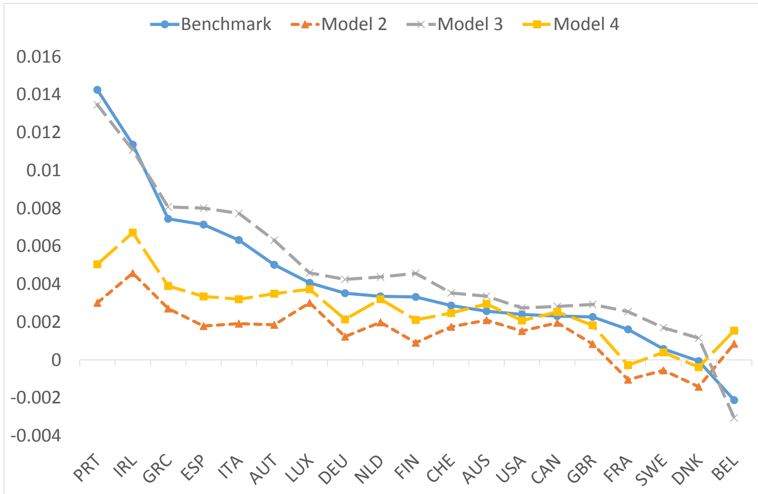
(b) Effect on avg. native wage



(c) Effect on labor income tax



(d) Effect on avg. native welfare



Note: Solid lines represent the benchmark model, whereas square-dotted, short-dashed and long-dashed lines represent Model 2, Model 3 and Model 4, respectively.

Table 4: Weighted average effects of high-skilled immigration

Variable	Benchmark	Model 2	Model 3	Model 4
u_n	-0.451	0.029	-0.601	0.104
w_n	-0.122	-0.138	0.029	0.054
τ	-0.794	0.191	-1.006	0.031
$\mathcal{W}_n$	0.339	0.130	0.401	0.217

Note: all values indicate variations in percentage points. Each country is weighted according to its native population size. Appendix B provides results for unweighted averages.

4.2.3 The effects of skill-balanced immigration

Figure 4 provides our simulation results on an increase in the stock of young immigrants by 1 percent of the total labor force, holding constant their actual education composition.

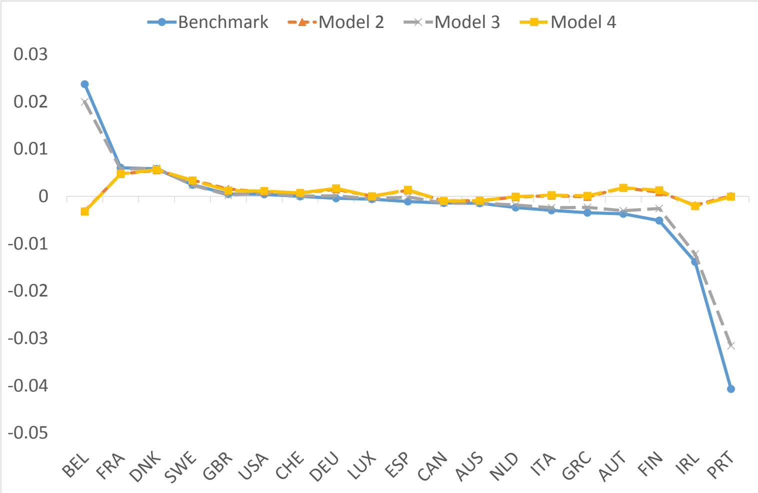
The benchmark model is the most optimistic model version for assessing the effect of skill-balanced migration on labor market outcomes. The native unemployment rate decreases in 12 out of 19 countries after the migration shock under the benchmark model. The other model variations find less optimistic results (see Figure 4a). In particular, Model 4 predicts a decrease in native unemployment rate only for 6 out of 19 countries. As far as labor income is concerned, native wages are found to increase for all countries under all of the four model versions, but slightly more when taking into account natives endogenous skill acquisition (see Figure 4b).

Figure 4c shows results for the fiscal effects of immigration over the 19 OECD countries. The benchmark model and Model 3 are found to be more optimistic than the other model versions for all countries but Belgium. In particular, 14 out of 19 countries experience a positive fiscal effect for the benchmark model and Model 3, while only 6 out of 19 countries experience positive fiscal effects under Model 2 and Model 4 after the skill-balanced immigration shock. This is coherent with the previous finding that taking into account age skill composition positively changes the fiscal impact of immigration on the domestic economy.

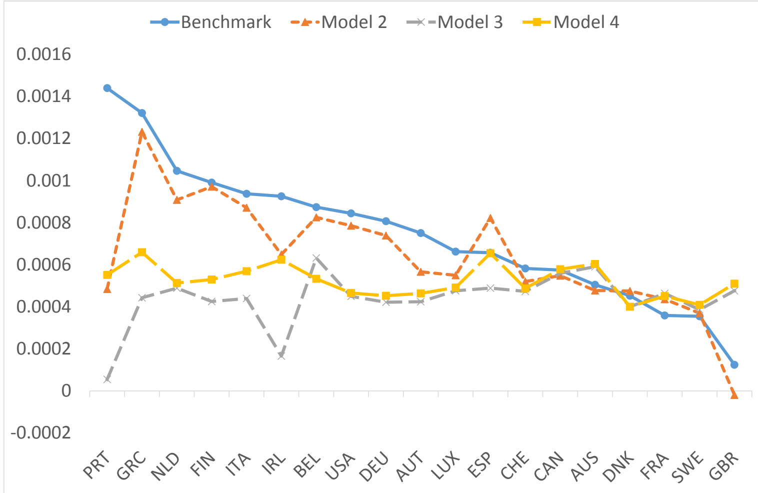
Because of a more positive labor outcome and fiscal impact, the benchmark model turns out to be the model version that predicts the highest increase in average native welfare when a skill-balanced immigration shock takes place in the considered OECD countries (see Table 5). As shown in Figure 4d, the average native welfare increases in all countries but Belgium, Denmark, France and Sweden under the benchmark model. The least optimistic version is Model 4, in which natives skill composition is exogenous and retirees are not accounted for, that predicts an increase in average native welfare for 13 of the considered 19 OECD countries.

Figure 4: Effects of skill-balanced immigration (1% of the total labor force) on 19 selected OECD countries

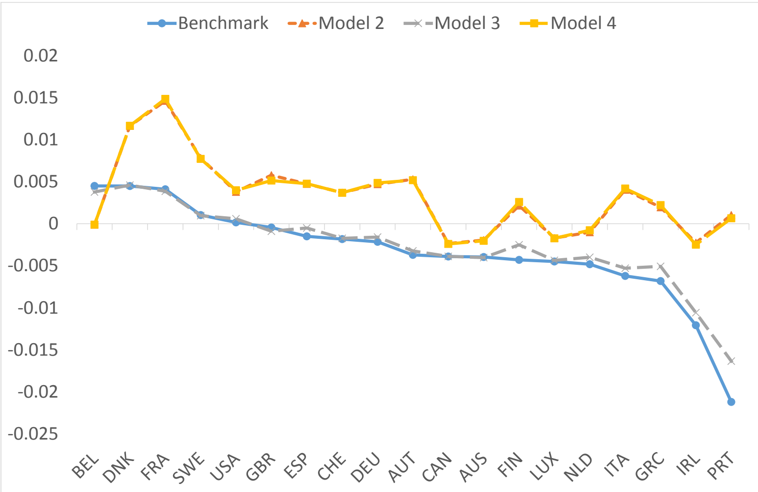
(a) Effect on avg. native unemployment rate



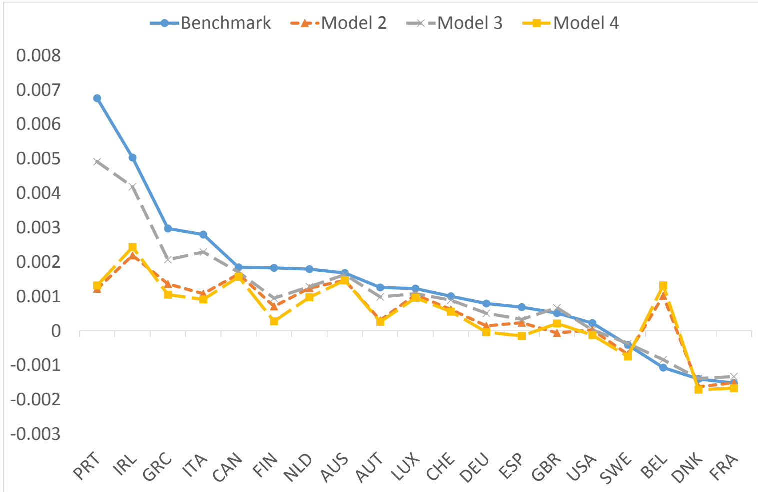
(b) Effect on avg. native wage



(c) Effect on labor income tax



(d) Effect on avg. native welfare



Note: Solid lines represent the benchmark model, whereas square-dotted, short-dashed and long-dashed lines represent Model 2, Model 3 and Model 4, respectively.

Table 5: Weighted average effects of skill-balanced immigration

Variable	Benchmark	Model 2	Model 3	Model 4
u_n	-0.022	0.117	0.019	0.126
w_n	0.072	0.067	0.045	0.05
τ	-0.133	0.454	-0.088	0.461
$\mathcal{W}_n$	0.07	0.018	0.048	0.006

Note: all values indicate variations in percentage points. Each country is weighted according to its native population size. Appendix B provides results for unweighted averages.

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 $\sigma_2 = 10000$ 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.

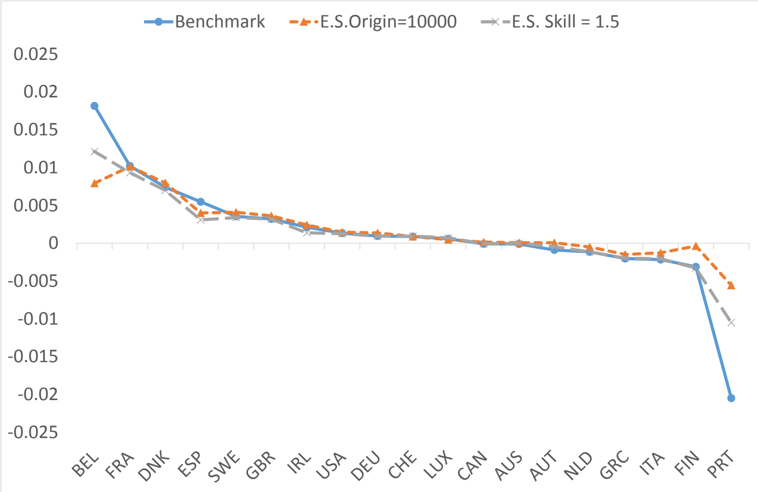
Figures 5, 6 and 7 illustrate the sensitivity of the immigration effects on labor market outcomes, labor income tax and average native welfare, under different calibrations of the benchmark model.

Let us start by considering the low-skilled immigration shock scenario (Figure 5). The unemployment rate is mostly insensitive to different parametrizations of σ_1 and σ_2 (see Figure 5a), with only Belgium and Portugal noticeably differing in the magnitude of effects, though not in the direction of the effects. Conversely, wage impacts are the ones that vary the most across different calibration (see Figure 5b), as σ_1 and σ_2 directly affect workers marginal productivity, and hence their wages. That being said, the countries ranking is mostly unaffected and the immigration effect on native wages is consistently positive even when the elasticity of substitution between immigrant and native workers tends to infinity. Results on the fiscal and native welfare impact are also rather robust (see Panels 5c and 5d), though calibrating $\sigma_2 = 10000$ yields, on average, slightly more pessimistic results, while setting $\sigma_1 = 1.5$ produces slightly more optimistic welfare gains.

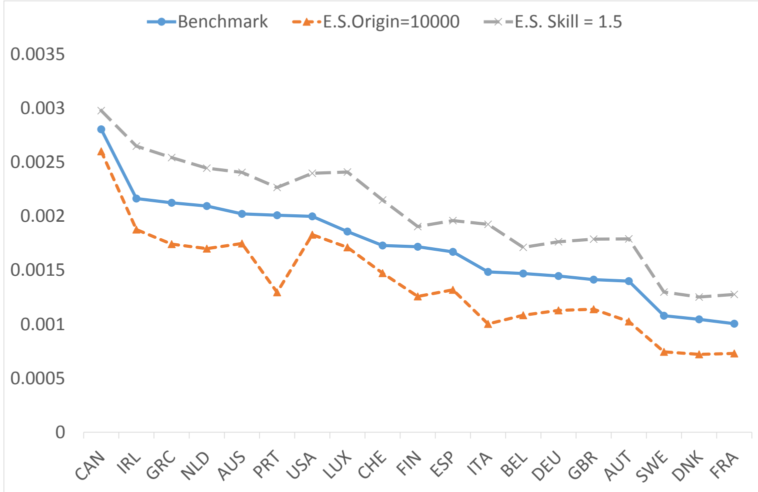
Let us now focus on the case in which the immigration shock is entirely characterized by high-skilled workers (Figure 6). The resulting effect of high-skilled immigration on the native unemployment rate is highly robust under different calibration choices of the elasticity parameters (see Figure 6a). Native wages effects vary across different parametrizations, with the benchmark one yielding the most optimistic results (see Figure 6b). However, despite the difference in magnitudes effect and countries rankings, under all parametrizations we find a decrease in average native wage in response to high-skilled immigration. Fiscal and Welfare effects are found to be

Figure 5: Effects of low-skilled immigration (1% of the total labor force) on 19 selected OECD countries - Sensitivity to parameters

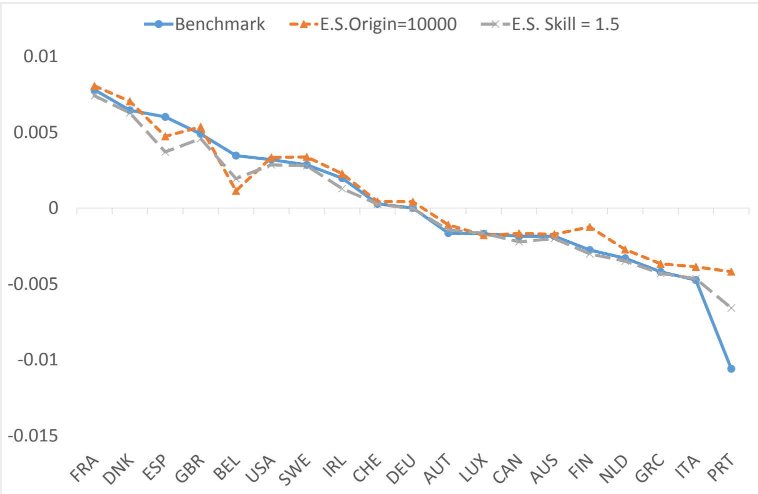
(a) Effect on avg. native unemployment rate



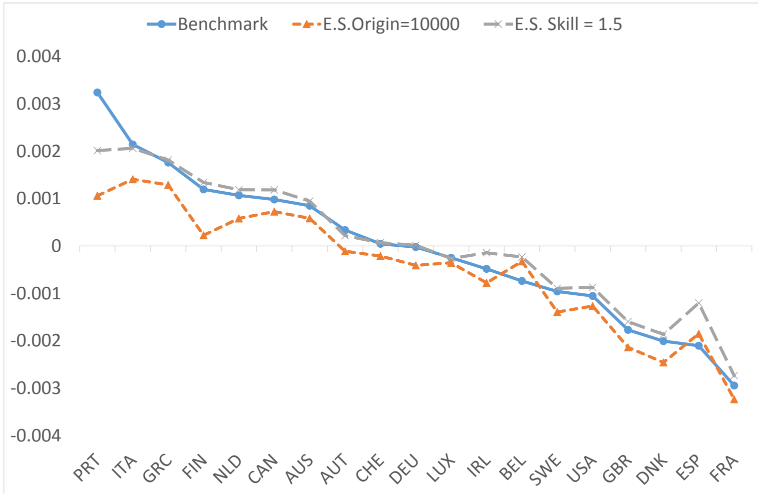
(b) Effect on avg. native wage



(c) Effect on labor income tax



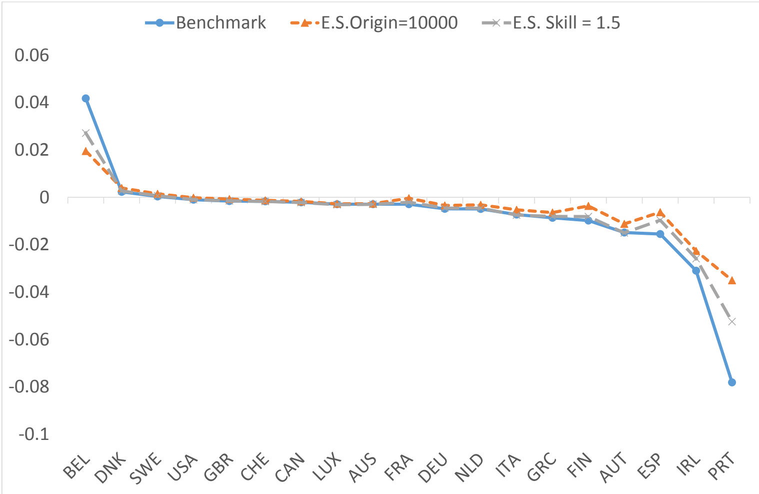
(d) Effect on avg. native welfare



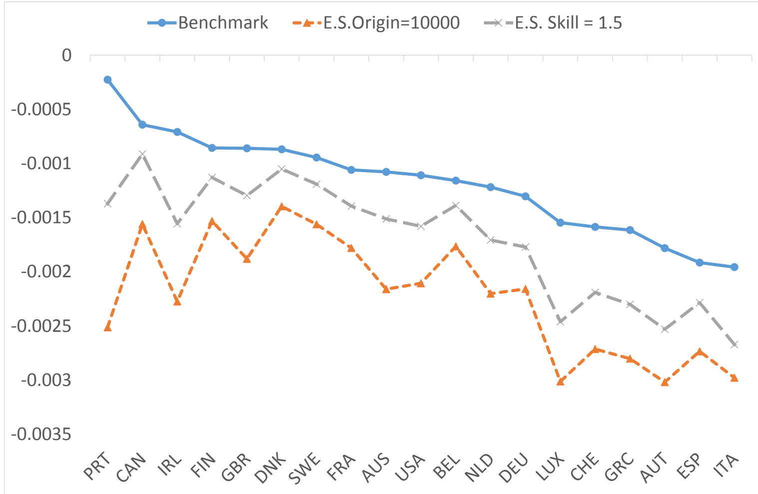
Note: Solid lines represent the benchmark parametrization, square-dotted lines indicates parametrization of $\sigma_1 = 10000$, dashed lines indicates parametrization of $\sigma_2 = 1.5$.

Figure 6: Effects of high-skilled immigration (1% of the total labor force) on 19 selected OECD countries - Sensitivity to parameters

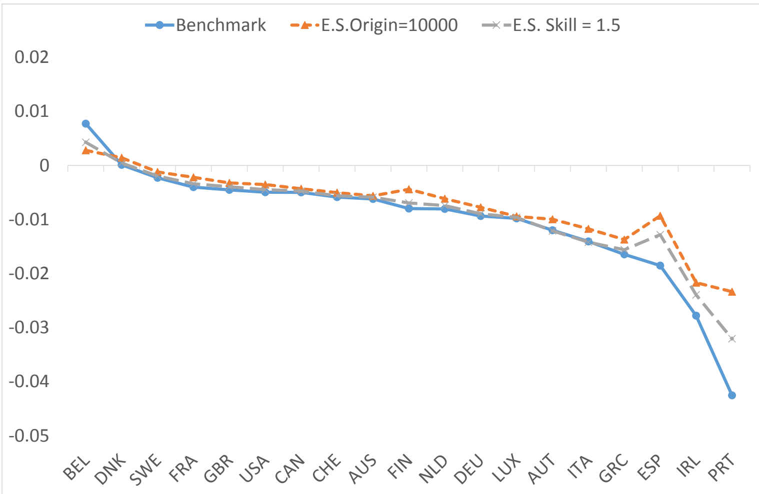
(a) Effect on avg. native unemployment rate



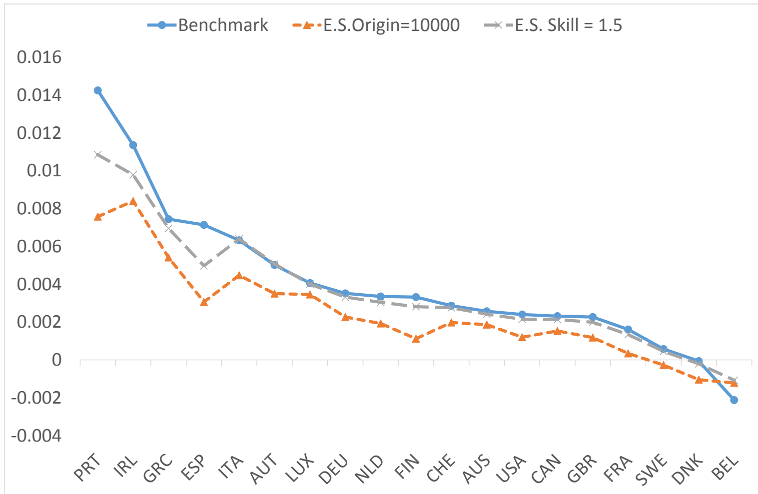
(b) Effect on avg. native wage



(c) Effect on labor income tax



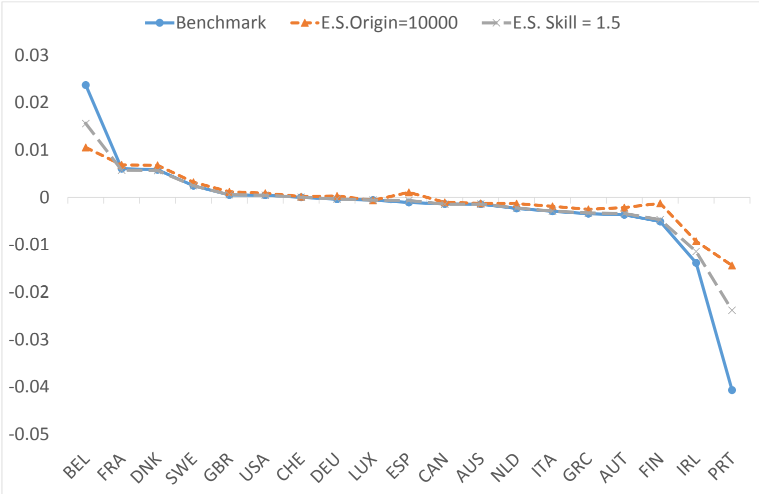
(d) Effect on avg. native welfare



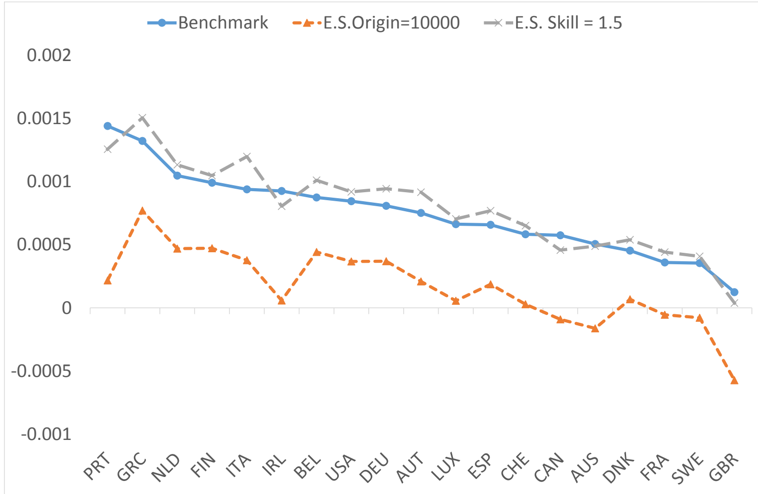
Note: Solid lines represent the benchmark parametrization, square-dotted lines indicates parametrization of $\sigma_1 = 10000$, dashed lines indicates parametrization of $\sigma_2 = 1.5$.

Figure 7: Effects of skill-balanced immigration (1% of the total labor force) on 19 selected OECD countries - Sensitivity to parameters

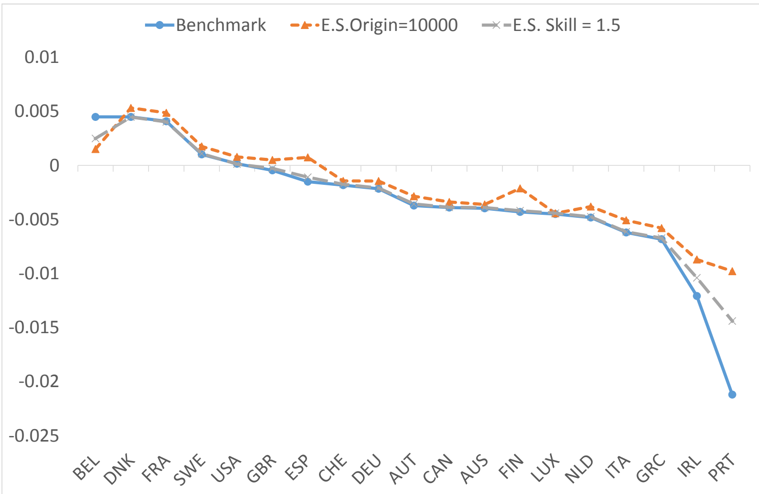
(a) Effect on avg. native unemployment rate



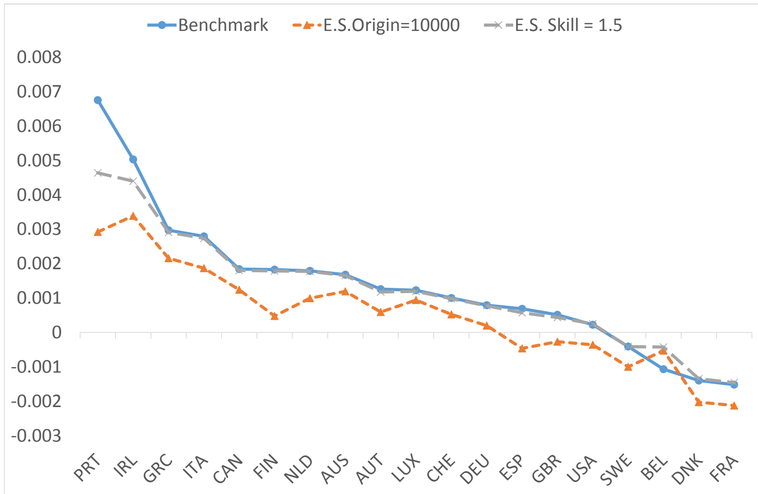
(b) Effect on avg. native wage



(c) Effect on labor income tax



(d) Effect on avg. native welfare



Note: Solid lines represent the benchmark parametrization, square-dotted lines indicates parametrization of $\sigma_1 = 10000$, dashed lines indicates parametrization of $\sigma_2 = 1.5$.

highly robust, with only Portugal and Spain noticeably varying across different parametrization choices (see Panels 6c and 6d).

Finally, we analyze how robust are our results in the case of a skill-balanced immigration shock (Figure 7). While native unemployment rate effects are highly robust in all countries but Portugal (see Figure 7a), native wages variations are sensible to the parametrization of the elasticity of substitution between migrant and native workers, σ_2 (see Figure 7b). Indeed, despite the countries ranking is mostly the same, the magnitude of the effects vary, so that when σ_2 tends to infinity, 5 out of 19 countries experience a negative native wage rate, whereas in the benchmark parametrization the native wages increase in all countries after the skill-balanced migration shock. As far as fiscal and welfare effects are concerned (Panels 7c and 7d), differences among different parametrizations are present but limited. In particular, setting $\sigma_2 = 10000$ we find that average native welfare decreases in 8 out of 19 countries, whereas in the benchmark parametrization it decreases in only 4 countries.

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 OECD countries considered. First, when young natives endogenously decide their education investment, natives are successfully able to avoid any displacement effect that a migration shock may generate. The only exception is for the case in which the migration shock consists of only low-skilled immigrants which, on average, generates a slight displacement effect. This latter negative effect is, however, offset by the increase on average native wages that takes place in all of the considered 19 countries. Second, migration influxes that include high-skilled workers have positive fiscal effects when age composition is taken into account. On the contrary, the other model versions that abstract 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 all countries but Belgium, Denmark, France and Sweden in response to a immigration shock that doesn't affect the observed immigrants education composition. However, these results change when the influx of migration is composed of only low-skilled workers, as only 9 of the analyzed 19 countries experience an increase in average welfare after the shock. Our results are mostly robust to sensitivity analysis on different degrees of substitution between workers of different skill and origin.

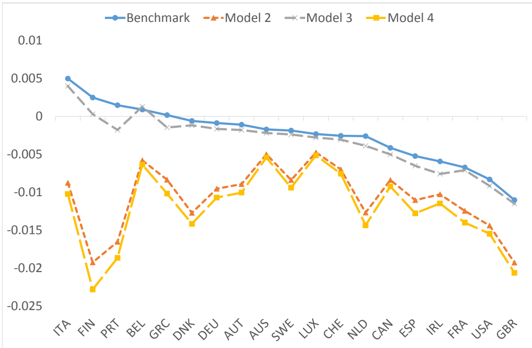
Our paper departs from a search model inspired by Battisti et al. (2018), in which we introduced intergenerational features. However, our analysis can still be extended to address several issues for future research. For example, one significant issue to be pursued in future work may be to allow for immigrants 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.

Appendix

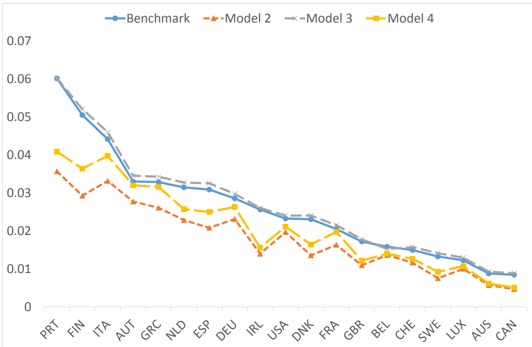
A Group-specific welfare effects

Figure 8: Immigration effect on avg. migrant welfare

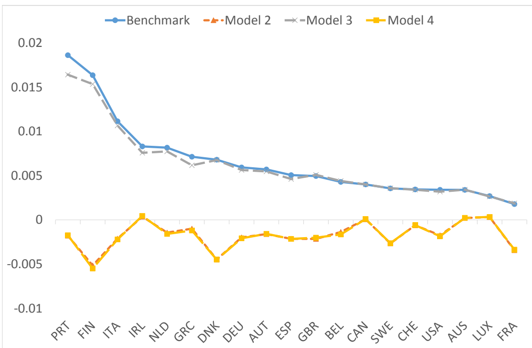
(a) Low-skilled immigration effect on migrants welfare



(b) High-skilled immigration effect on migrants welfare



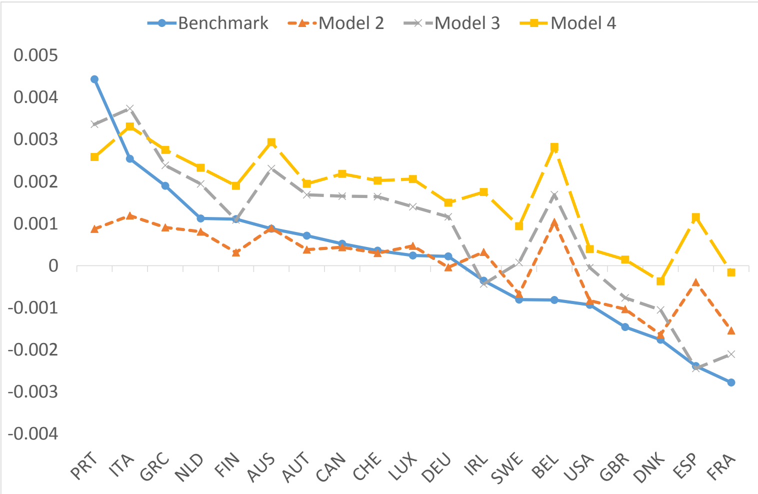
(c) Skill-balanced immigration effect on migrants welfare



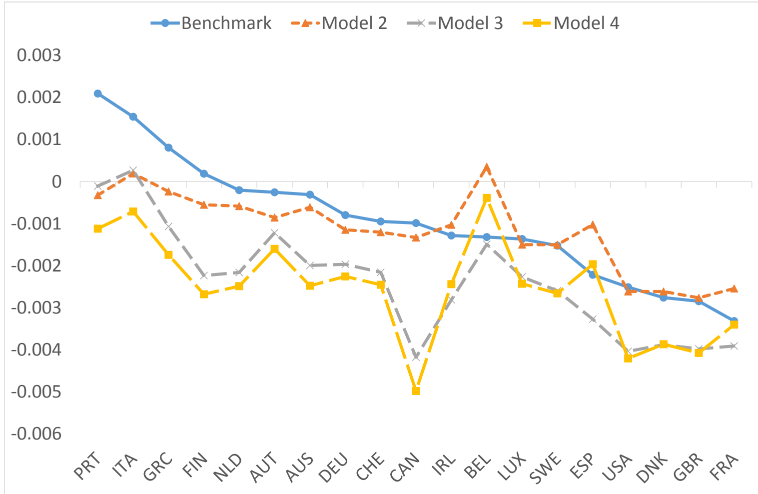
Note: we use the following average immigrant welfare index $\mathcal{W}_m \equiv (\sum_s E_{ms}\mathcal{J}^E_{ms} + \sum_s U_{ms}\mathcal{J}^U_{ms} + \sum_s R_{ms}\mathcal{J}^R_{ms})\ (\sum_s (Q_{ms} + R_{ms}))$.

Figure 9: Group-specific effects of low-skilled immigration (1% of the total labor force)

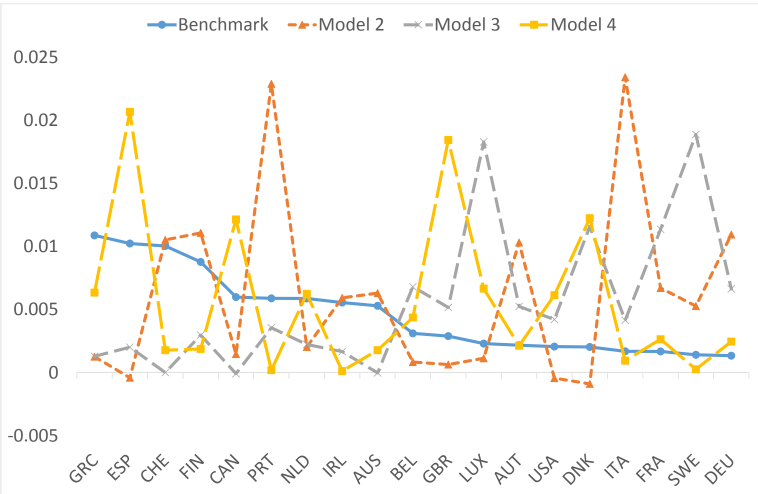
(a) High-skilled natives welfare



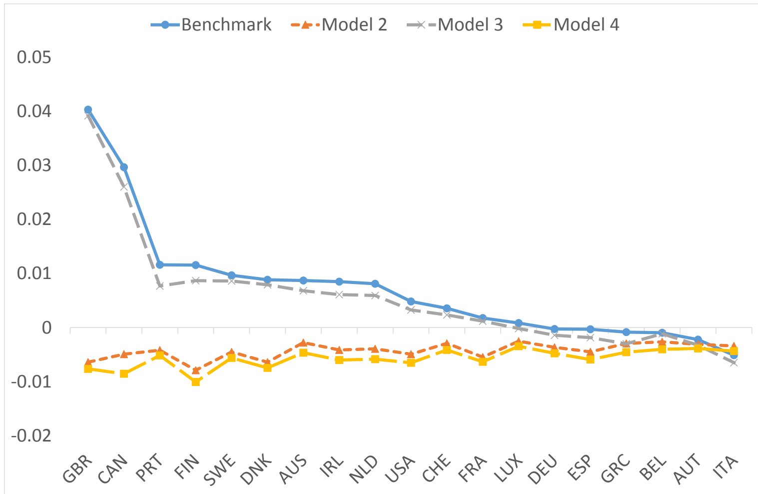
(b) Low-skilled natives welfare



(c) High-skilled immigrants welfare



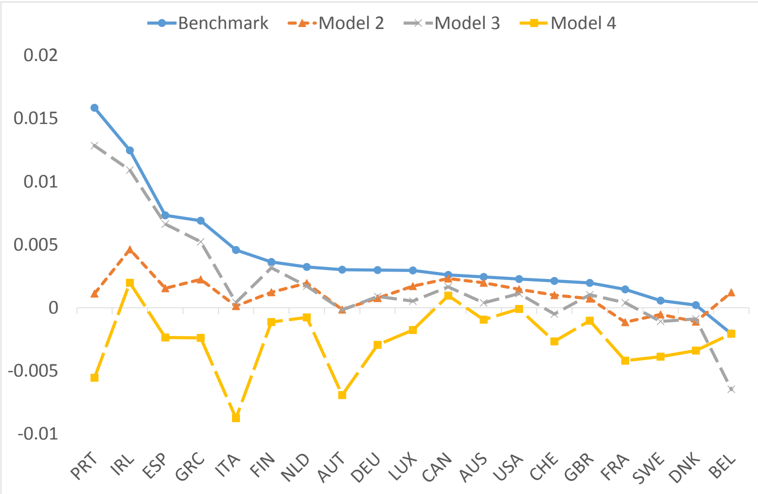
(d) Low-skilled immigrants welfare



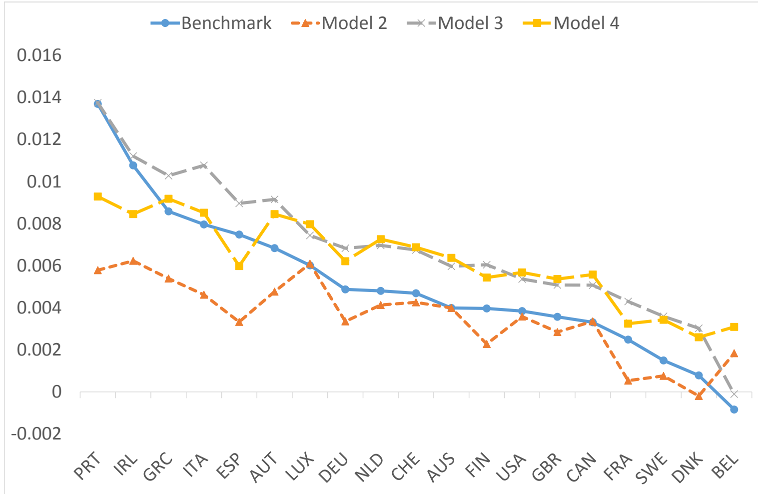
Note: we use the welfare index $\mathcal{W}_{nh} \equiv \frac{E_{nh}\mathcal{J}^E_{nh}+U_{nh}\mathcal{J}^U_{nh}-\frac{z^*}{2}Q_{nh}+R_{nh}\mathcal{J}^R_{nh}}{(Q_{nh}+R_{nh})}$ for native high-skilled; we use $\mathcal{W}_{os} \equiv \frac{E_{os}\mathcal{J}^E_{os}+U_{os}\mathcal{J}^U_{os}+R_{os}\mathcal{J}^R_{os}}{(Q_{os}+R_{os})}$ otherwise.

Figure 10: Group-specific effects of high-skilled immigration (1% of the total labor force)

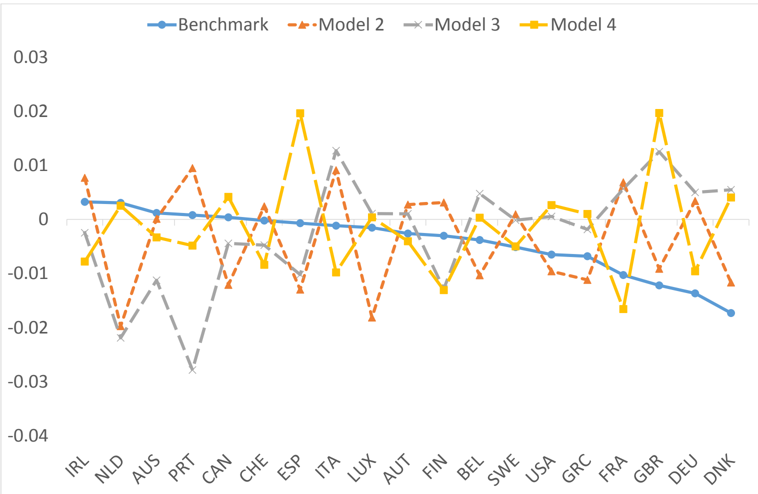
(a) High-skilled natives welfare



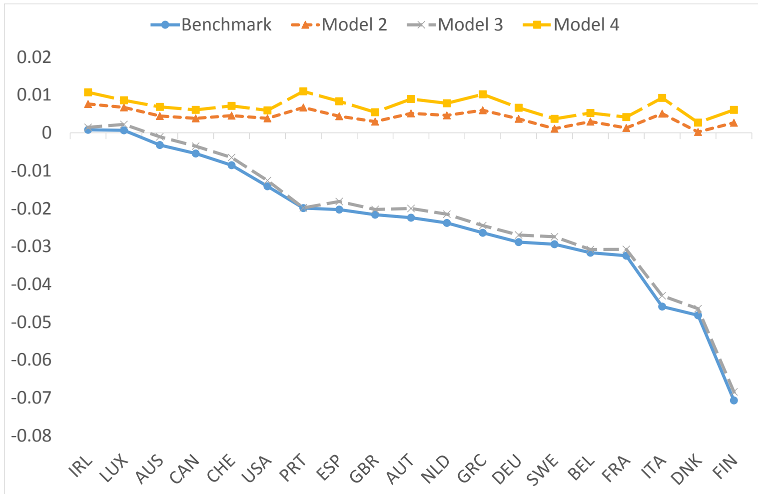
(b) Low-skilled natives welfare



(c) High-skilled immigrants welfare



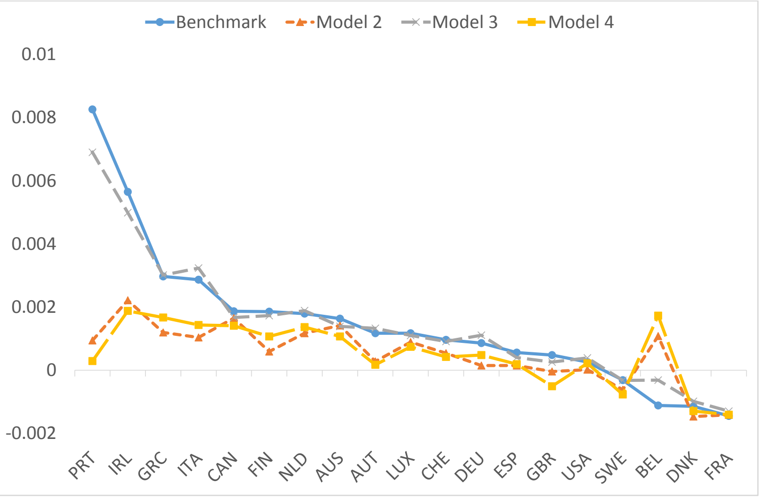
(d) Low-skilled immigrants welfare



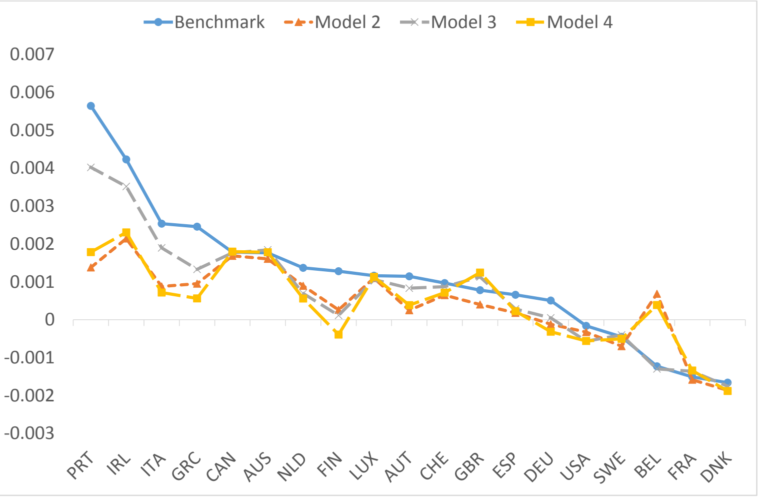
Note: we use the welfare index $\mathcal{W}_{nh} \equiv \frac{E_{nh}\mathcal{J}^{E}_{nh}+U_{nh}\mathcal{J}^{U}_{nh}-\frac{z^*}{2}Q_{nh}+R_{nh}\mathcal{J}^{R}_{nh}}{(Q_{nh}+R_{nh})}$ for native high-skilled; we use $\mathcal{W}_{os} \equiv \frac{E_{os}\mathcal{J}^{E}_{os}+U_{os}\mathcal{J}^{U}_{os}+R_{os}\mathcal{J}^{R}_{os}}{(Q_{os}+R_{os})}$ otherwise.

Figure 11: Group-specific effects of low-skilled immigration (1% of the total labor force)

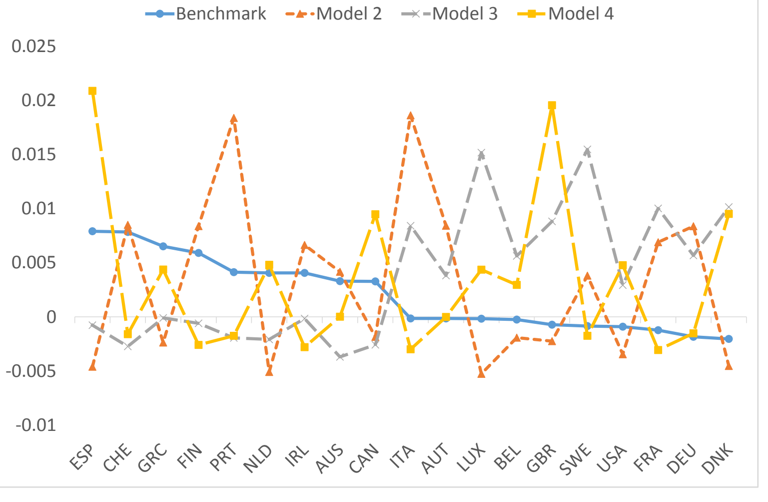
(a) High-skilled natives welfare



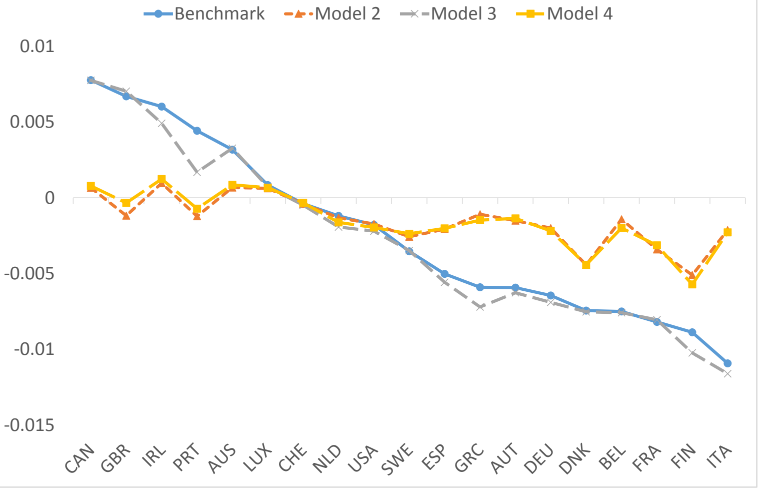
(b) Low-skilled natives welfare



(c) High-skilled immigrants welfare



(d) Low-skilled immigrants welfare

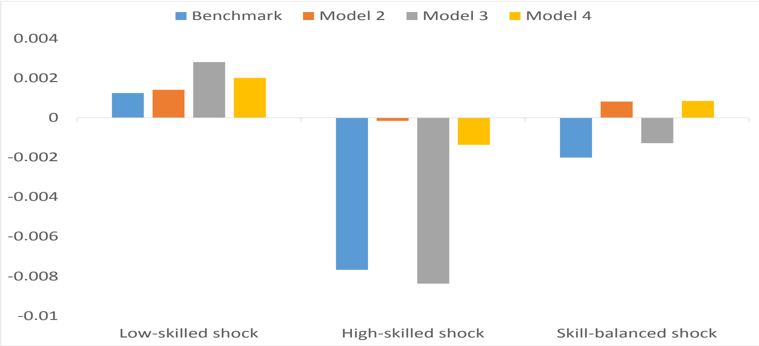


Note: we use the welfare index $\mathcal{W}_{nh} \equiv \frac{E_{nh}\mathcal{J}^E_{nh}+U_{nh}\mathcal{J}^U_{nh}-\frac{z^*}{2}Q_{nh}+R_{nh}\mathcal{J}^R_{nh}}{(Q_{nh}+R_{nh})}$ for native high-skilled; we use $\mathcal{W}_{os} \equiv \frac{E_{os}\mathcal{J}^E_{os}+U_{os}\mathcal{J}^U_{os}+R_{os}\mathcal{J}^R_{os}}{(Q_{os}+R_{os})}$ otherwise.

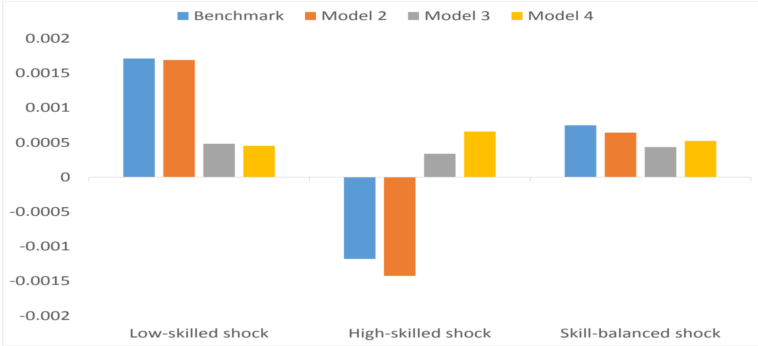
B Unweighted average effects of immigration

Figure 12: Unweighted average effects of immigration immigration (1% of the total labor force) on 19 selected OECD countries

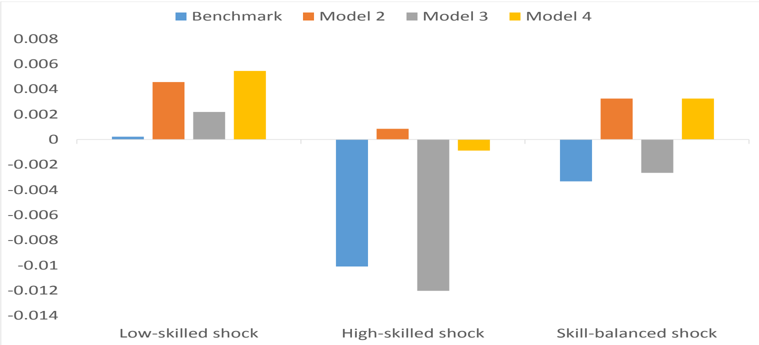
(a) Effect on avg. native unemployment rate



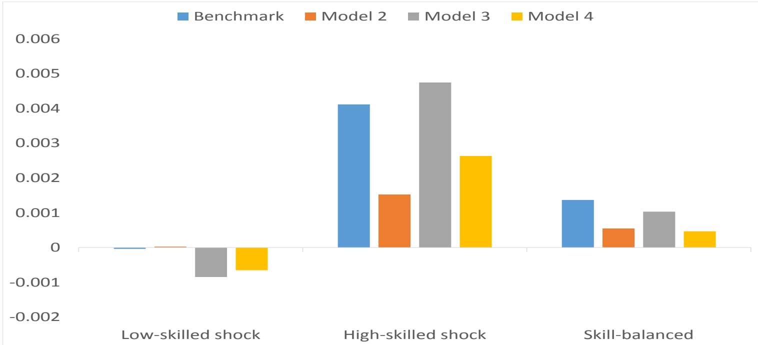
(b) Effect on avg. native wage



(c) Effect on labor income tax



(d) Effect on avg. native welfare



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